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# Matplotlib

*Release 3.1.1*

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**Part I**

**User's Guide**



## INSTALLING

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**Note:** If you wish to contribute to the project, it's recommended you *install the latest development version*.

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## 1.1 Installing an official release

Matplotlib and its dependencies are available as wheel packages for macOS, Windows and Linux distributions:

```
python -m pip install -U pip
python -m pip install -U matplotlib
```

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**Note:** The following backends work out of the box: Agg, ps, pdf, svg and TkAgg.

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For support of other GUI frameworks, LaTeX rendering, saving animations and a larger selection of file formats, you may need to install *additional dependencies*.

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Although not required, we suggest also installing IPython for interactive use. To easily install a complete Scientific Python stack, see *Scientific Python Distributions* below.

### 1.1.1 Test data

The wheels (\*.whl) on the [PyPI download page](#) do not contain test data or example code.

If you want to try the many demos that come in the Matplotlib source distribution, download the \*.tar.gz file and look in the `examples` subdirectory.

To run the test suite:

- extract the `lib/matplotlib/tests` or `lib/mpl_toolkits/tests` directories from the source distribution;
- install test dependencies: `pytest`, `Pillow`, `MiKTeX`, `GhostScript`, `ffmpeg`, `avconv`, `ImageMagick`, and `Inkscape`;
- run `python -mpytest`.

## 1.2 Third-party distributions of Matplotlib

### 1.2.1 Scientific Python Distributions

[Anaconda](#) and [Canopy](#) and [ActiveState](#) are excellent choices that “just work” out of the box for Windows, macOS and common Linux platforms. [WinPython](#) is an option for Windows users. All of these distributions include Matplotlib and *lots* of other useful (data) science tools.

### 1.2.2 Linux: using your package manager

If you are on Linux, you might prefer to use your package manager. Matplotlib is packaged for almost every major Linux distribution.

- Debian / Ubuntu: `sudo apt-get install python3-matplotlib`
- Fedora: `sudo dnf install python3-matplotlib`
- Red Hat: `sudo yum install python3-matplotlib`
- Arch: `sudo pacman -S python-matplotlib`

## 1.3 Installing from source

If you are interested in contributing to Matplotlib development, running the latest source code, or just like to build everything yourself, it is not difficult to build Matplotlib from source. Grab the latest *tar.gz* release file from [the PyPI files page](#), or if you want to develop Matplotlib or just need the latest bugfixed version, grab the latest git version, and see *Install from source*.

The standard environment variables `CC`, `CXX`, `PKG_CONFIG` are respected. This means you can set them if your toolchain is prefixed. This may be used for cross compiling.

```
export CC=x86_64-pc-linux-gnu-gcc
export CXX=x86_64-pc-linux-gnu-g++
export PKG_CONFIG=x86_64-pc-linux-gnu-pkg-config
```

Once you have satisfied the requirements detailed below (mainly Python, NumPy, libpng and FreeType), you can build Matplotlib.

```
cd matplotlib
python -mpip install .
```

We provide a [setup.cfg](#) file which you can use to customize the build process. For example, which default backend to use, whether some of the optional libraries that Matplotlib ships with are installed, and so on. This file will be particularly useful to those packaging Matplotlib.

If you have installed prerequisites to nonstandard places and need to inform Matplotlib where they are, edit `setupext.py` and add the base dirs to the `basedir` dictionary entry for your `sys.platform`; e.g., if the header of some required library is in `/some/path/include/someheader.h`, put `/some/path` in the `basedir` list for your platform.

### 1.3.1 Dependencies

Matplotlib requires the following dependencies:

- Python ( $\geq 3.6$ )
- FreeType ( $\geq 2.3$ )
- libpng ( $\geq 1.2$ )
- NumPy ( $\geq 1.11$ )
- `setuptools`
- `cycler` ( $\geq 0.10.0$ )
- `dateutil` ( $\geq 2.1$ )
- `kiwisolver` ( $\geq 1.0.0$ )
- `pyparsing`

Optionally, you can also install a number of packages to enable better user interface toolkits. See *What is a backend?* for more details on the optional Matplotlib backends and the capabilities they provide.

- `tk` ( $\geq 8.3$ ,  $\neq 8.6.0$  or  $8.6.1$ ): for the Tk-based backends;
- `PyQt4` ( $\geq 4.6$ ) or `PySide` ( $\geq 1.0.3$ ): for the Qt4-based backends;
- `PyQt5`: for the Qt5-based backends;
- `PyGObject`: for the GTK3-based backends;
- `wxpython` ( $\geq 4$ ): for the WX-based backends;
- `cairoffi` ( $\geq 0.8$ ) or `pycairo`: for the cairo-based backends;
- `Tornado`: for the WebAgg backend;

For better support of animation output format and image file formats, LaTeX, etc., you can install the following:

- `ffmpeg/avconv`: for saving movies;
- `ImageMagick`: for saving animated gifs;
- `Pillow` ( $\geq 3.4$ ): for a larger selection of image file formats: JPEG, BMP, and TIFF image files;
- `LaTeX` and `GhostScript` ( $\geq 9.0$ ): for rendering text with LaTeX.

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**Note:** Matplotlib depends on non-Python libraries.

On Linux and OSX, `pkg-config` can be used to find required non-Python libraries and thus make the install go more smoothly if the libraries and headers are not in the expected locations.

If not using `pkg-config` (in particular on Windows), you may need to set the include path (to the FreeType, libpng, and zlib headers) and link path (to the FreeType, libpng, and zlib libraries) explicitly, if they are not in standard locations. This can be done using standard environment variables - on Linux and OSX:

```
export CFLAGS='-I/directory/containing/ft2build.h ...'  
export LDFLAGS='-L/directory/containing/libfreetype.so ...'
```

and on Windows:

```
set CL=/IC:\directory\containing\ft2build.h ...  
set LINK=/LIBPATH:C:\directory\containing\freetype.lib ...
```

where ... means "also give, in the same format, the directories containing `png.h` and `zlib.h` for the include path, and for `libpng.so/png.lib` and `libz.so/z.lib` for the link path."

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**Note:** The following libraries are shipped with Matplotlib:

- `Agg`: the Anti-Grain Geometry C++ rendering engine;
- `qhull`: to compute Delaunay triangulation;
- `ttconv`: a TrueType font utility.

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### 1.3.2 Building on Linux

It is easiest to use your system package manager to install the dependencies.

If you are on Debian/Ubuntu, you can get all the dependencies required to build Matplotlib with:

```
sudo apt-get build-dep python-matplotlib
```

If you are on Fedora, you can get all the dependencies required to build Matplotlib with:

```
sudo dnf builddep python-matplotlib
```

If you are on RedHat, you can get all the dependencies required to build Matplotlib by first installing `yum-builddep` and then running:

```
su -c "yum-builddep python-matplotlib"
```

These commands do not build Matplotlib, but instead get and install the build dependencies, which will make building from source easier.

### 1.3.3 Building on macOS

The build situation on macOS is complicated by the various places one can get the libpng and FreeType requirements (MacPorts, Fink, /usr/X11R6), the different architectures (e.g., x86, ppc, universal), and the different macOS versions (e.g., 10.4 and 10.5). We recommend that you build the way we do for the macOS release: get the source from the tarball or the git repository and install the required dependencies through a third-party package manager. Two widely used package managers are Homebrew, and MacPorts. The following example illustrates how to install libpng and FreeType using brew:

```
brew install libpng freetype pkg-config
```

If you are using MacPorts, execute the following instead:

```
port install libpng freetype pkgconfig
```

After installing the above requirements, install Matplotlib from source by executing:

```
python -mpip install .
```

Note that your environment is somewhat important. Some conda users have found that, to run the tests, their PYTHONPATH must include /path/to/anaconda/.../site-packages and their DYLD\_FALLBACK\_LIBRARY\_PATH must include /path/to/anaconda/lib.

### 1.3.4 Building on Windows

The Python shipped from <https://www.python.org> is compiled with Visual Studio 2015 for 3.5+. Python extensions should be compiled with the same compiler, see e.g. <https://packaging.python.org/guides/packaging-binary-extensions/#setting-up-a-build-environment-on-windows> for how to set up a build environment.

Since there is no canonical Windows package manager, the methods for building FreeType, zlib, and libpng from source code are documented as a build script at [matplotlib-winbuild](#).

There are a few possibilities to build Matplotlib on Windows:

- Wheels via [matplotlib-winbuild](#)
- Wheels by using conda packages (see below)
- Conda packages (see below)

#### Wheel builds using conda packages

This is a wheel build, but we use conda packages to get all the requirements. The binary requirements (png, FreeType,...) are statically linked and therefore not needed during the wheel install.

Set up the conda environment. Note, if you want a qt backend, add `pyqt` to the list of conda packages.

```
conda create -n "matplotlib_build" python=3.7 numpy python-dateutil pyparsing tornado  
↳cycler tk libpng zlib freetype msinttypes  
conda activate matplotlib_build
```

For building, call the script `build_alllocal.cmd` in the root folder of the repository:

```
build_alllocal.cmd
```

### Conda packages

The conda packaging scripts for Matplotlib are available at <https://github.com/conda-forge/matplotlib-feedstock>.

## TUTORIALS

This page contains more in-depth guides for using Matplotlib. It is broken up into beginner, intermediate, and advanced sections, as well as sections covering specific topics.

For shorter examples, see our [examples page](#). You can also find [external resources](#) and a [FAQ](#) in our [user guide](#).

### 2.1 Introductory

These tutorials cover the basics of creating visualizations with Matplotlib, as well as some best-practices in using the package effectively.

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**Note:** Click [here](#) to download the full example code

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#### 2.1.1 Usage Guide

This tutorial covers some basic usage patterns and best-practices to help you get started with Matplotlib.

##### General Concepts

`matplotlib` has an extensive codebase that can be daunting to many new users. However, most of `matplotlib` can be understood with a fairly simple conceptual framework and knowledge of a few important points.

Plotting requires action on a range of levels, from the most general (e.g., 'contour this 2-D array') to the most specific (e.g., 'color this screen pixel red'). The purpose of a plotting package is to assist you in visualizing your data as easily as possible, with all the necessary control - that is, by using relatively high-level commands most of the time, and still have the ability to use the low-level commands when needed.

Therefore, everything in `matplotlib` is organized in a hierarchy. At the top of the hierarchy is the `matplotlib` "state-machine environment" which is provided by the `matplotlib.pyplot` module. At this level, simple functions are used to add plot elements (lines, images, text, etc.) to the current axes in the current figure.

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**Note:** Pyplot's state-machine environment behaves similarly to MATLAB and should be most familiar to users with MATLAB experience.

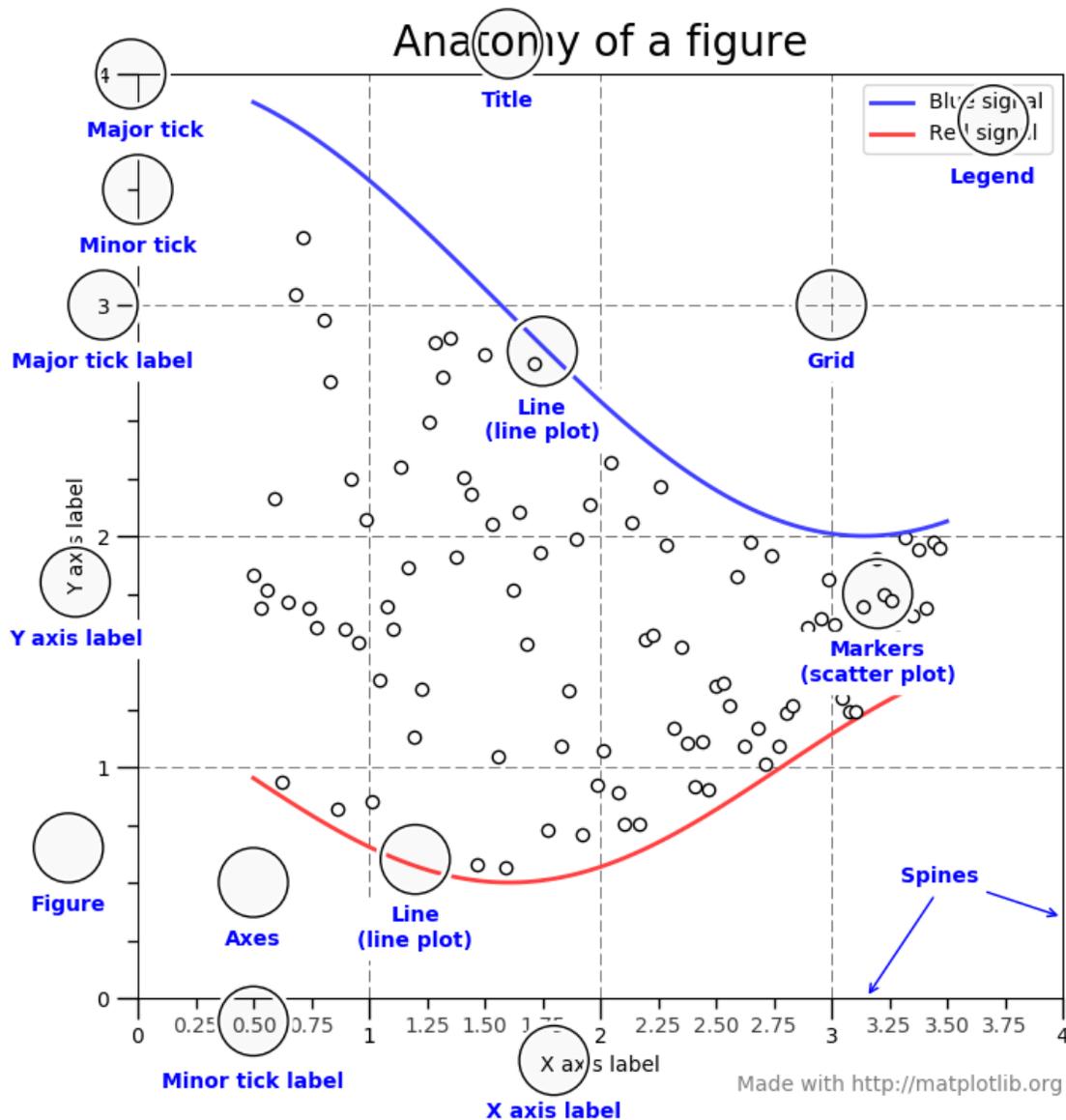
---

The next level down in the hierarchy is the first level of the object-oriented interface, in which pyplot is used only for a few functions such as figure creation, and the user explicitly creates and keeps track of the figure and axes objects. At this level, the user uses pyplot to create figures, and through those figures, one or more axes objects can be created. These axes objects are then used for most plotting actions.

For even more control - which is essential for things like embedding matplotlib plots in GUI applications - the pyplot level may be dropped completely, leaving a purely object-oriented approach.

```
# sphinx_gallery_thumbnail_number = 3
import matplotlib.pyplot as plt
import numpy as np
```

## Parts of a Figure



Figure

The **whole** figure. The figure keeps track of all the child *Axes*, a smattering of 'special' artists (titles, figure legends, etc), and the **canvas**. (Don't worry too much about the canvas, it is crucial as it is the object that actually does the drawing to get you your plot, but as the user it is more-or-less invisible to you). A figure can have any number of *Axes*, but to be useful should have at least one.

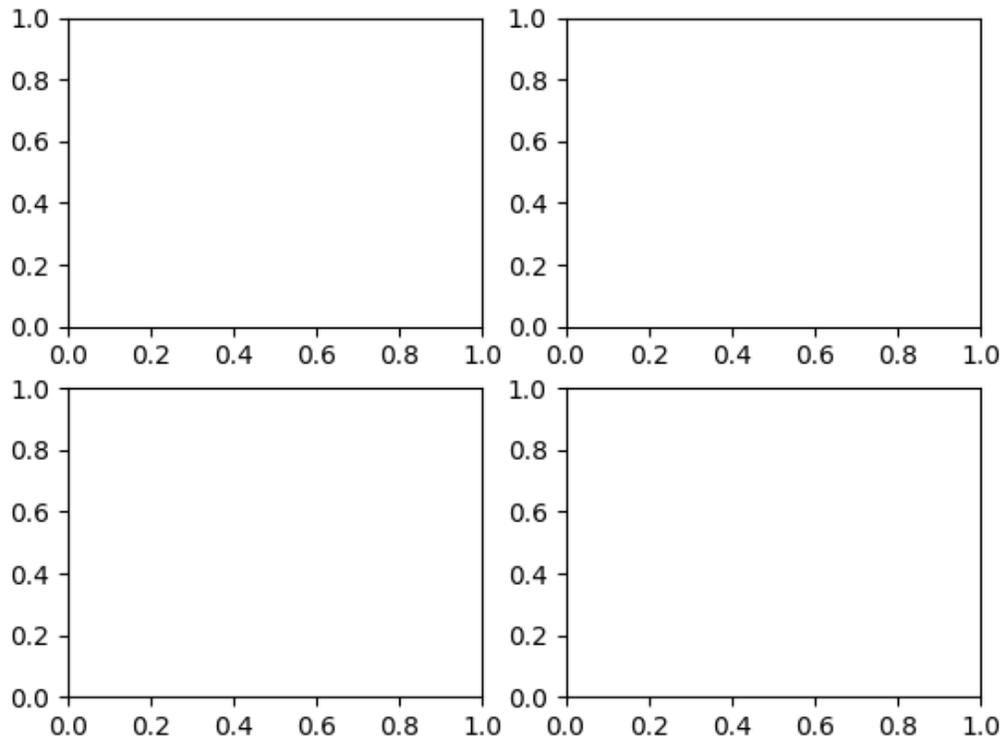
The easiest way to create a new figure is with `pyplot`:

```
fig = plt.figure() # an empty figure with no axes
fig.suptitle('No axes on this figure') # Add a title so we know which it is

fig, ax_lst = plt.subplots(2, 2) # a figure with a 2x2 grid of Axes
```

No axes on this figure

•



•

### Axes

This is what you think of as 'a plot', it is the region of the image with the data space. A given figure can contain many *Axes*, but a given *Axes* object can only be in one *Figure*. The *Axes* contains two (or three in the case of 3D) *Axis* objects (be aware of the difference between **Axes** and **Axis**) which take care of the data limits (the data limits can also be controlled via set via the `set_xlim()` and `set_ylim()` *Axes* methods). Each *Axes* has a title (set via `set_title()`), an x-label (set via `set_xlabel()`), and a y-label set via `set_ylabel()`.

The *Axes* class and it's member functions are the primary entry point to working with the OO interface.

### Axis

These are the number-line-like objects. They take care of setting the graph limits and generating the ticks (the marks on the axis) and ticklabels (strings labeling the ticks). The location of the ticks is determined by a *Locator* object and the ticklabel strings are formatted by a *Formatter*. The combination of the correct *Locator* and *Formatter* gives very fine control over the tick locations and labels.

### Artist

Basically everything you can see on the figure is an artist (even the Figure, Axes, and Axis objects). This includes Text objects, Line2D objects, collection objects, Patch objects ... (you get the idea). When the figure is rendered, all of the artists are drawn to the **canvas**. Most Artists are tied to an Axes; such an Artist cannot be shared by multiple Axes, or moved from one to another.

### Types of inputs to plotting functions

All of plotting functions expect `np.array` or `np.ma.masked_array` as input. Classes that are 'array-like' such as `pandas` data objects and `np.matrix` may or may not work as intended. It is best to convert these to `np.array` objects prior to plotting.

For example, to convert a `pandas.DataFrame`

```
a = pandas.DataFrame(np.random.rand(4,5), columns = list('abcde'))
a_asarray = a.values
```

and to convert a `np.matrix`

```
b = np.matrix([[1,2],[3,4]])
b_asarray = np.asarray(b)
```

### Matplotlib, pyplot and pylab: how are they related?

Matplotlib is the whole package and `matplotlib.pyplot` is a module in Matplotlib.

For functions in the `pyplot` module, there is always a "current" figure and axes (which is created automatically on request). For example, in the following example, the first call to `plt.plot` creates the axes, then subsequent calls to `plt.plot` add additional lines on the same axes, and `plt.xlabel`, `plt.ylabel`, `plt.title` and `plt.legend` set the axes labels and title and add a legend.

```
x = np.linspace(0, 2, 100)

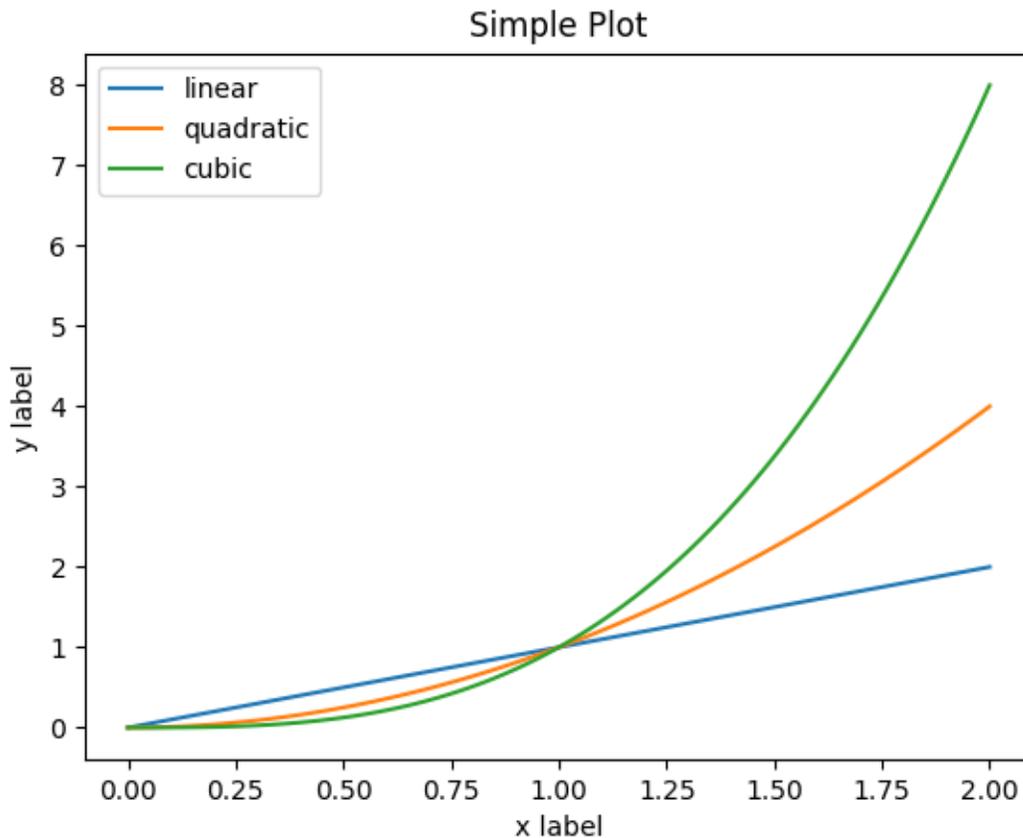
plt.plot(x, x, label='linear')
plt.plot(x, x**2, label='quadratic')
plt.plot(x, x**3, label='cubic')

plt.xlabel('x label')
plt.ylabel('y label')

plt.title("Simple Plot")

plt.legend()

plt.show()
```



`pylab` is a convenience module that bulk imports `matplotlib.pyplot` (for plotting) and `numpy` (for mathematics and working with arrays) in a single namespace. `pylab` is deprecated and its use is strongly discouraged because of namespace pollution. Use `pyplot` instead.

For non-interactive plotting it is suggested to use `pyplot` to create the figures and then the OO interface for plotting.

### Coding Styles

When viewing this documentation and examples, you will find different coding styles and usage patterns. These styles are perfectly valid and have their pros and cons. Just about all of the examples can be converted into another style and achieve the same results. The only caveat is to avoid mixing the coding styles for your own code.

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**Note:** Developers for `matplotlib` have to follow a specific style and guidelines. See *The Matplotlib Developers' Guide*.

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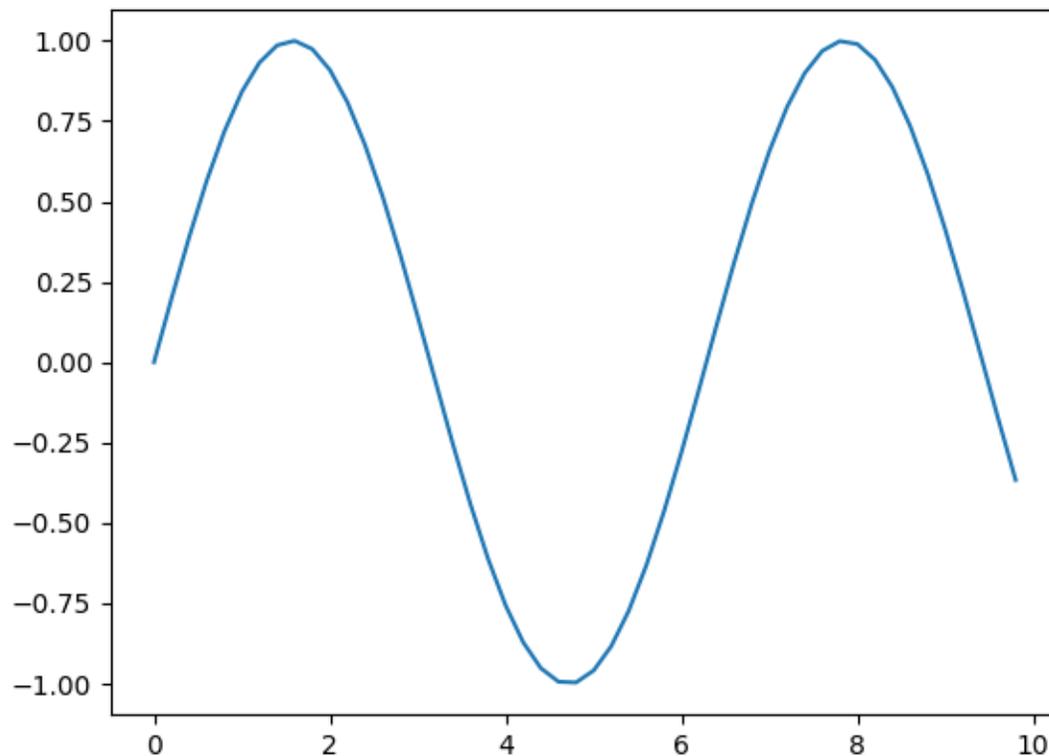
Of the different styles, there are two that are officially supported. Therefore, these are the preferred ways to use `matplotlib`.

For the `pyplot` style, the imports at the top of your scripts will typically be:

```
import matplotlib.pyplot as plt
import numpy as np
```

Then one calls, for example, `np.arange`, `np.zeros`, `np.pi`, `plt.figure`, `plt.plot`, `plt.show`, etc. Use the pyplot interface for creating figures, and then use the object methods for the rest:

```
x = np.arange(0, 10, 0.2)
y = np.sin(x)
fig, ax = plt.subplots()
ax.plot(x, y)
plt.show()
```



So, why all the extra typing instead of the MATLAB-style (which relies on global state and a flat namespace)? For very simple things like this example, the only advantage is academic: the wordier styles are more explicit, more clear as to where things come from and what is going on. For more complicated applications, this explicitness and clarity becomes increasingly valuable, and the richer and more complete object-oriented interface will likely make the program easier to write and maintain.

Typically one finds oneself making the same plots over and over again, but with different data sets, which leads to needing to write specialized functions to do the plotting. The recommended function signature is something like:

```
def my_plotter(ax, data1, data2, param_dict):
    """
    A helper function to make a graph

    Parameters
    -----
    ax : Axes
        The axes to draw to

    data1 : array
        The x data

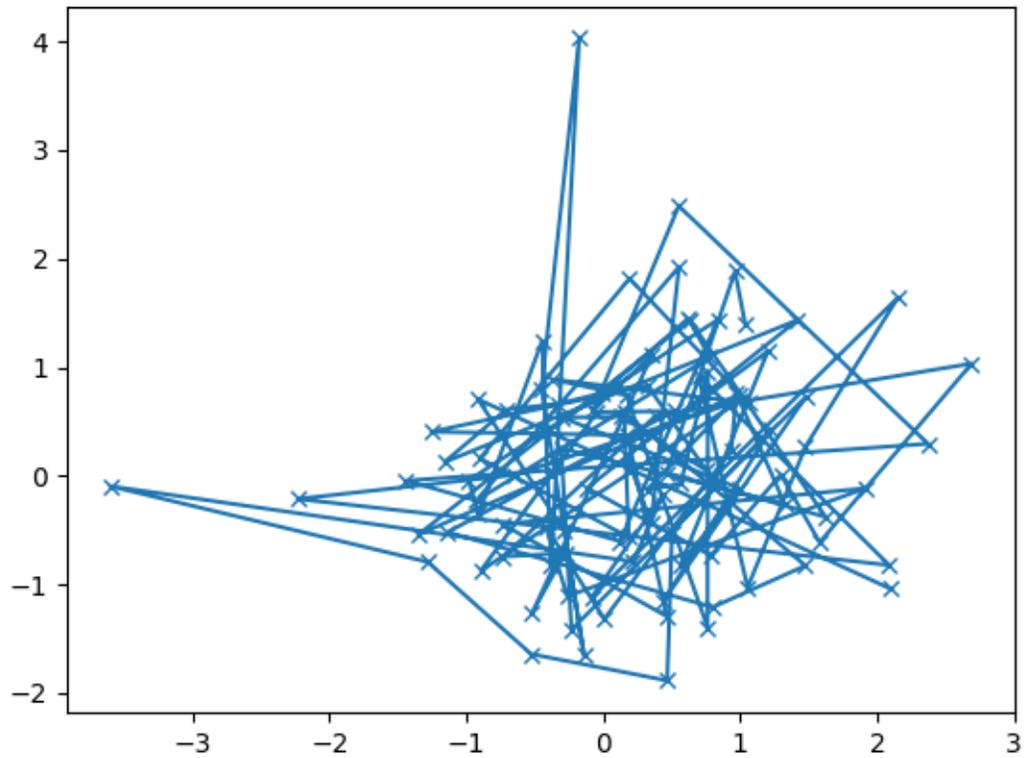
    data2 : array
        The y data

    param_dict : dict
        Dictionary of kwargs to pass to ax.plot

    Returns
    -----
    out : list
        list of artists added
    """
    out = ax.plot(data1, data2, **param_dict)
    return out

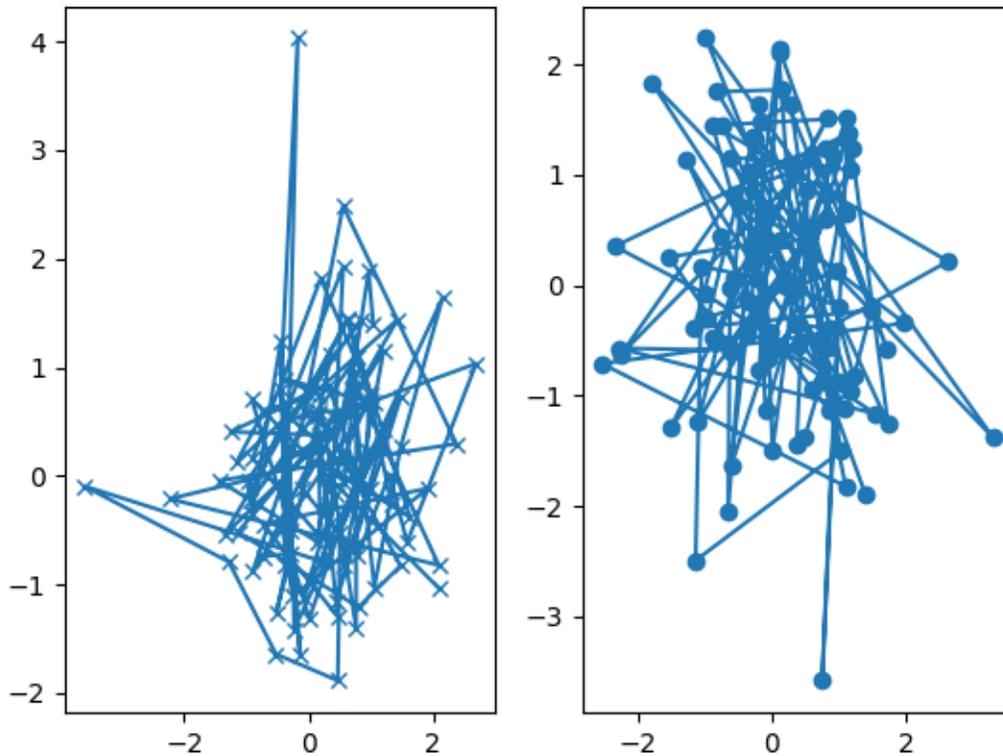
# which you would then use as:

data1, data2, data3, data4 = np.random.randn(4, 100)
fig, ax = plt.subplots(1, 1)
my_plotter(ax, data1, data2, {'marker': 'x'})
```



or if you wanted to have 2 sub-plots:

```
fig, (ax1, ax2) = plt.subplots(1, 2)
my_plotter(ax1, data1, data2, {'marker': 'x'})
my_plotter(ax2, data3, data4, {'marker': 'o'})
```



Again, for these simple examples this style seems like overkill, however once the graphs get slightly more complex it pays off.

## Backends

### What is a backend?

A lot of documentation on the website and in the mailing lists refers to the “backend” and many new users are confused by this term. matplotlib targets many different use cases and output formats. Some people use matplotlib interactively from the python shell and have plotting windows pop up when they type commands. Some people run [Jupyter](#) notebooks and draw inline plots for quick data analysis. Others embed matplotlib into graphical user interfaces like wxpython or pygtk to build rich applications. Some people use matplotlib in batch scripts to generate postscript images from numerical simulations, and still others run web application servers to dynamically serve up graphs.

To support all of these use cases, matplotlib can target different outputs, and each of these capabilities is called a backend; the “frontend” is the user facing code, i.e., the plotting code, whereas the “backend” does all the hard work behind-the-scenes to make the figure. There are two types of backends: user interface backends (for use in pygtk, wxpython, tkinter, qt4, or macosx; also referred to as “interactive backends”) and hardcopy backends to make image files (PNG, SVG, PDF, PS; also referred to as “non-interactive backends”).

There are four ways to configure your backend. If they conflict each other, the method men-

tioned last in the following list will be used, e.g. calling `use()` will override the setting in your `matplotlibrc`.

1. The backend parameter in your `matplotlibrc` file (see *Customizing Matplotlib with style sheets and rcParams*):

```
backend : WXAgg    # use wxpython with antigrain (agg) rendering
```

2. Setting the `MPLBACKEND` environment variable, either for your current shell or for a single script. On Unix:

```
> export MPLBACKEND=module://my_backend
> python simple_plot.py

> MPLBACKEND="module://my_backend" python simple_plot.py
```

On Windows, only the former is possible:

```
> set MPLBACKEND=module://my_backend
> python simple_plot.py
```

Setting this environment variable will override the backend parameter in *any* `matplotlibrc`, even if there is a `matplotlibrc` in your current working directory. Therefore setting `MPLBACKEND` globally, e.g. in your `.bashrc` or `.profile`, is discouraged as it might lead to counter-intuitive behavior.

3. If your script depends on a specific backend you can use the `use()` function:

```
import matplotlib
matplotlib.use('PS')    # generate postscript output by default
```

If you use the `use()` function, this must be done before importing `matplotlib.pyplot`. Calling `use()` after `pyplot` has been imported will have no effect. Using `use()` will require changes in your code if users want to use a different backend. Therefore, you should avoid explicitly calling `use()` unless absolutely necessary.

---

**Note:** Backend name specifications are not case-sensitive; e.g., `'GTK3Agg'` and `'gtk3agg'` are equivalent.

---

With a typical installation of `matplotlib`, such as from a binary installer or a linux distribution package, a good default backend will already be set, allowing both interactive work and plotting from scripts, with output to the screen and/or to a file, so at least initially you will not need to use any of the methods given above.

If, however, you want to write graphical user interfaces, or a web application server (*Matplotlib in a web application server*), or need a better understanding of what is going on, read on. To make things a little more customizable for graphical user interfaces, `matplotlib` separates the concept of the renderer (the thing that actually does the drawing) from the canvas (the place where the drawing goes). The canonical renderer for user interfaces is `Agg` which uses the [Anti-Grain Geometry C++](#) library to make a raster (pixel) image of the figure. All of the user interfaces except `macosx` can be used with `agg` rendering, e.g., `WXAgg`, `GTK3Agg`, `QT4Agg`, `QT5Agg`, `TkAgg`. In addition, some of the user interfaces support other rendering engines. For example, with `GTK+ 3`, you can also select `Cairo` rendering (backend `GTK3Cairo`).

For the rendering engines, one can also distinguish between `vector` or `raster` renderers. Vector graphics languages issue drawing commands like "draw a line from this point to this

point” and hence are scale free, and raster backends generate a pixel representation of the line whose accuracy depends on a DPI setting.

Here is a summary of the matplotlib renderers (there is an eponymous backend for each; these are *non-interactive backends*, capable of writing to a file):

Renderer	Filetypes	Description
<i>AGG</i>	<i>png</i>	<i>raster graphics</i> - high quality images using the <a href="#">Anti-Grain Geometry</a> engine
PS	<i>ps eps</i>	<i>vector graphics</i> - <a href="#">Postscript</a> output
PDF	<i>pdf</i>	<i>vector graphics</i> - <a href="#">Portable Document Format</a>
SVG	<i>svg</i>	<i>vector graphics</i> - <a href="#">Scalable Vector Graphics</a>
<i>Cairo</i>	<i>png ps pdf svg</i>	<i>raster graphics</i> and <i>vector graphics</i> - using the <a href="#">Cairo graphics</a> library

And here are the user interfaces and renderer combinations supported; these are *interactive backends*, capable of displaying to the screen and of using appropriate renderers from the table above to write to a file:

Backend	Description
Qt5Agg	Agg rendering in a <i>Qt5</i> canvas (requires <a href="#">PyQt5</a> ). This backend can be activated in IPython with <code>%matplotlib qt5</code> .
ipympl	Agg rendering embedded in a Jupyter widget. (requires <code>ipympl</code> ). This backend can be enabled in a Jupyter notebook with <code>%matplotlib ipympl</code> .
GTK3Agg	Agg rendering to a <i>GTK 3.x</i> canvas (requires <a href="#">PyGObject</a> , and <code>pycairo</code> or <code>cairocffi</code> ). This backend can be activated in IPython with <code>%matplotlib gtk3</code> .
macosx	Agg rendering into a Cocoa canvas in OSX. This backend can be activated in IPython with <code>%matplotlib osx</code> .
TkAgg	Agg rendering to a <i>Tk</i> canvas (requires <a href="#">TkInter</a> ). This backend can be activated in IPython with <code>%matplotlib tk</code> .
nbAgg	Embed an interactive figure in a Jupyter classic notebook. This backend can be enabled in Jupyter notebooks via <code>%matplotlib notebook</code> .
WebAgg	On <code>show()</code> will start a tornado server with an interactive figure.
GTK3Cairo	Cairo rendering to a <i>GTK 3.x</i> canvas (requires <a href="#">PyGObject</a> , and <code>pycairo</code> or <code>cairocffi</code> ).
Qt4Agg	Agg rendering to a <i>Qt4</i> canvas (requires <a href="#">PyQt4</a> or <code>pyside</code> ). This backend can be activated in IPython with <code>%matplotlib qt4</code> .
WXAgg	Agg rendering to a <i>wxWidgets</i> canvas (requires <a href="#">wxPython 4</a> ). This backend can be activated in IPython with <code>%matplotlib wx</code> .

## ipympl

The Jupyter widget ecosystem is moving too fast to support directly in Matplotlib. To install `ipympl`

```
pip install ipympl
jupyter nbextension enable --py --sys-prefix ipympl
```

or

```
conda install ipympl -c conda-forge
```

See [jupyter-matplotlib](#) for more details.

### GTK and Cairo

GTK3 backends (*both* `GTK3Agg` and `GTK3Cairo`) depend on Cairo (`pycairo`  $\geq$  1.11.0 or `cairocffi`).

### How do I select PyQt4 or PySide?

The `QT_API` environment variable can be set to either `pyqt` or `pyside` to use PyQt4 or PySide, respectively.

Since the default value for the bindings to be used is PyQt4, `matplotlib` first tries to import it, if the import fails, it tries to import PySide.

### What is interactive mode?

Use of an interactive backend (see *What is a backend?*) permits—but does not by itself require or ensure—plotting to the screen. Whether and when plotting to the screen occurs, and whether a script or shell session continues after a plot is drawn on the screen, depends on the functions and methods that are called, and on a state variable that determines whether `matplotlib` is in “interactive mode”. The default Boolean value is set by the `matplotlibrc` file, and may be customized like any other configuration parameter (see *Customizing Matplotlib with style sheets and rcParams*). It may also be set via `matplotlib.interactive()`, and its value may be queried via `matplotlib.is_interactive()`. Turning interactive mode on and off in the middle of a stream of plotting commands, whether in a script or in a shell, is rarely needed and potentially confusing, so in the following we will assume all plotting is done with interactive mode either on or off.

---

**Note:** Major changes related to interactivity, and in particular the role and behavior of `show()`, were made in the transition to `matplotlib` version 1.0, and bugs were fixed in 1.0.1. Here we describe the version 1.0.1 behavior for the primary interactive backends, with the partial exception of `macosx`.

---

Interactive mode may also be turned on via `matplotlib.pyplot.ion()`, and turned off via `matplotlib.pyplot.ioff()`.

---

**Note:** Interactive mode works with suitable backends in `ipython` and in the ordinary python shell, but it does *not* work in the IDLE IDE. If the default backend does not support interactivity, an interactive backend can be explicitly activated using any of the methods discussed in *What is a backend?*

---

### Interactive example

From an ordinary python prompt, or after invoking `ipython` with no options, try this:

```
import matplotlib.pyplot as plt
plt.ion()
plt.plot([1.6, 2.7])
```

Assuming you are running version 1.0.1 or higher, and you have an interactive backend installed and selected by default, you should see a plot, and your terminal prompt should also be active; you can type additional commands such as:

```
plt.title("interactive test")
plt.xlabel("index")
```

and you will see the plot being updated after each line. Since version 1.5, modifying the plot by other means *should* also automatically update the display on most backends. Get a reference to the *Axes* instance, and call a method of that instance:

```
ax = plt.gca()
ax.plot([3.1, 2.2])
```

If you are using certain backends (like `macosx`), or an older version of matplotlib, you may not see the new line added to the plot immediately. In this case, you need to explicitly call `draw()` in order to update the plot:

```
plt.draw()
```

### Non-interactive example

Start a fresh session as in the previous example, but now turn interactive mode off:

```
import matplotlib.pyplot as plt
plt.ioff()
plt.plot([1.6, 2.7])
```

Nothing happened—or at least nothing has shown up on the screen (unless you are using `macosx` backend, which is anomalous). To make the plot appear, you need to do this:

```
plt.show()
```

Now you see the plot, but your terminal command line is unresponsive; the `show()` command *blocks* the input of additional commands until you manually kill the plot window.

What good is this—being forced to use a blocking function? Suppose you need a script that plots the contents of a file to the screen. You want to look at that plot, and then end the script. Without some blocking command such as `show()`, the script would flash up the plot and then end immediately, leaving nothing on the screen.

In addition, non-interactive mode delays all drawing until `show()` is called; this is more efficient than redrawing the plot each time a line in the script adds a new feature.

Prior to version 1.0, `show()` generally could not be called more than once in a single script (although sometimes one could get away with it); for version 1.0.1 and above, this restriction is lifted, so one can write a script like this:

```
import numpy as np
import matplotlib.pyplot as plt

plt.ioff()
for i in range(3):
    plt.plot(np.random.rand(10))
plt.show()
```

which makes three plots, one at a time. I.e. the second plot will show up, once the first plot is closed.

## Summary

In interactive mode, pyplot functions automatically draw to the screen.

When plotting interactively, if using object method calls in addition to pyplot functions, then call `draw()` whenever you want to refresh the plot.

Use non-interactive mode in scripts in which you want to generate one or more figures and display them before ending or generating a new set of figures. In that case, use `show()` to display the figure(s) and to block execution until you have manually destroyed them.

## Performance

Whether exploring data in interactive mode or programmatically saving lots of plots, rendering performance can be a painful bottleneck in your pipeline. Matplotlib provides a couple ways to greatly reduce rendering time at the cost of a slight change (to a settable tolerance) in your plot's appearance. The methods available to reduce rendering time depend on the type of plot that is being created.

### Line segment simplification

For plots that have line segments (e.g. typical line plots, outlines of polygons, etc.), rendering performance can be controlled by the `path.simplify` and `path.simplify_threshold` parameters in your `matplotlibrc` file (see *Customizing Matplotlib with style sheets and rcParams* for more information about the `matplotlibrc` file). The `path.simplify` parameter is a boolean indicating whether or not line segments are simplified at all. The `path.simplify_threshold` parameter controls how much line segments are simplified; higher thresholds result in quicker rendering.

The following script will first display the data without any simplification, and then display the same data with simplification. Try interacting with both of them:

```
import numpy as np
import matplotlib.pyplot as plt
import matplotlib as mpl

# Setup, and create the data to plot
y = np.random.rand(100000)
y[50000:] *= 2
y[np.logspace(1, np.log10(50000), 400).astype(int)] = -1
```

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```
mpl.rcParams['path.simplify'] = True

mpl.rcParams['path.simplify_threshold'] = 0.0
plt.plot(y)
plt.show()

mpl.rcParams['path.simplify_threshold'] = 1.0
plt.plot(y)
plt.show()
```

Matplotlib currently defaults to a conservative simplification threshold of 1/9. If you want to change your default settings to use a different value, you can change your `matplotlibrc` file. Alternatively, you could create a new style for interactive plotting (with maximal simplification) and another style for publication quality plotting (with minimal simplification) and activate them as necessary. See *Customizing Matplotlib with style sheets and rcParams* for instructions on how to perform these actions.

The simplification works by iteratively merging line segments into a single vector until the next line segment's perpendicular distance to the vector (measured in display-coordinate space) is greater than the `path.simplify_threshold` parameter.

---

**Note:** Changes related to how line segments are simplified were made in version 2.1. Rendering time will still be improved by these parameters prior to 2.1, but rendering time for some kinds of data will be vastly improved in versions 2.1 and greater.

---

### Marker simplification

Markers can also be simplified, albeit less robustly than line segments. Marker simplification is only available to *Line2D* objects (through the `markevery` property). Wherever *Line2D* construction parameter are passed through, such as `matplotlib.pyplot.plot()` and `matplotlib.axes.Axes.plot()`, the `markevery` parameter can be used:

```
plt.plot(x, y, markevery=10)
```

The `markevery` argument allows for naive subsampling, or an attempt at evenly spaced (along the *x* axis) sampling. See the `/gallery/lines_bars_and_markers/markevery_demo` for more information.

### Splitting lines into smaller chunks

If you are using the Agg backend (see *What is a backend?*), then you can make use of the `agg.path.chunksize` rc parameter. This allows you to specify a chunk size, and any lines with greater than that many vertices will be split into multiple lines, each of which have no more than `agg.path.chunksize` many vertices. (Unless `agg.path.chunksize` is zero, in which case there is no chunking.) For some kind of data, chunking the line up into reasonable sizes can greatly decrease rendering time.

The following script will first display the data without any chunk size restriction, and then display the same data with a chunk size of 10,000. The difference can best be seen when the figures are large, try maximizing the GUI and then interacting with them:

```
import numpy as np
import matplotlib.pyplot as plt
import matplotlib as mpl
mpl.rcParams['path.simplify_threshold'] = 1.0

# Setup, and create the data to plot
y = np.random.rand(100000)
y[50000:] *= 2
y[np.logspace(1, np.log10(50000), 400).astype(int)] = -1
mpl.rcParams['path.simplify'] = True

mpl.rcParams['agg.path.chunksize'] = 0
plt.plot(y)
plt.show()

mpl.rcParams['agg.path.chunksize'] = 10000
plt.plot(y)
plt.show()
```

## Legends

The default legend behavior for axes attempts to find the location that covers the fewest data points (`loc='best'`). This can be a very expensive computation if there are lots of data points. In this case, you may want to provide a specific location.

## Using the *fast* style

The *fast* style can be used to automatically set simplification and chunking parameters to reasonable settings to speed up plotting large amounts of data. It can be used simply by running:

```
import matplotlib.style as mplstyle
mplstyle.use('fast')
```

It is very light weight, so it plays nicely with other styles, just make sure the fast style is applied last so that other styles do not overwrite the settings:

```
mplstyle.use(['dark_background', 'ggplot', 'fast'])
```

---

**Note:** Click [here](#) to download the full example code

---

## 2.1.2 Pyplot tutorial

An introduction to the pyplot interface.

## Intro to pyplot

`matplotlib.pyplot` is a collection of command style functions that make matplotlib work like MATLAB. Each `pyplot` function makes some change to a figure: e.g., creates a figure, creates a plotting area in a figure, plots some lines in a plotting area, decorates the plot with labels, etc.

In `matplotlib.pyplot` various states are preserved across function calls, so that it keeps track of things like the current figure and plotting area, and the plotting functions are directed to the current axes (please note that "axes" here and in most places in the documentation refers to the *axes part of a figure* and not the strict mathematical term for more than one axis).

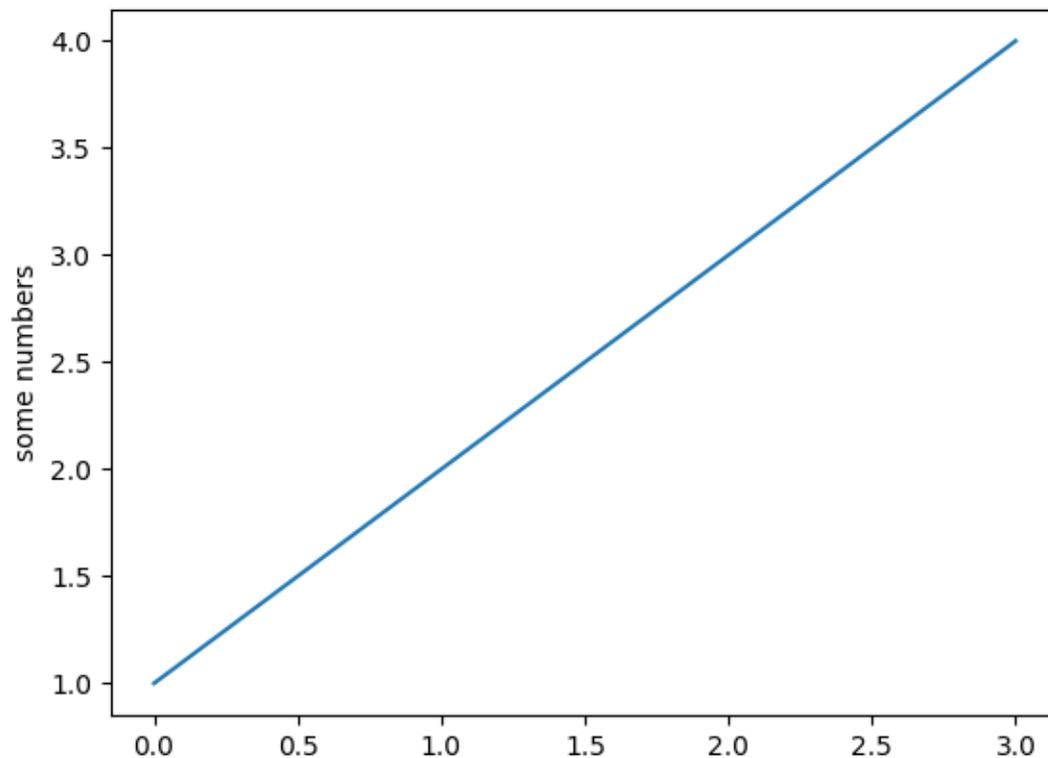
---

**Note:** the `pyplot` API is generally less-flexible than the object-oriented API. Most of the function calls you see here can also be called as methods from an `Axes` object. We recommend browsing the tutorials and examples to see how this works.

---

Generating visualizations with `pyplot` is very quick:

```
import matplotlib.pyplot as plt
plt.plot([1, 2, 3, 4])
plt.ylabel('some numbers')
plt.show()
```

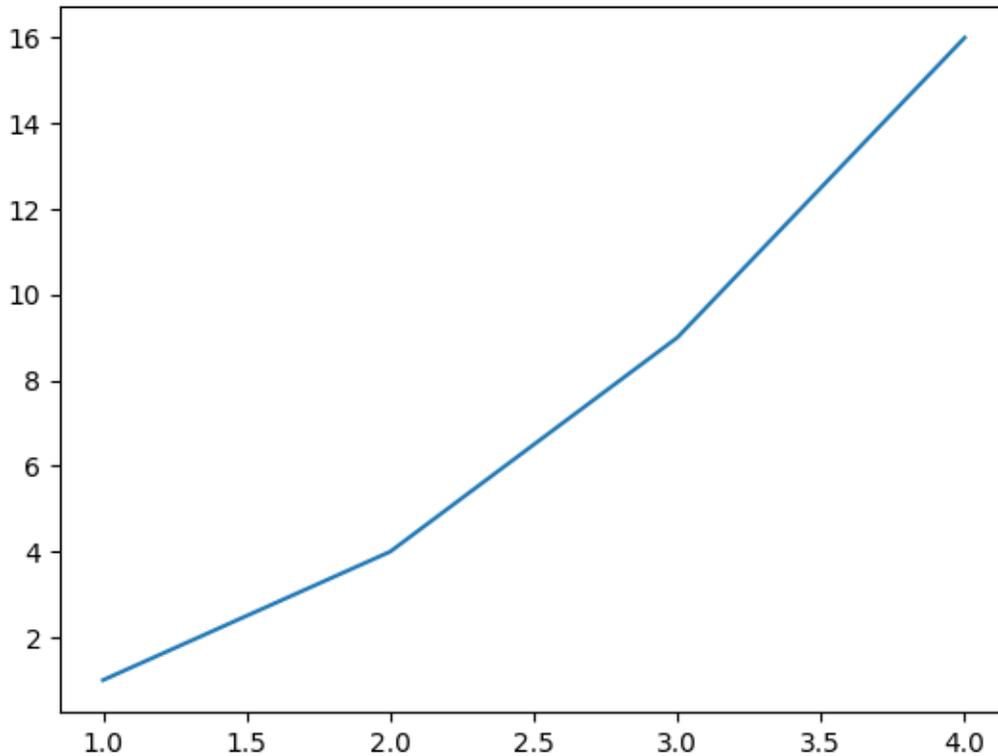


You may be wondering why the x-axis ranges from 0-3 and the y-axis from 1-4. If you provide a

single list or array to the `plot()` command, matplotlib assumes it is a sequence of y values, and automatically generates the x values for you. Since python ranges start with 0, the default x vector has the same length as y but starts with 0. Hence the x data are `[0,1,2,3]`.

`plot()` is a versatile command, and will take an arbitrary number of arguments. For example, to plot x versus y, you can issue the command:

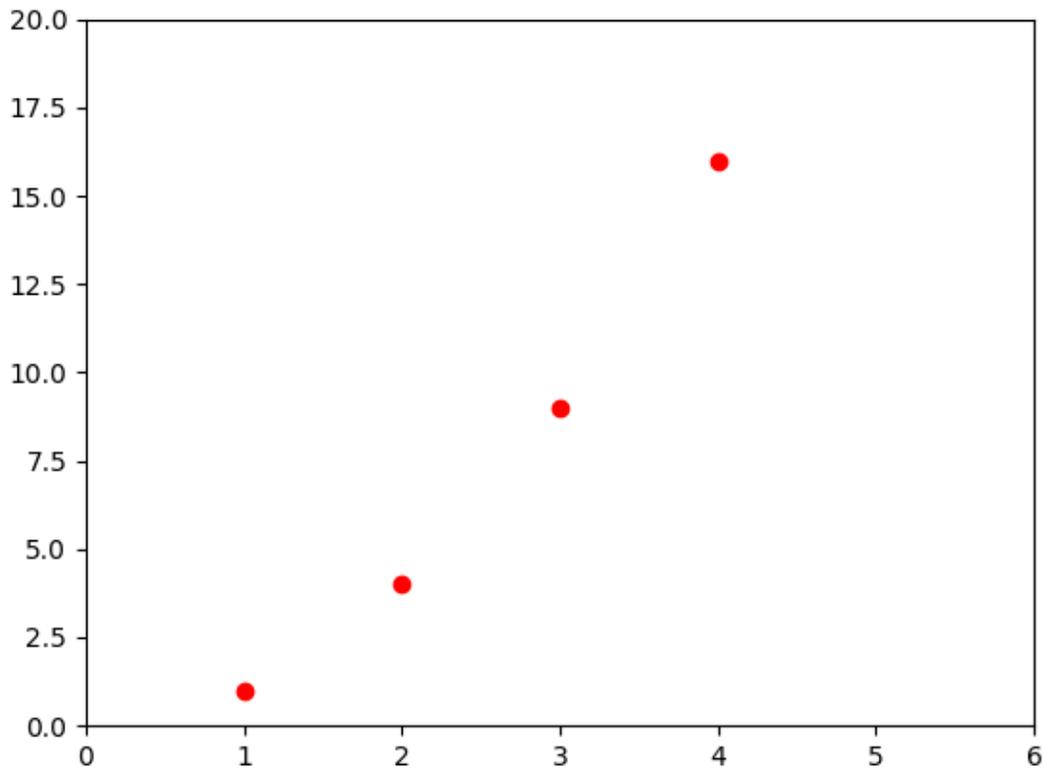
```
plt.plot([1, 2, 3, 4], [1, 4, 9, 16])
```



### Formatting the style of your plot

For every x, y pair of arguments, there is an optional third argument which is the format string that indicates the color and line type of the plot. The letters and symbols of the format string are from MATLAB, and you concatenate a color string with a line style string. The default format string is 'b-', which is a solid blue line. For example, to plot the above with red circles, you would issue

```
plt.plot([1, 2, 3, 4], [1, 4, 9, 16], 'ro')
plt.axis([0, 6, 0, 20])
plt.show()
```



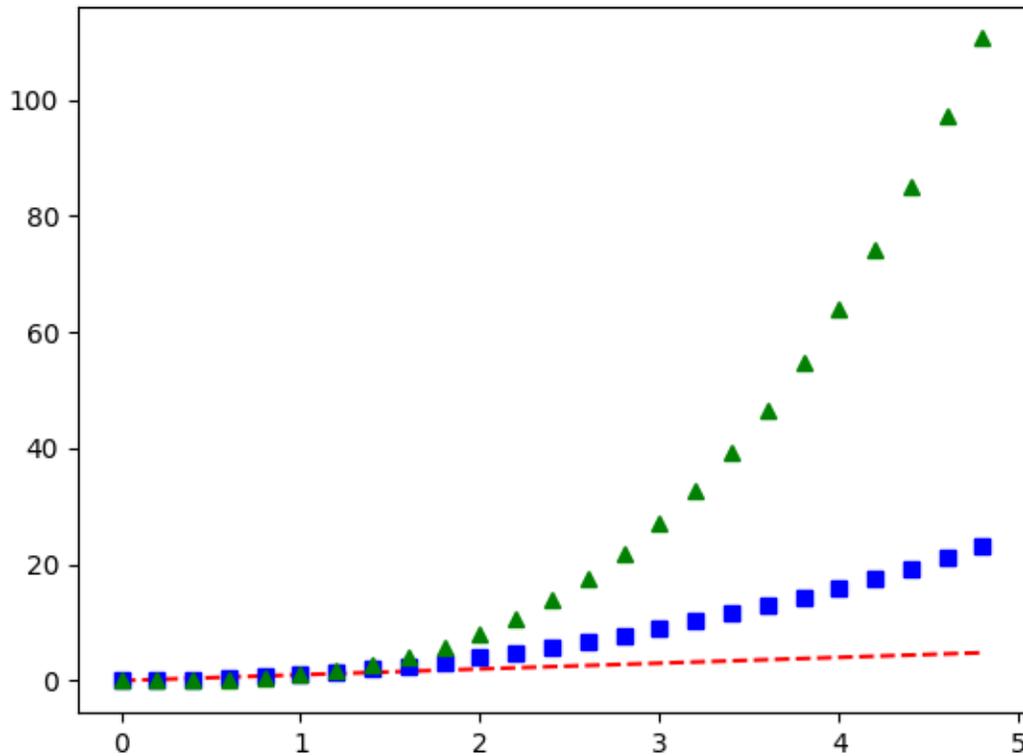
See the `plot()` documentation for a complete list of line styles and format strings. The `axis()` command in the example above takes a list of `[xmin, xmax, ymin, ymax]` and specifies the viewport of the axes.

If matplotlib were limited to working with lists, it would be fairly useless for numeric processing. Generally, you will use `numpy` arrays. In fact, all sequences are converted to `numpy` arrays internally. The example below illustrates a plotting several lines with different format styles in one command using arrays.

```
import numpy as np

# evenly sampled time at 200ms intervals
t = np.arange(0., 5., 0.2)

# red dashes, blue squares and green triangles
plt.plot(t, t, 'r--', t, t**2, 'bs', t, t**3, 'g^')
plt.show()
```



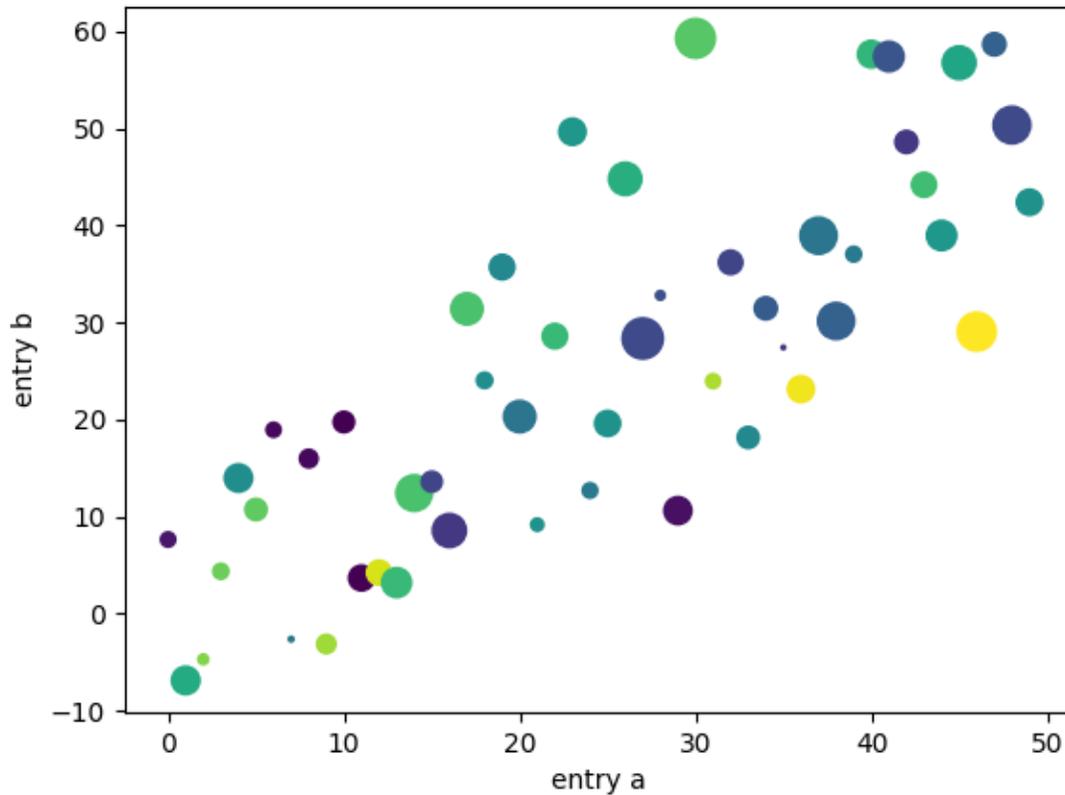
### Plotting with keyword strings

There are some instances where you have data in a format that lets you access particular variables with strings. For example, with `numpy.recarray` or `pandas.DataFrame`.

Matplotlib allows you provide such an object with the `data` keyword argument. If provided, then you may generate plots with the strings corresponding to these variables.

```
data = {'a': np.arange(50),
        'c': np.random.randint(0, 50, 50),
        'd': np.random.randn(50)}
data['b'] = data['a'] + 10 * np.random.randn(50)
data['d'] = np.abs(data['d']) * 100

plt.scatter('a', 'b', c='c', s='d', data=data)
plt.xlabel('entry a')
plt.ylabel('entry b')
plt.show()
```



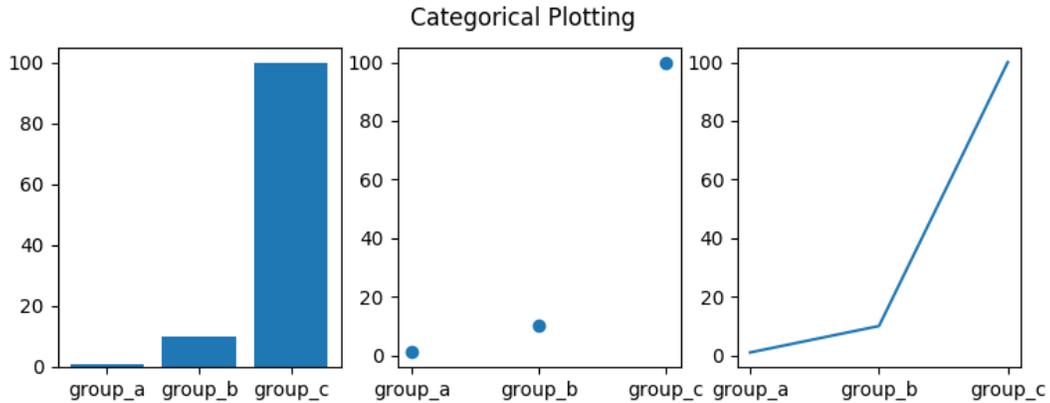
### Plotting with categorical variables

It is also possible to create a plot using categorical variables. Matplotlib allows you to pass categorical variables directly to many plotting functions. For example:

```
names = ['group_a', 'group_b', 'group_c']
values = [1, 10, 100]

plt.figure(figsize=(9, 3))

plt.subplot(131)
plt.bar(names, values)
plt.subplot(132)
plt.scatter(names, values)
plt.subplot(133)
plt.plot(names, values)
plt.suptitle('Categorical Plotting')
plt.show()
```



### Controlling line properties

Lines have many attributes that you can set: linewidth, dash style, antialiased, etc; see `matplotlib.lines.Line2D`. There are several ways to set line properties

- Use keyword args:

```
plt.plot(x, y, linewidth=2.0)
```

- Use the setter methods of a `Line2D` instance. `plot` returns a list of `Line2D` objects; e.g., `line1, line2 = plot(x1, y1, x2, y2)`. In the code below we will suppose that we have only one line so that the list returned is of length 1. We use tuple unpacking with `line`, to get the first element of that list:

```
line, = plt.plot(x, y, '-')
line.set_antialiased(False) # turn off antialiasing
```

- Use the `setp()` command. The example below uses a MATLAB-style command to set multiple properties on a list of lines. `setp` works transparently with a list of objects or a single object. You can either use python keyword arguments or MATLAB-style string/value pairs:

```
lines = plt.plot(x1, y1, x2, y2)
# use keyword args
plt.setp(lines, color='r', linewidth=2.0)
# or MATLAB style string value pairs
plt.setp(lines, 'color', 'r', 'linewidth', 2.0)
```

Here are the available `Line2D` properties.

Property	Value Type
<code>alpha</code>	float
<code>animated</code>	[True   False]
<code>antialiased</code> or <code>aa</code>	[True   False]
<code>clip_box</code>	a <code>matplotlib.transform.Bbox</code> instance
<code>clip_on</code>	[True   False]
<code>clip_path</code>	a <code>Path</code> instance and a <code>Transform</code> instance, a <code>Patch</code>
<code>color</code> or <code>c</code>	any <code>matplotlib</code> color

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Table 1 – continued from previous page

	Property   Value Type
contains	the hit testing function
dash_capstyle	['butt'   'round'   'projecting']
dash_joinstyle	['miter'   'round'   'bevel']
dashes	sequence of on/off ink in points
data	(np.array xdata, np.array ydata)
figure	a matplotlib.figure.Figure instance
label	any string
linestyle or ls	['-'   '--'   '-.'   ':'   'steps'   ...]
linewidth or lw	float value in points
marker	['+'   ','   '.'   '1'   '2'   '3'   '4' ]
markeredgecolor or mec	any matplotlib color
markeredgewidth or mew	float value in points
markerfacecolor or mfc	any matplotlib color
markersize or ms	float
markevery	[ None   integer   (startind, stride) ]
picker	used in interactive line selection
pickradius	the line pick selection radius
solid_capstyle	['butt'   'round'   'projecting']
solid_joinstyle	['miter'   'round'   'bevel']
transform	a matplotlib.transforms.Transform instance
visible	[True   False]
xdata	np.array
ydata	np.array
zorder	any number

To get a list of settable line properties, call the `setp()` function with a line or lines as argument

```
In [69]: lines = plt.plot([1, 2, 3])
```

```
In [70]: plt.setp(lines)
alpha: float
animated: [True | False]
antialiased or aa: [True | False]
...snip
```

### Working with multiple figures and axes

MATLAB, and *pyplot*, have the concept of the current figure and the current axes. All plotting commands apply to the current axes. The function `gca()` returns the current axes (a `matplotlib.axes.Axes` instance), and `gcf()` returns the current figure (`matplotlib.figure.Figure` instance). Normally, you don't have to worry about this, because it is all taken care of behind the scenes. Below is a script to create two subplots.

```
def f(t):
    return np.exp(-t) * np.cos(2*np.pi*t)

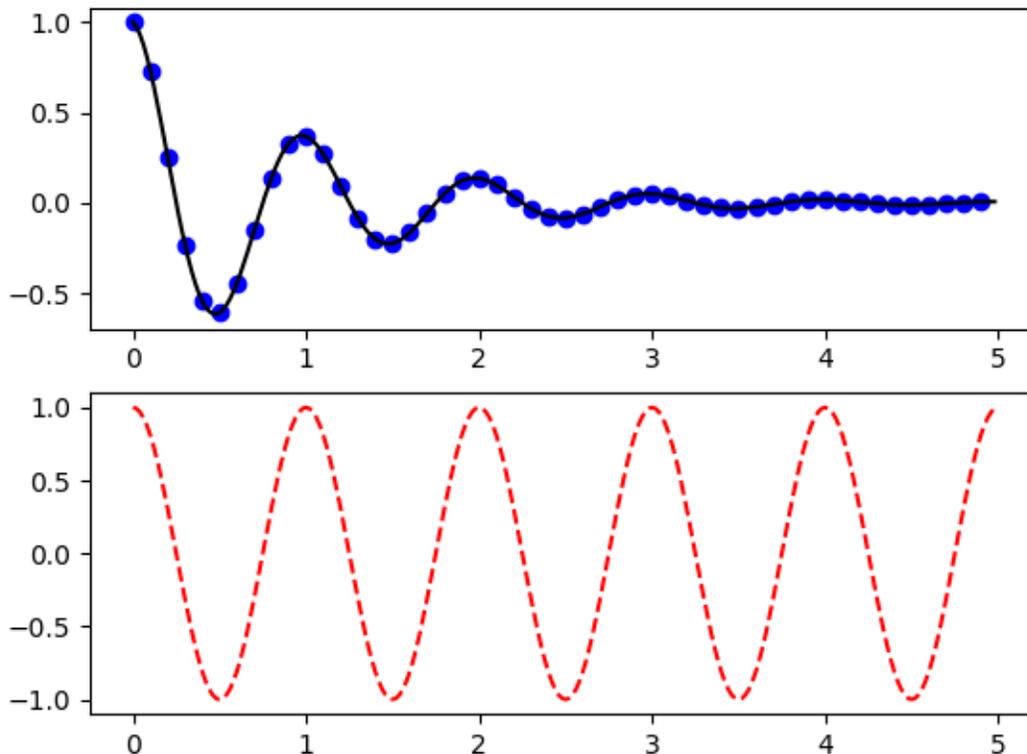
t1 = np.arange(0.0, 5.0, 0.1)
t2 = np.arange(0.0, 5.0, 0.02)
```

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```
plt.figure()
plt.subplot(211)
plt.plot(t1, f(t1), 'bo', t2, f(t2), 'k')

plt.subplot(212)
plt.plot(t2, np.cos(2*np.pi*t2), 'r--')
plt.show()
```



The `figure()` command here is optional because `figure(1)` will be created by default, just as a `subplot(111)` will be created by default if you don't manually specify any axes. The `subplot()` command specifies `numrows`, `numcols`, `plot_number` where `plot_number` ranges from 1 to `numrows*numcols`. The commas in the subplot command are optional if `numrows*numcols < 10`. So `subplot(211)` is identical to `subplot(2, 1, 1)`.

You can create an arbitrary number of subplots and axes. If you want to place an axes manually, i.e., not on a rectangular grid, use the `axes()` command, which allows you to specify the location as `axes([left, bottom, width, height])` where all values are in fractional (0 to 1) coordinates. See [/gallery/subplots\\_axes\\_and\\_figures/axes\\_demo](/gallery/subplots_axes_and_figures/axes_demo) for an example of placing axes manually and [/gallery/subplots\\_axes\\_and\\_figures/subplot\\_demo](/gallery/subplots_axes_and_figures/subplot_demo) for an example with lots of subplots.

You can create multiple figures by using multiple `figure()` calls with an increasing figure number. Of course, each figure can contain as many axes and subplots as your heart desires:

```

import matplotlib.pyplot as plt
plt.figure(1)           # the first figure
plt.subplot(211)       # the first subplot in the first figure
plt.plot([1, 2, 3])
plt.subplot(212)       # the second subplot in the first figure
plt.plot([4, 5, 6])

plt.figure(2)          # a second figure
plt.plot([4, 5, 6])    # creates a subplot(111) by default

plt.figure(1)          # figure 1 current; subplot(212) still current
plt.subplot(211)       # make subplot(211) in figure1 current
plt.title('Easy as 1, 2, 3') # subplot 211 title

```

You can clear the current figure with `clf()` and the current axes with `cla()`. If you find it annoying that states (specifically the current image, figure and axes) are being maintained for you behind the scenes, don't despair: this is just a thin stateful wrapper around an object oriented API, which you can use instead (see *Artist tutorial*)

If you are making lots of figures, you need to be aware of one more thing: the memory required for a figure is not completely released until the figure is explicitly closed with `close()`. Deleting all references to the figure, and/or using the window manager to kill the window in which the figure appears on the screen, is not enough, because pyplot maintains internal references until `close()` is called.

### Working with text

The `text()` command can be used to add text in an arbitrary location, and the `xlabel()`, `ylabel()` and `title()` are used to add text in the indicated locations (see *Text in Matplotlib Plots* for a more detailed example)

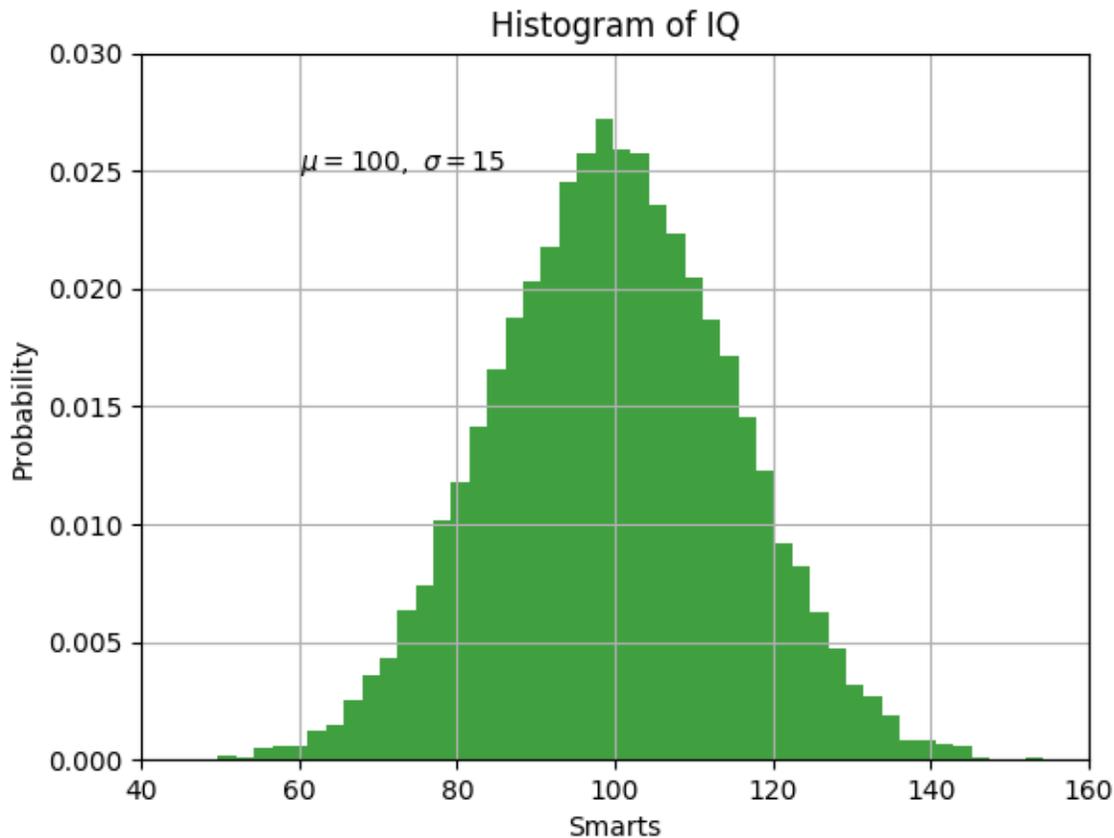
```

mu, sigma = 100, 15
x = mu + sigma * np.random.randn(10000)

# the histogram of the data
n, bins, patches = plt.hist(x, 50, density=1, facecolor='g', alpha=0.75)

plt.xlabel('Smarts')
plt.ylabel('Probability')
plt.title('Histogram of IQ')
plt.text(60, .025, r'$\mu=100,\ \sigma=15$')
plt.axis([40, 160, 0, 0.03])
plt.grid(True)
plt.show()

```



All of the `text()` commands return an `matplotlib.text.Text` instance. Just as with with lines above, you can customize the properties by passing keyword arguments into the text functions or using `setp()`:

```
t = plt.xlabel('my data', fontsize=14, color='red')
```

These properties are covered in more detail in *Text properties and layout*.

### Using mathematical expressions in text

matplotlib accepts TeX equation expressions in any text expression. For example to write the expression  $\sigma_i = 15$  in the title, you can write a TeX expression surrounded by dollar signs:

```
plt.title(r'$\sigma_i=15$')
```

The `r` preceding the title string is important - it signifies that the string is a *raw* string and not to treat backslashes as python escapes. matplotlib has a built-in TeX expression parser and layout engine, and ships its own math fonts - for details see *Writing mathematical expressions*. Thus you can use mathematical text across platforms without requiring a TeX installation. For those who have LaTeX and dvipng installed, you can also use LaTeX to format your text and incorporate the output directly into your display figures or saved postscript - see *Text rendering With LaTeX*.

## Annotating text

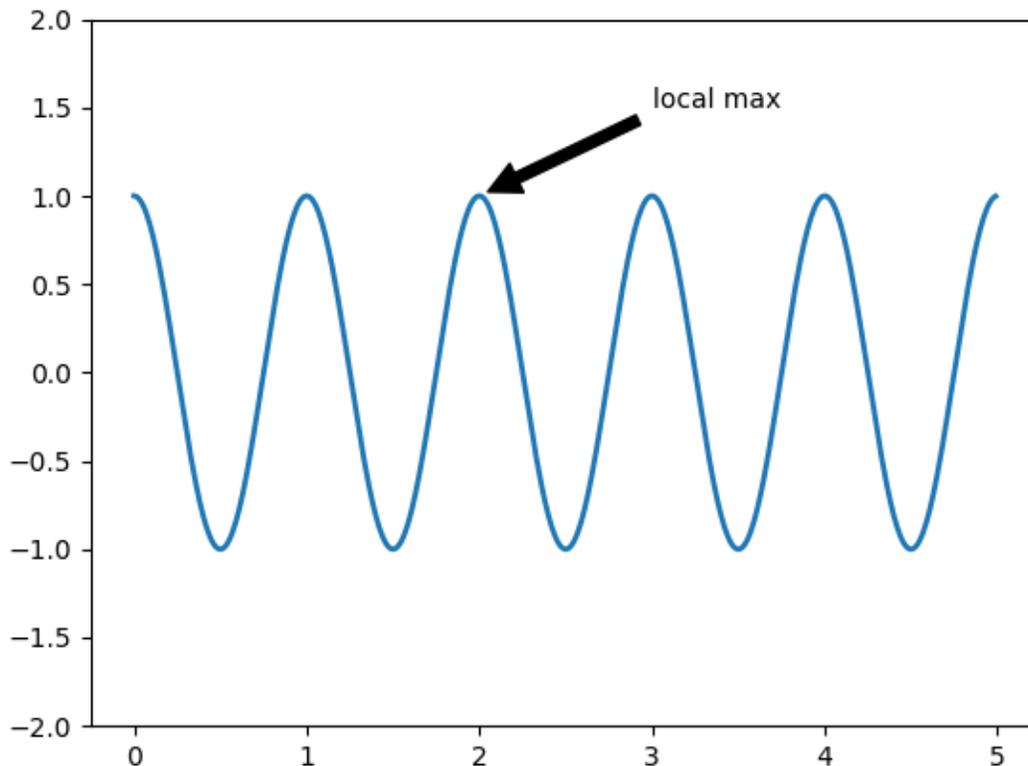
The uses of the basic `text()` command above place text at an arbitrary position on the Axes. A common use for text is to annotate some feature of the plot, and the `annotate()` method provides helper functionality to make annotations easy. In an annotation, there are two points to consider: the location being annotated represented by the argument `xy` and the location of the text `xytext`. Both of these arguments are  $(x,y)$  tuples.

```
ax = plt.subplot(111)

t = np.arange(0.0, 5.0, 0.01)
s = np.cos(2*np.pi*t)
line, = plt.plot(t, s, lw=2)

plt.annotate('local max', xy=(2, 1), xytext=(3, 1.5),
            arrowprops=dict(facecolor='black', shrink=0.05),
            )

plt.ylim(-2, 2)
plt.show()
```



In this basic example, both the `xy` (arrow tip) and `xytext` locations (text location) are in data coordinates. There are a variety of other coordinate systems one can choose - see *Basic annotation* and *Advanced Annotation* for details. More examples can be found in

/gallery/text\_labels\_and\_annotations/annotation\_demo.

### Logarithmic and other nonlinear axes

`matplotlib.pyplot` supports not only linear axis scales, but also logarithmic and logit scales. This is commonly used if data spans many orders of magnitude. Changing the scale of an axis is easy:

```
plt.xscale('log')
```

An example of four plots with the same data and different scales for the y axis is shown below.

```
from matplotlib.ticker import NullFormatter # useful for `logit` scale

# Fixing random state for reproducibility
np.random.seed(19680801)

# make up some data in the interval ]0, 1[
y = np.random.normal(loc=0.5, scale=0.4, size=1000)
y = y[(y > 0) & (y < 1)]
y.sort()
x = np.arange(len(y))

# plot with various axes scales
plt.figure()

# linear
plt.subplot(221)
plt.plot(x, y)
plt.yscale('linear')
plt.title('linear')
plt.grid(True)

# log
plt.subplot(222)
plt.plot(x, y)
plt.yscale('log')
plt.title('log')
plt.grid(True)

# symmetric log
plt.subplot(223)
plt.plot(x, y - y.mean())
plt.yscale('symlog', lincthreshy=0.01)
plt.title('symlog')
plt.grid(True)

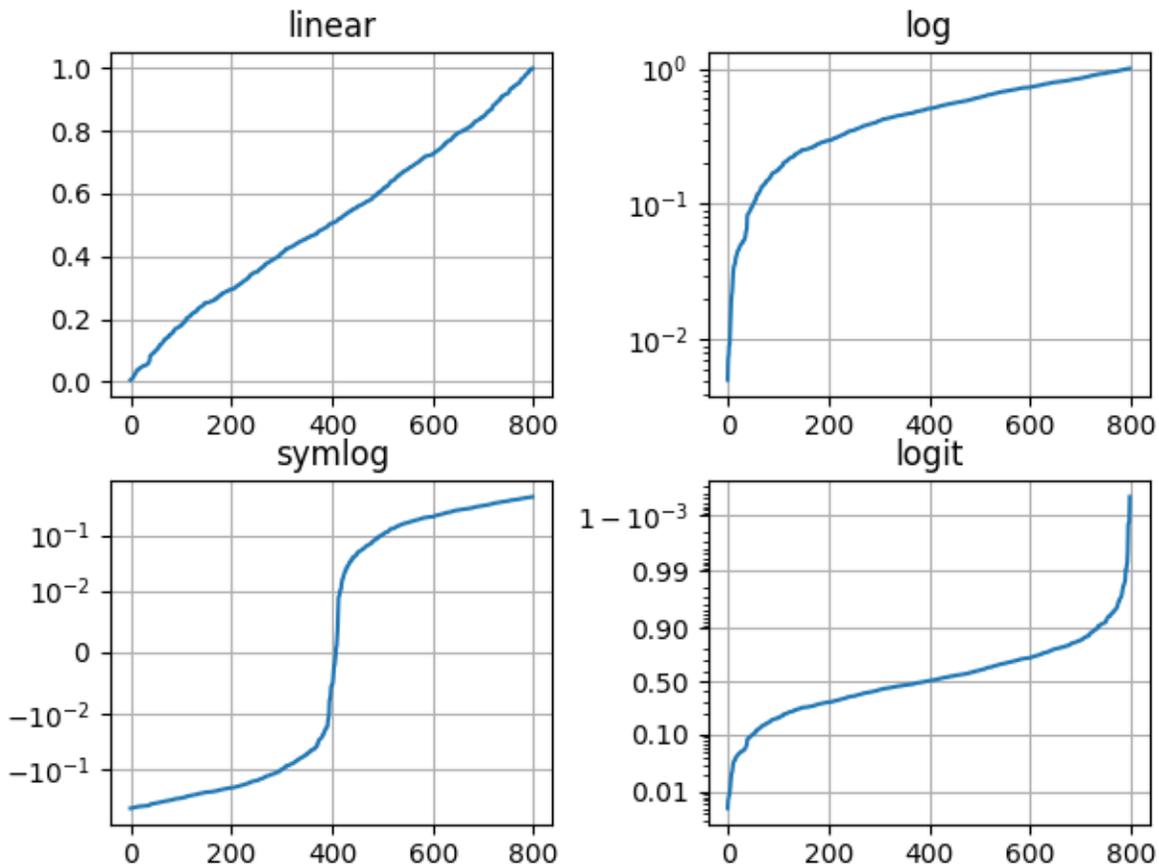
# logit
plt.subplot(224)
plt.plot(x, y)
plt.yscale('logit')
```

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```
plt.title('logit')
plt.grid(True)
# Format the minor tick labels of the y-axis into empty strings with
# `NullFormatter`, to avoid cumbering the axis with too many labels.
plt.gca().yaxis.set_minor_formatter(NullFormatter())
# Adjust the subplot layout, because the logit one may take more space
# than usual, due to y-tick labels like "1 - 10^{-3}"
plt.subplots_adjust(top=0.92, bottom=0.08, left=0.10, right=0.95, hspace=0.25,
                    wspace=0.35)

plt.show()
```



It is also possible to add your own scale, see *Developer's guide for creating scales and transformations* for details.

---

**Note:** Click [here](#) to download the full example code

---

### 2.1.3 Sample plots in Matplotlib

Here you'll find a host of example plots with the code that generated them.

## Line Plot

Here's how to create a line plot with text labels using `plot()`.

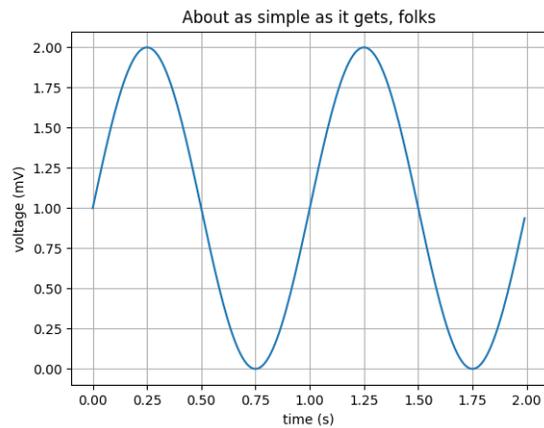


Fig. 1: Simple Plot

## Multiple subplots in one figure

Multiple axes (i.e. subplots) are created with the `subplot()` function:

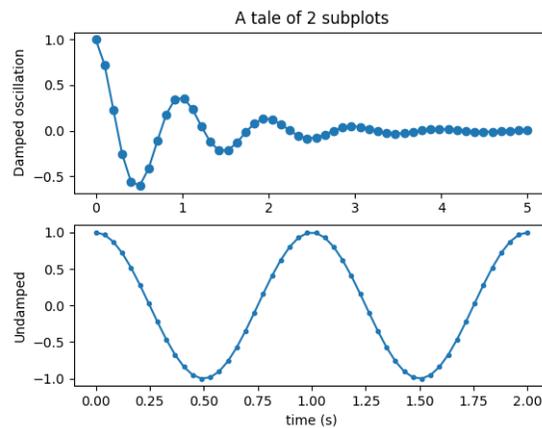


Fig. 2: Subplot

## Images

Matplotlib can display images (assuming equally spaced horizontal dimensions) using the `imshow()` function.

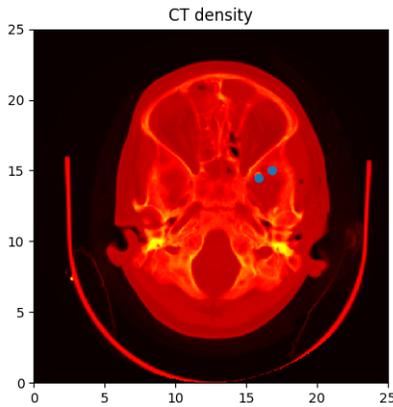


Fig. 3: Example of using `imshow()` to display a CT scan

### Contouring and pseudocolor

The `pcolormesh()` function can make a colored representation of a two-dimensional array, even if the horizontal dimensions are unevenly spaced. The `contour()` function is another way to represent the same data:

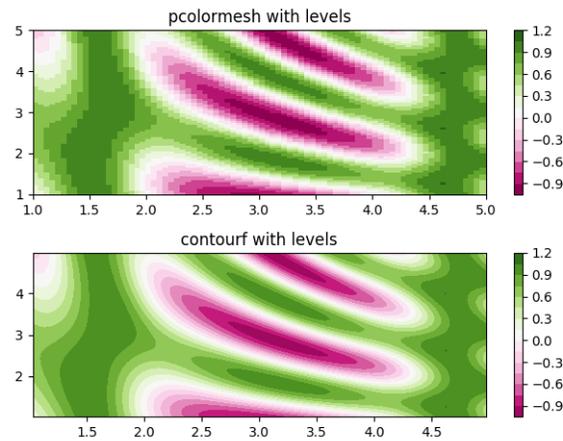


Fig. 4: Example comparing `pcolormesh()` and `contour()` for plotting two-dimensional data

### Histograms

The `hist()` function automatically generates histograms and returns the bin counts or probabilities:

### Paths

You can add arbitrary paths in Matplotlib using the `matplotlib.path` module:

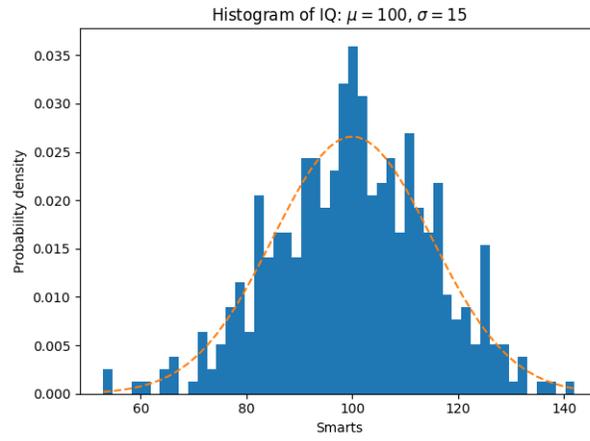


Fig. 5: Histogram Features

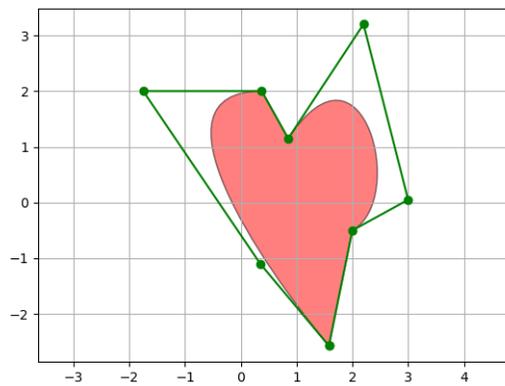


Fig. 6: Path Patch

### Three-dimensional plotting

The `mplot3d` toolkit (see *Getting started* and `mplot3d-examples-index`) has support for simple 3d graphs including surface, wireframe, scatter, and bar charts.

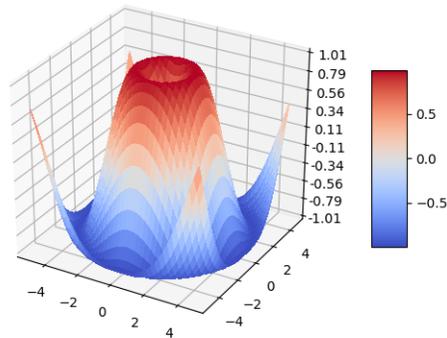


Fig. 7: Surface3d

Thanks to John Porter, Jonathon Taylor, Reinier Heeres, and Ben Root for the `mplot3d` toolkit. This toolkit is included with all standard Matplotlib installs.

### Streamplot

The `streamplot()` function plots the streamlines of a vector field. In addition to simply plotting the streamlines, it allows you to map the colors and/or line widths of streamlines to a separate parameter, such as the speed or local intensity of the vector field.

This feature complements the `quiver()` function for plotting vector fields. Thanks to Tom Flannaghan and Tony Yu for adding the streamplot function.

### Ellipses

In support of the [Phoenix](#) mission to Mars (which used Matplotlib to display ground tracking of spacecraft), Michael Droettboom built on work by Charlie Moad to provide an extremely accurate 8-spline approximation to elliptical arcs (see `Arc`), which are insensitive to zoom level.

### Bar charts

Use the `bar()` function to make bar charts, which includes customizations such as error bars: You can also create stacked bars (`bar_stacked.py`), or horizontal bar charts (`barh.py`).

### Pie charts

The `pie()` function allows you to create pie charts. Optional features include auto-labeling the percentage of area, exploding one or more wedges from the center of the pie, and a shadow

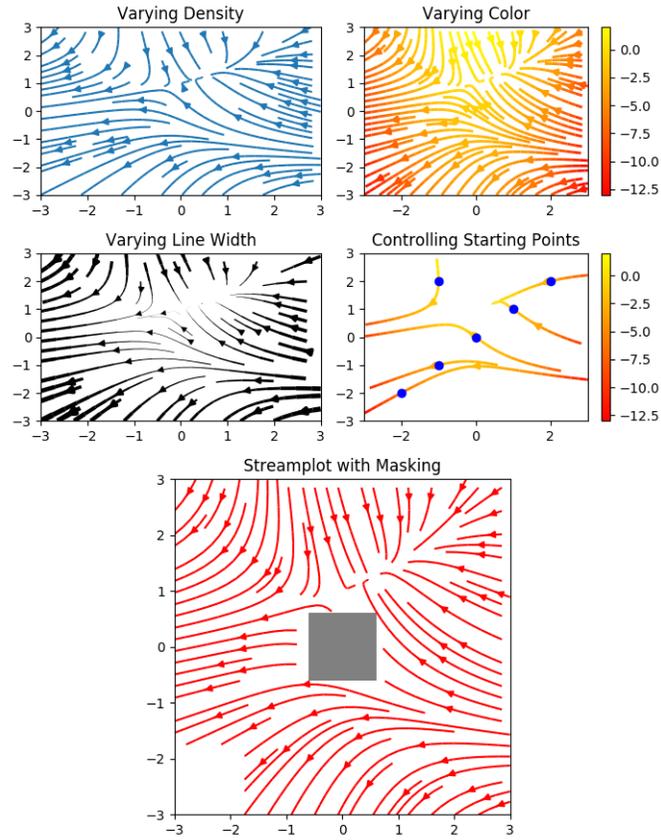


Fig. 8: Streamplot with various plotting options.

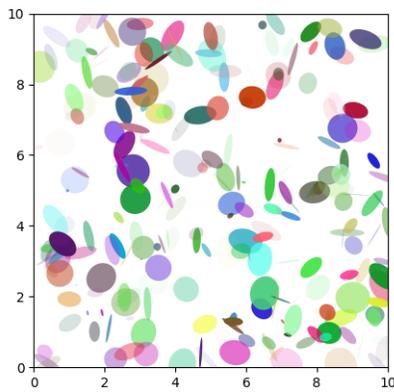


Fig. 9: Ellipse Demo

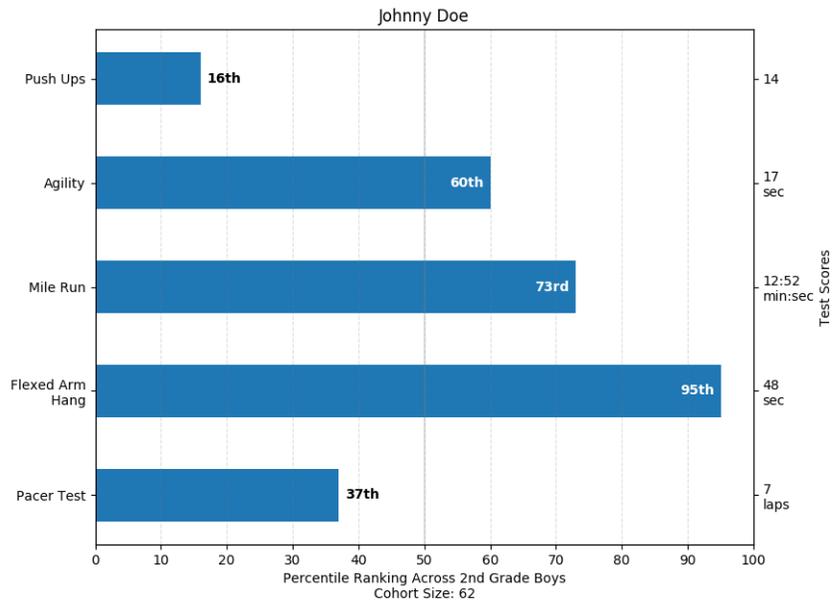


Fig. 10: Barchart Demo

effect. Take a close look at the attached code, which generates this figure in just a few lines of code.

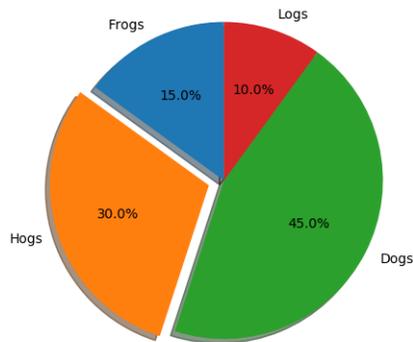


Fig. 11: Pie Features

## Tables

The `table()` function adds a text table to an axes.

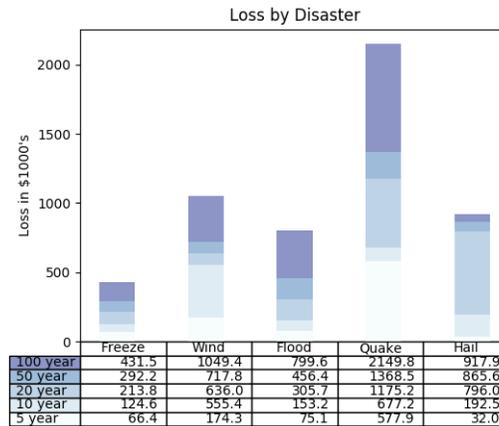


Fig. 12: Table Demo

### Scatter plots

The `scatter()` function makes a scatter plot with (optional) size and color arguments. This example plots changes in Google's stock price, with marker sizes reflecting the trading volume and colors varying with time. Here, the alpha attribute is used to make semitransparent circle markers.

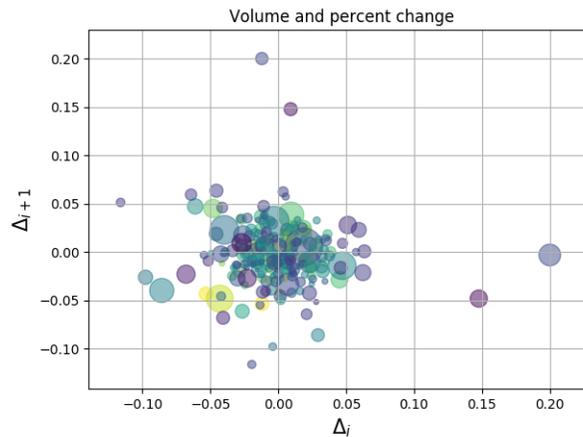


Fig. 13: Scatter Demo2

### GUI widgets

Matplotlib has basic GUI widgets that are independent of the graphical user interface you are using, allowing you to write cross GUI figures and widgets. See `matplotlib.widgets` and the [widget examples](#).

### Filled curves

The `fill()` function lets you plot filled curves and polygons:

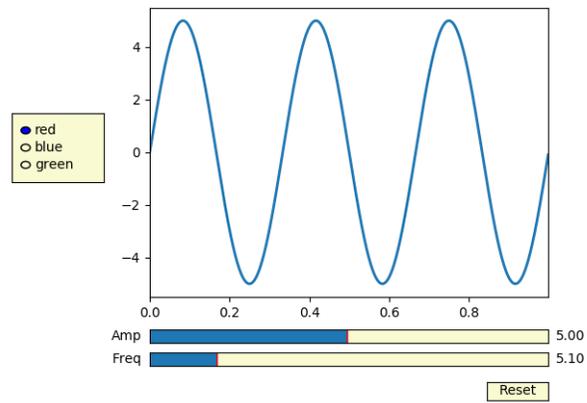


Fig. 14: Slider and radio-button GUI.

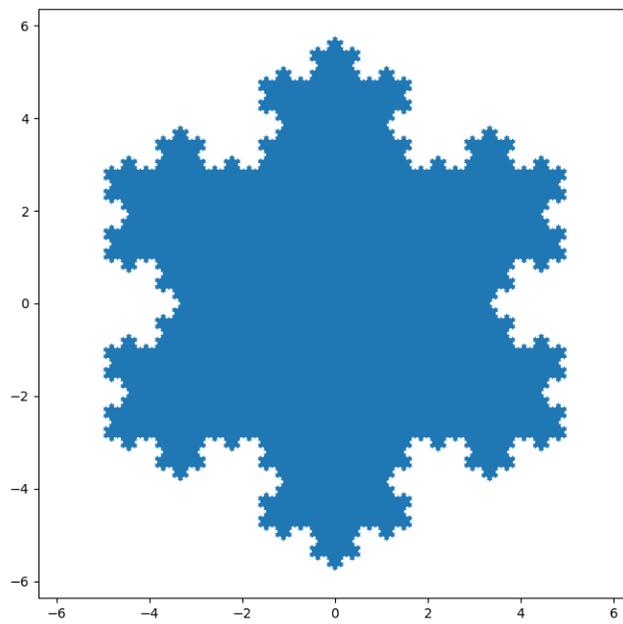


Fig. 15: Fill

Thanks to Andrew Straw for adding this function.

### Date handling

You can plot timeseries data with major and minor ticks and custom tick formatters for both.

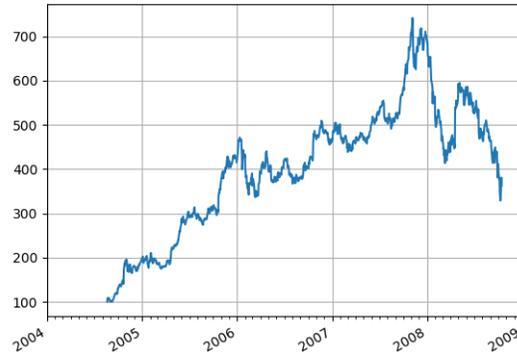


Fig. 16: Date

See `matplotlib.ticker` and `matplotlib.dates` for details and usage.

### Log plots

The `semilogx()`, `semilogy()` and `loglog()` functions simplify the creation of logarithmic plots.

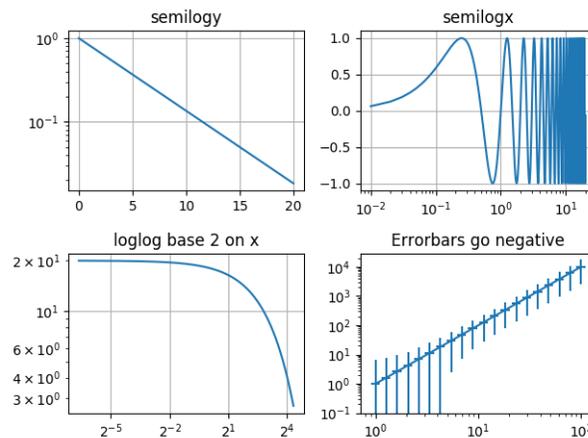


Fig. 17: Log Demo

Thanks to Andrew Straw, Darren Dale and Gregory Lielens for contributions log-scaling infrastructure.

## Polar plots

The `polar()` function generates polar plots.

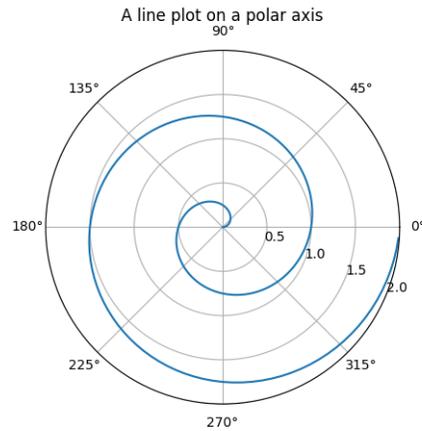


Fig. 18: Polar Demo

## Legends

The `legend()` function automatically generates figure legends, with MATLAB-compatible legend-placement functions.

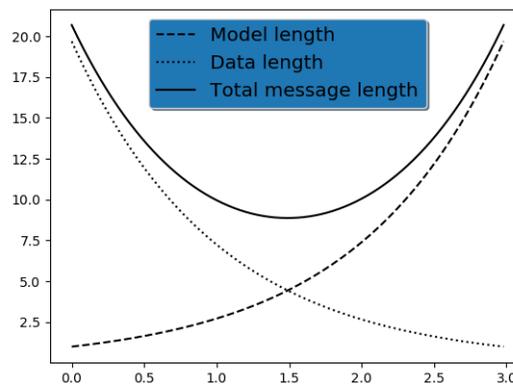


Fig. 19: Legend

Thanks to Charles Twardy for input on the legend function.

## TeX-notation for text objects

Below is a sampling of the many TeX expressions now supported by Matplotlib's internal mathtext engine. The mathtext module provides TeX style mathematical expressions using [FreeType](#) and the DejaVu, BaKoMa computer modern, or [STIX](#) fonts. See the `matplotlib.mathtext` module for additional details.

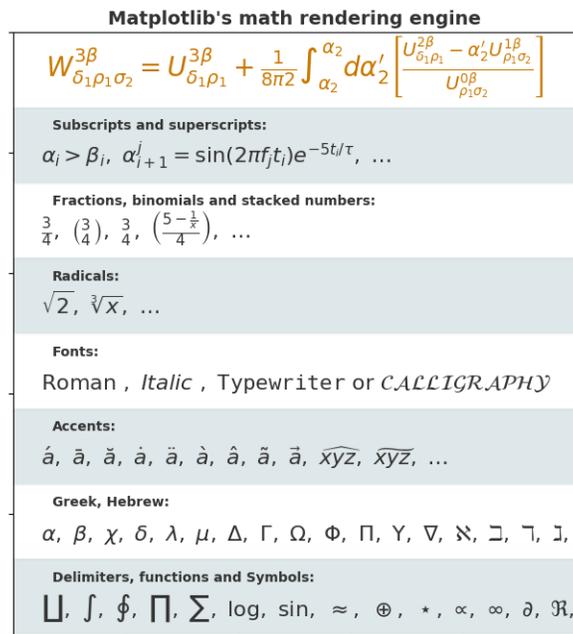


Fig. 20: Mathtext Examples

Matplotlib's mathtext infrastructure is an independent implementation and does not require TeX or any external packages installed on your computer. See the tutorial at *Writing mathematical expressions*.

### Native TeX rendering

Although Matplotlib's internal math rendering engine is quite powerful, sometimes you need TeX. Matplotlib supports external TeX rendering of strings with the *usetex* option.

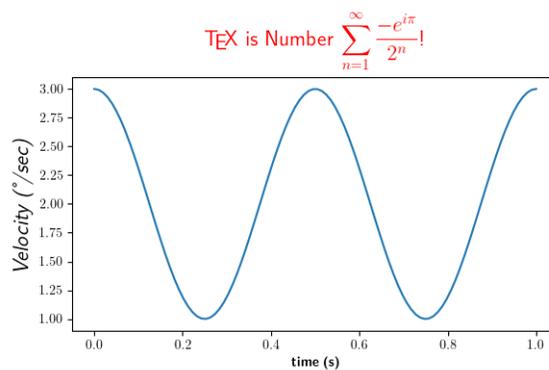
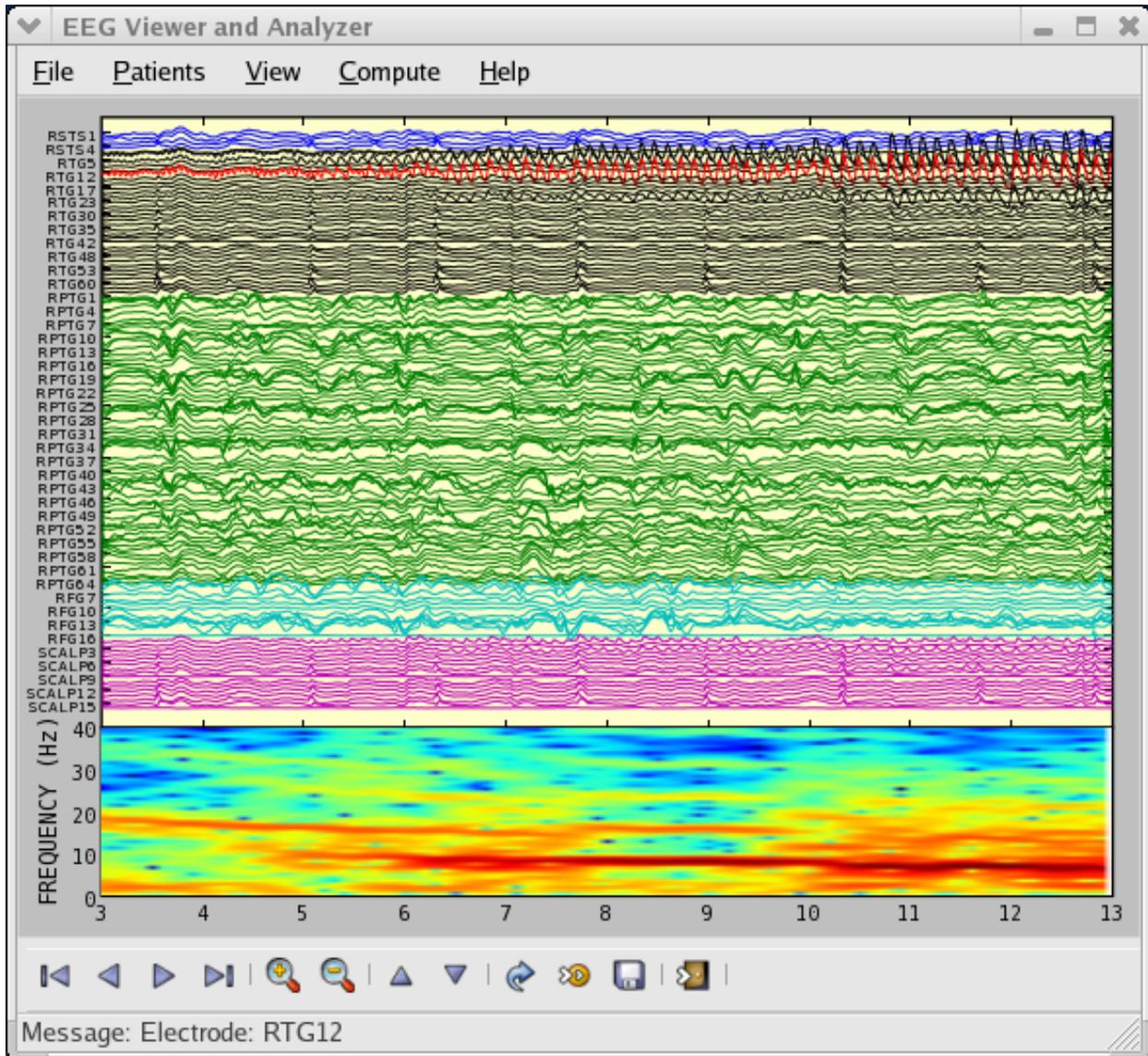


Fig. 21: Tex Demo

## EEG GUI

You can embed Matplotlib into pygtk, wx, Tk, or Qt applications. Here is a screenshot of an EEG viewer called `pbrain`.



The lower axes uses `spectrogram()` to plot the spectrogram of one of the EEG channels.

For examples of how to embed Matplotlib in different toolkits, see:

- [/gallery/user\\_interfaces/embedding\\_in\\_gtk3\\_sgskip](#)
- [/gallery/user\\_interfaces/embedding\\_in\\_wx2\\_sgskip](#)
- [/gallery/user\\_interfaces/mpl\\_with\\_glade3\\_sgskip](#)
- [/gallery/user\\_interfaces/embedding\\_in\\_qt\\_sgskip](#)
- [/gallery/user\\_interfaces/embedding\\_in\\_tk\\_sgskip](#)

### XKCD-style sketch plots

Just for fun, Matplotlib supports plotting in the style of `xkcd`.

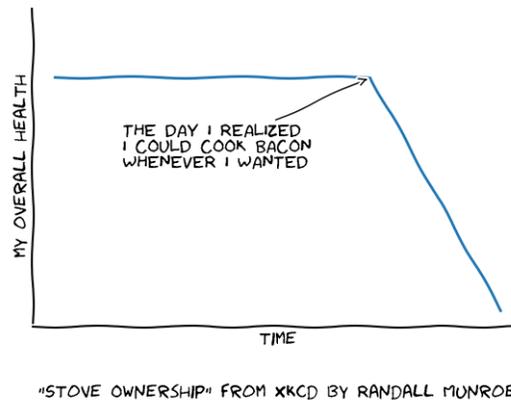
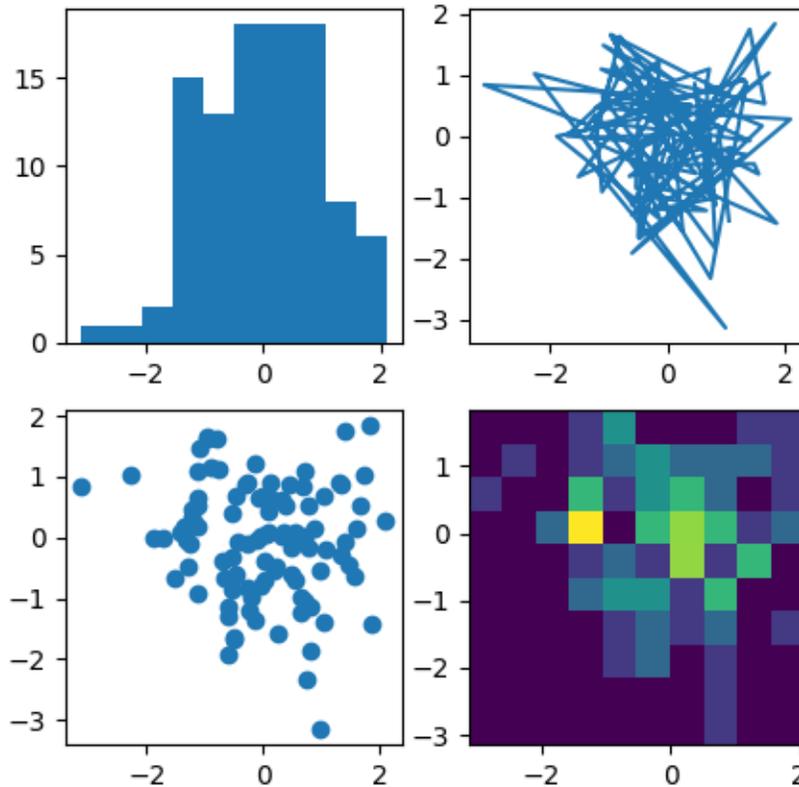


Fig. 22: `xkcd`

### Subplot example

Many plot types can be combined in one figure to create powerful and flexible representations of data.



```
import matplotlib.pyplot as plt
import numpy as np

np.random.seed(19680801)
data = np.random.randn(2, 100)

fig, axes = plt.subplots(2, 2, figsize=(5, 5))
axes[0, 0].hist(data[0])
axes[1, 0].scatter(data[0], data[1])
axes[0, 1].plot(data[0], data[1])
axes[1, 1].hist2d(data[0], data[1])

plt.show()
```

**Note:** Click [here](#) to download the full example code

## 2.1.4 Image tutorial

A short tutorial on plotting images with Matplotlib.

### Startup commands

First, let's start IPython. It is a most excellent enhancement to the standard Python prompt, and it ties in especially well with Matplotlib. Start IPython either at a shell, or the IPython Notebook now.

With IPython started, we now need to connect to a GUI event loop. This tells IPython where (and how) to display plots. To connect to a GUI loop, execute the `%matplotlib` magic at your IPython prompt. There's more detail on exactly what this does at [IPython's documentation on GUI event loops](#).

If you're using IPython Notebook, the same commands are available, but people commonly use a specific argument to the `%matplotlib` magic:

```
In [1]: %matplotlib inline
```

This turns on inline plotting, where plot graphics will appear in your notebook. This has important implications for interactivity. For inline plotting, commands in cells below the cell that outputs a plot will not affect the plot. For example, changing the color map is not possible from cells below the cell that creates a plot. However, for other backends, such as Qt5, that open a separate window, cells below those that create the plot will change the plot - it is a live object in memory.

This tutorial will use matplotlib's imperative-style plotting interface, `pyplot`. This interface maintains global state, and is very useful for quickly and easily experimenting with various plot settings. The alternative is the object-oriented interface, which is also very powerful, and generally more suitable for large application development. If you'd like to learn about the object-oriented interface, a great place to start is our *Usage guide*. For now, let's get on with the imperative-style approach:

```
import matplotlib.pyplot as plt
import matplotlib.image as mpimg
```

### Importing image data into Numpy arrays

Loading image data is supported by the [Pillow](#) library. Natively, Matplotlib only supports PNG images. The commands shown below fall back on Pillow if the native read fails.

The image used in this example is a PNG file, but keep that Pillow requirement in mind for your own data.

Here's the image we're going to play with:



It's a 24-bit RGB PNG image (8 bits for each of R, G, B). Depending on where you get your data, the other kinds of image that you'll most likely encounter are RGBA images, which allow for transparency, or single-channel grayscale (luminosity) images. You can right click on it and choose "Save image as" to download it to your computer for the rest of this tutorial.

And here we go...

```
img = mpimg.imread('../../_static/stinkbug.png')
print(img)
```

Out:

```
[[[0.40784314 0.40784314 0.40784314]
 [0.40784314 0.40784314 0.40784314]
 [0.40784314 0.40784314 0.40784314]
 ...
 [0.42745098 0.42745098 0.42745098]
 [0.42745098 0.42745098 0.42745098]
 [0.42745098 0.42745098 0.42745098]]

 [[0.4117647 0.4117647 0.4117647 ]
 [0.4117647 0.4117647 0.4117647 ]
 [0.4117647 0.4117647 0.4117647 ]
 ...
```

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```
[0.42745098 0.42745098 0.42745098]
[0.42745098 0.42745098 0.42745098]
[0.42745098 0.42745098 0.42745098]]

[[0.41960785 0.41960785 0.41960785]
 [0.41568628 0.41568628 0.41568628]
 [0.41568628 0.41568628 0.41568628]
 ...
 [0.43137255 0.43137255 0.43137255]
 [0.43137255 0.43137255 0.43137255]
 [0.43137255 0.43137255 0.43137255]]

...

[[[0.4392157 0.4392157 0.4392157 ]
 [0.43529412 0.43529412 0.43529412]
 [0.43137255 0.43137255 0.43137255]
 ...
 [0.45490196 0.45490196 0.45490196]
 [0.4509804 0.4509804 0.4509804 ]
 [0.4509804 0.4509804 0.4509804 ]]]

[[[0.44313726 0.44313726 0.44313726]
 [0.44313726 0.44313726 0.44313726]
 [0.4392157 0.4392157 0.4392157 ]
 ...
 [0.4509804 0.4509804 0.4509804 ]
 [0.44705883 0.44705883 0.44705883]
 [0.44705883 0.44705883 0.44705883]]]

[[[0.44313726 0.44313726 0.44313726]
 [0.4509804 0.4509804 0.4509804 ]
 [0.4509804 0.4509804 0.4509804 ]
 ...
 [0.44705883 0.44705883 0.44705883]
 [0.44705883 0.44705883 0.44705883]
 [0.44313726 0.44313726 0.44313726]]]]
```

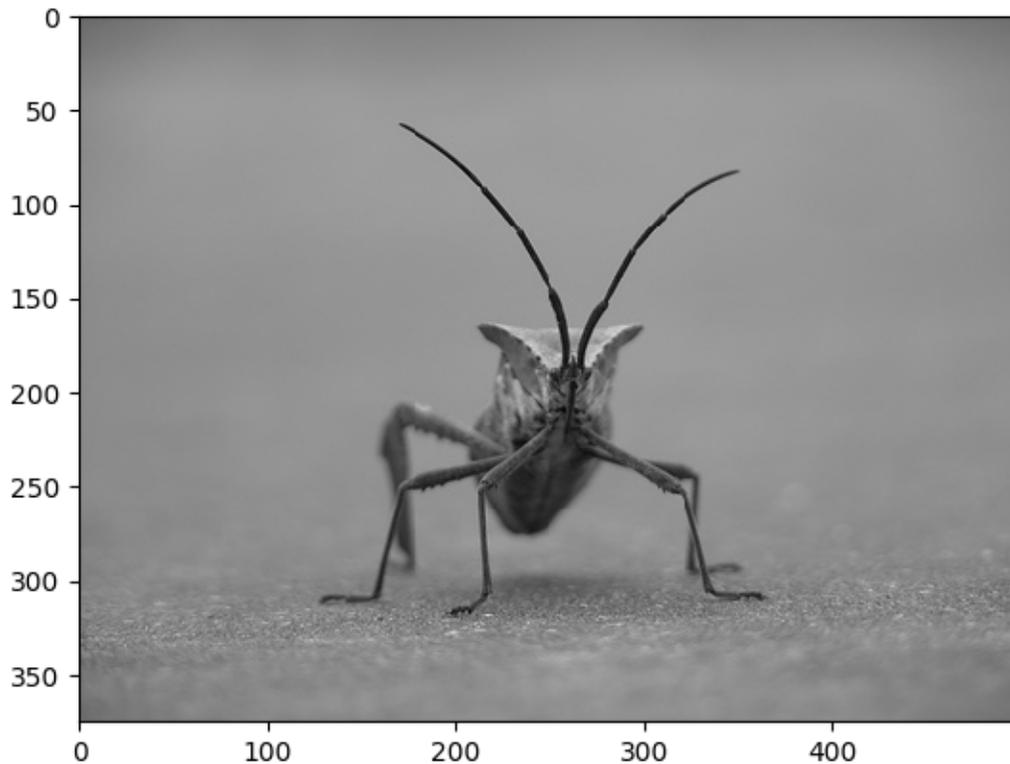
Note the dtype there - float32. Matplotlib has rescaled the 8 bit data from each channel to floating point data between 0.0 and 1.0. As a side note, the only datatype that Pillow can work with is uint8. Matplotlib plotting can handle float32 and uint8, but image reading/writing for any format other than PNG is limited to uint8 data. Why 8 bits? Most displays can only render 8 bits per channel worth of color gradation. Why can they only render 8 bits/channel? Because that's about all the human eye can see. More here (from a photography standpoint): [Luminous Landscape bit depth tutorial](#).

Each inner list represents a pixel. Here, with an RGB image, there are 3 values. Since it's a black and white image, R, G, and B are all similar. An RGBA (where A is alpha, or transparency), has 4 values per inner list, and a simple luminance image just has one value (and is thus only a 2-D array, not a 3-D array). For RGB and RGBA images, matplotlib supports float32 and uint8 data types. For grayscale, matplotlib supports only float32. If your array data does not meet one of these descriptions, you need to rescale it.

### Plotting numpy arrays as images

So, you have your data in a numpy array (either by importing it, or by generating it). Let's render it. In Matplotlib, this is performed using the `imshow()` function. Here we'll grab the plot object. This object gives you an easy way to manipulate the plot from the prompt.

```
imgplot = plt.imshow(img)
```



You can also plot any numpy array.

### Applying pseudocolor schemes to image plots

Pseudocolor can be a useful tool for enhancing contrast and visualizing your data more easily. This is especially useful when making presentations of your data using projectors - their contrast is typically quite poor.

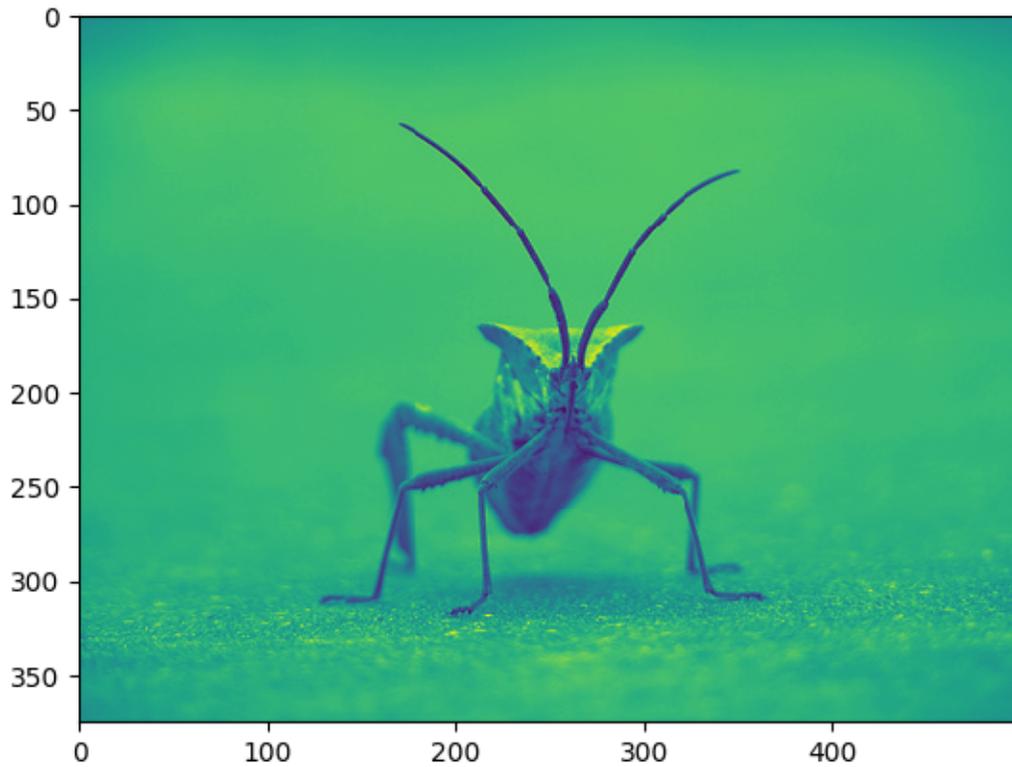
Pseudocolor is only relevant to single-channel, grayscale, luminosity images. We currently have an RGB image. Since R, G, and B are all similar (see for yourself above or in your data), we can just pick one channel of our data:

```
lum_img = img[:, :, 0]
# This is array slicing. You can read more in the `Numpy tutorial
```

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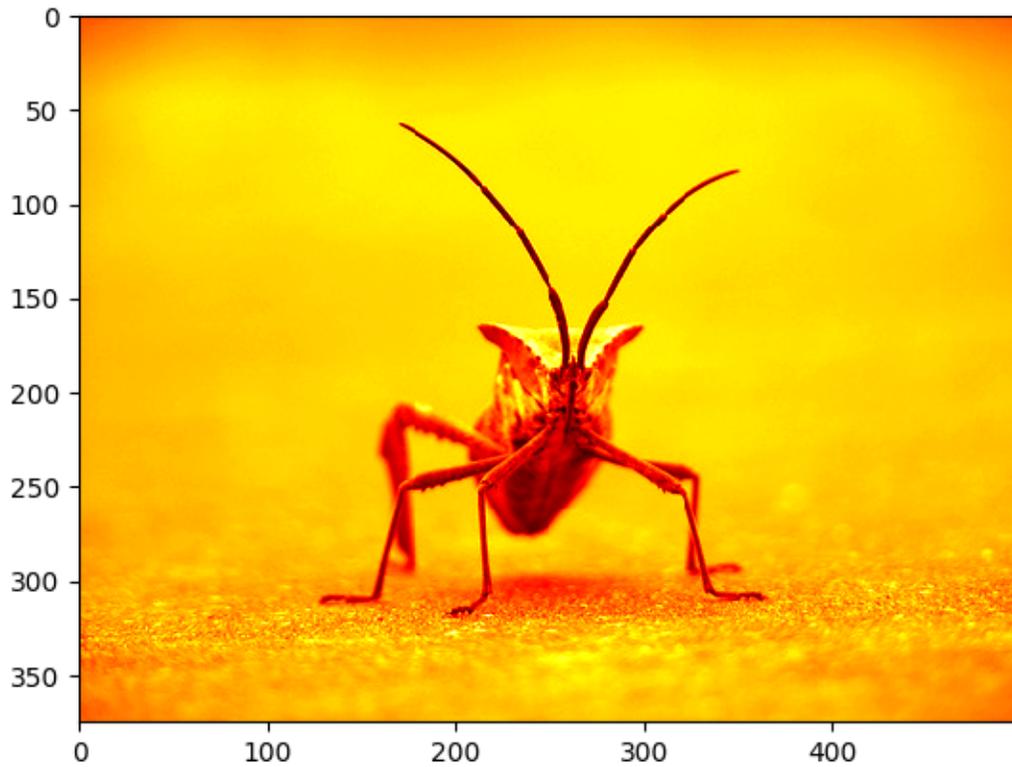
(continued from previous page)

```
# <https://docs.scipy.org/doc/numpy/user/quickstart.html>`_.  
plt.imshow(lum_img)
```



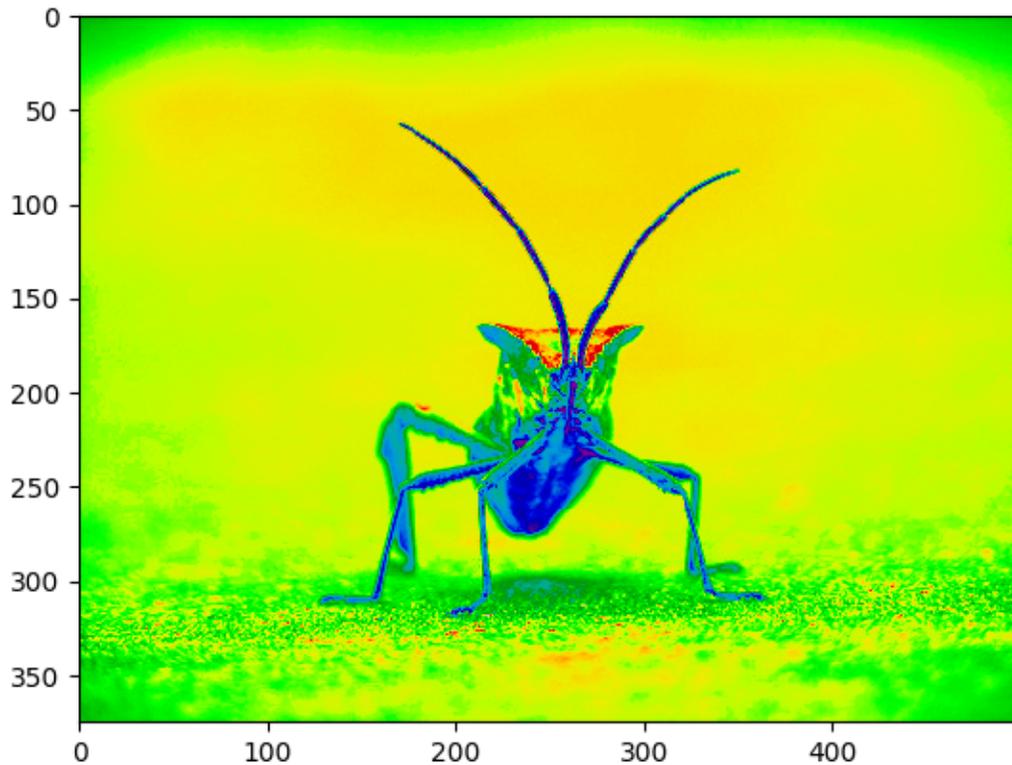
Now, with a luminosity (2D, no color) image, the default colormap (aka lookup table, LUT), is applied. The default is called viridis. There are plenty of others to choose from.

```
plt.imshow(lum_img, cmap="hot")
```



Note that you can also change colormaps on existing plot objects using the `set_cmap()` method:

```
imgplot = plt.imshow(lum_img)
imgplot.set_cmap('nipy_spectral')
```



---

**Note:** However, remember that in the IPython notebook with the inline backend, you can't make changes to plots that have already been rendered. If you create `imgplot` here in one cell, you cannot call `set_cmap()` on it in a later cell and expect the earlier plot to change. Make sure that you enter these commands together in one cell. `plt` commands will not change plots from earlier cells.

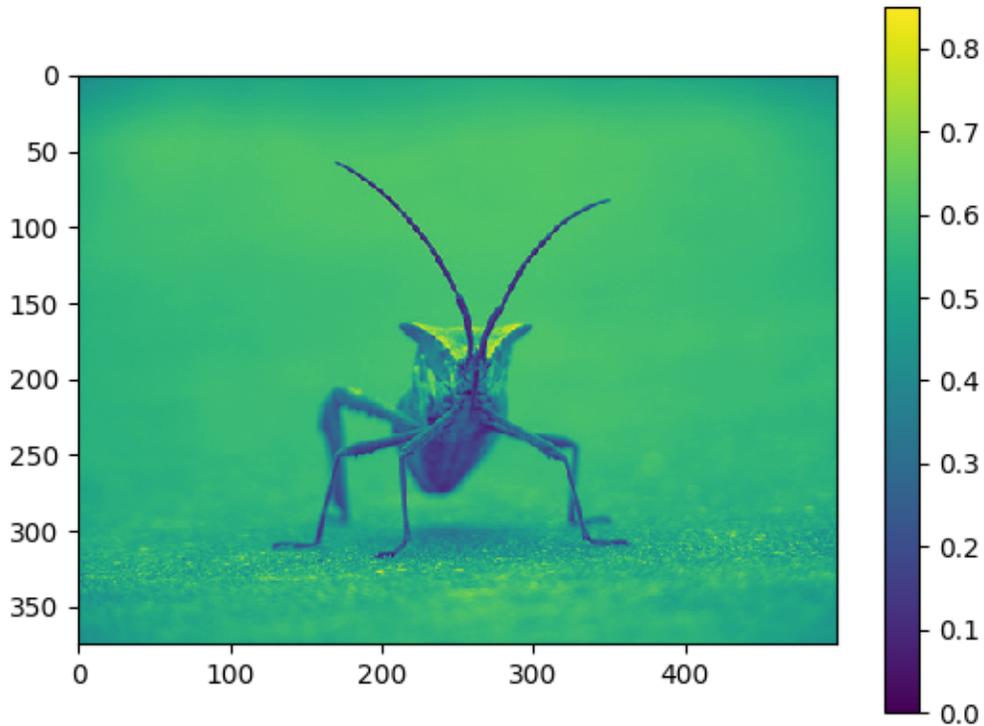
---

There are many other colormap schemes available. See the [list](#) and [images of the colormaps](#).

### Color scale reference

It's helpful to have an idea of what value a color represents. We can do that by adding color bars.

```
imgplot = plt.imshow(lum_img)
plt.colorbar()
```

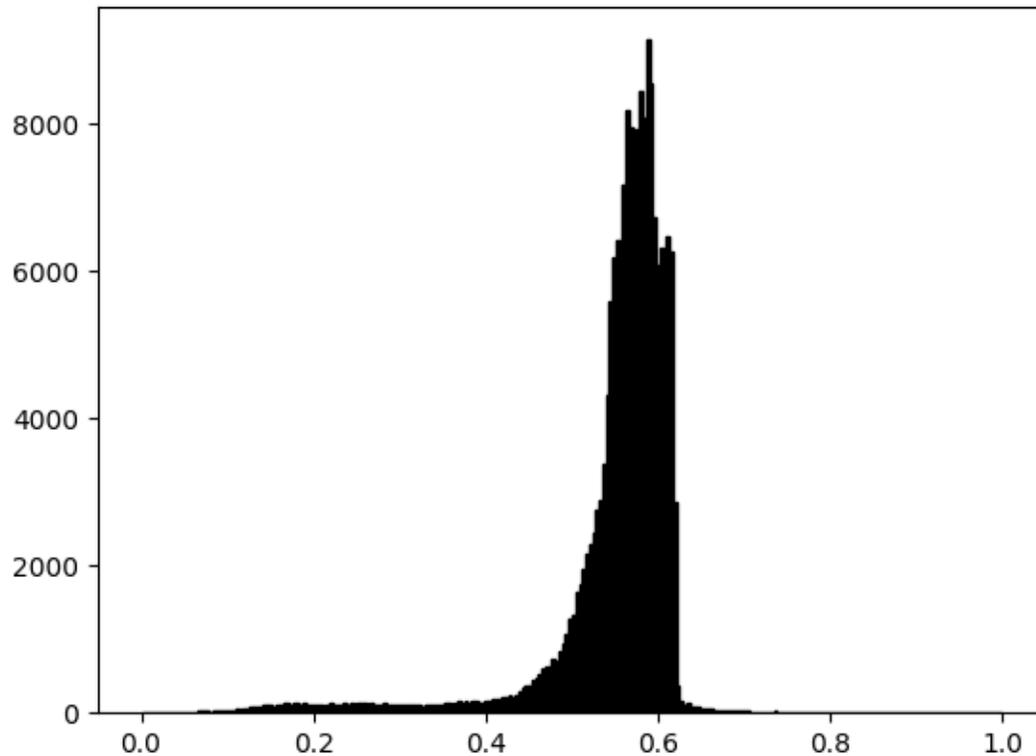


This adds a colorbar to your existing figure. This won't automatically change if you change you switch to a different colormap - you have to re-create your plot, and add in the colorbar again.

### Examining a specific data range

Sometimes you want to enhance the contrast in your image, or expand the contrast in a particular region while sacrificing the detail in colors that don't vary much, or don't matter. A good tool to find interesting regions is the histogram. To create a histogram of our image data, we use the `hist()` function.

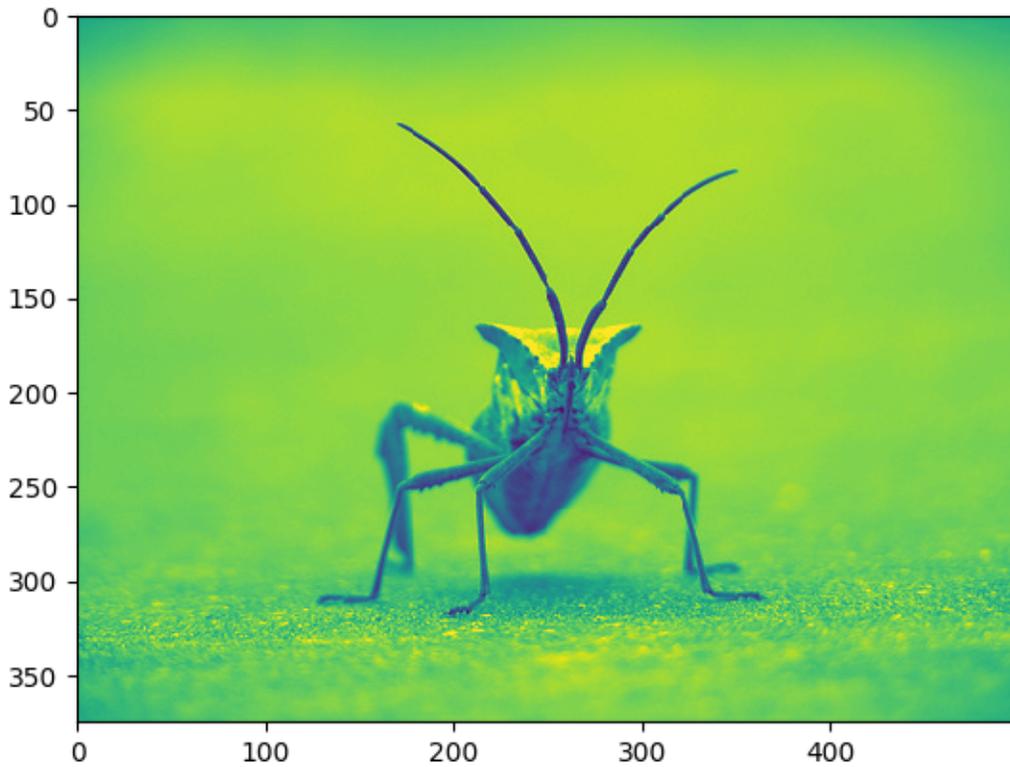
```
plt.hist(lum_img.ravel(), bins=256, range=(0.0, 1.0), fc='k', ec='k')
```



Most often, the “interesting” part of the image is around the peak, and you can get extra contrast by clipping the regions above and/or below the peak. In our histogram, it looks like there’s not much useful information in the high end (not many white things in the image). Let’s adjust the upper limit, so that we effectively “zoom in on” part of the histogram. We do this by passing the `clim` argument to `imshow`. You could also do this by calling the `set_clim()` method of the image plot object, but make sure that you do so in the same cell as your plot command when working with the IPython Notebook - it will not change plots from earlier cells.

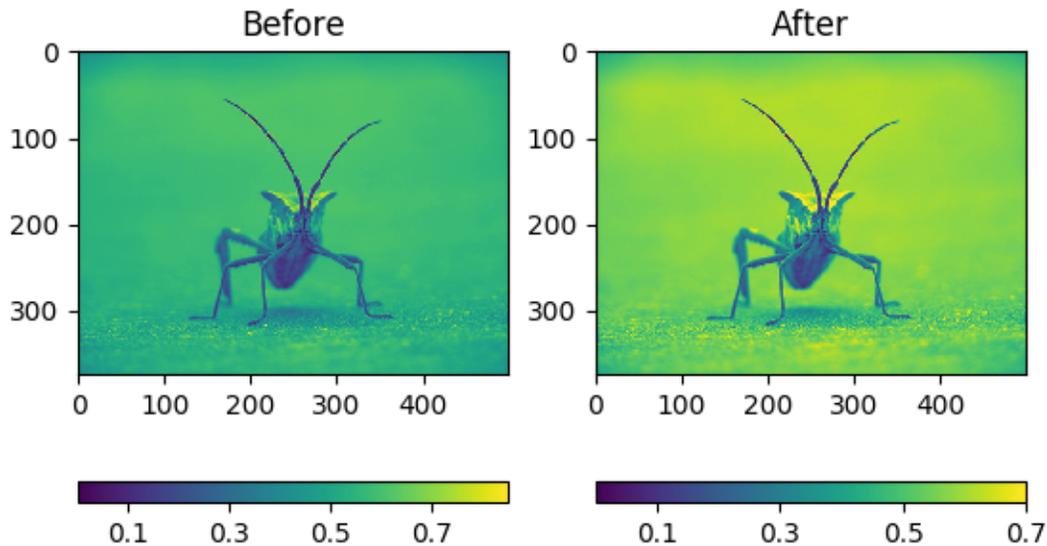
You can specify the `clim` in the call to `plot`.

```
imgplot = plt.imshow(lum_img, clim=(0.0, 0.7))
```



You can also specify the clim using the returned object

```
fig = plt.figure()
a = fig.add_subplot(1, 2, 1)
imgplot = plt.imshow(lum_img)
a.set_title('Before')
plt.colorbar(ticks=[0.1, 0.3, 0.5, 0.7], orientation='horizontal')
a = fig.add_subplot(1, 2, 2)
imgplot = plt.imshow(lum_img)
imgplot.set_clim(0.0, 0.7)
a.set_title('After')
plt.colorbar(ticks=[0.1, 0.3, 0.5, 0.7], orientation='horizontal')
```



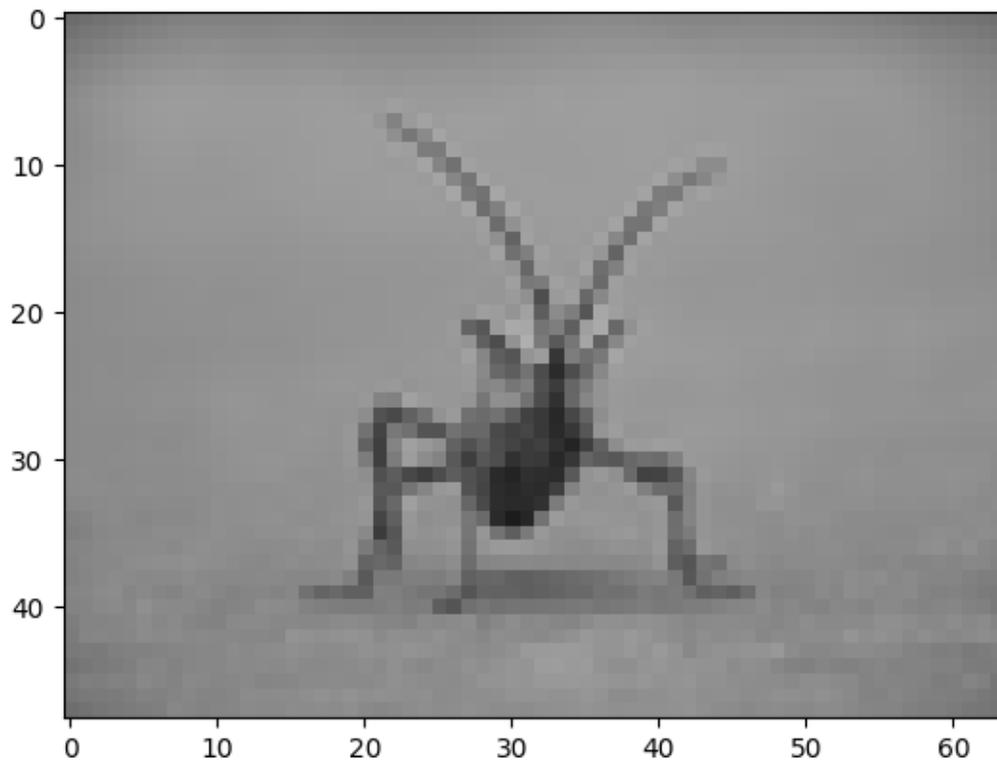
### Array Interpolation schemes

Interpolation calculates what the color or value of a pixel "should" be, according to different mathematical schemes. One common place that this happens is when you resize an image. The number of pixels change, but you want the same information. Since pixels are discrete, there's missing space. Interpolation is how you fill that space. This is why your images sometimes come out looking pixelated when you blow them up. The effect is more pronounced when the difference between the original image and the expanded image is greater. Let's take our image and shrink it. We're effectively discarding pixels, only keeping a select few. Now when we plot it, that data gets blown up to the size on your screen. The old pixels aren't there anymore, and the computer has to draw in pixels to fill that space.

We'll use the Pillow library that we used to load the image also to resize the image.

```
from PIL import Image

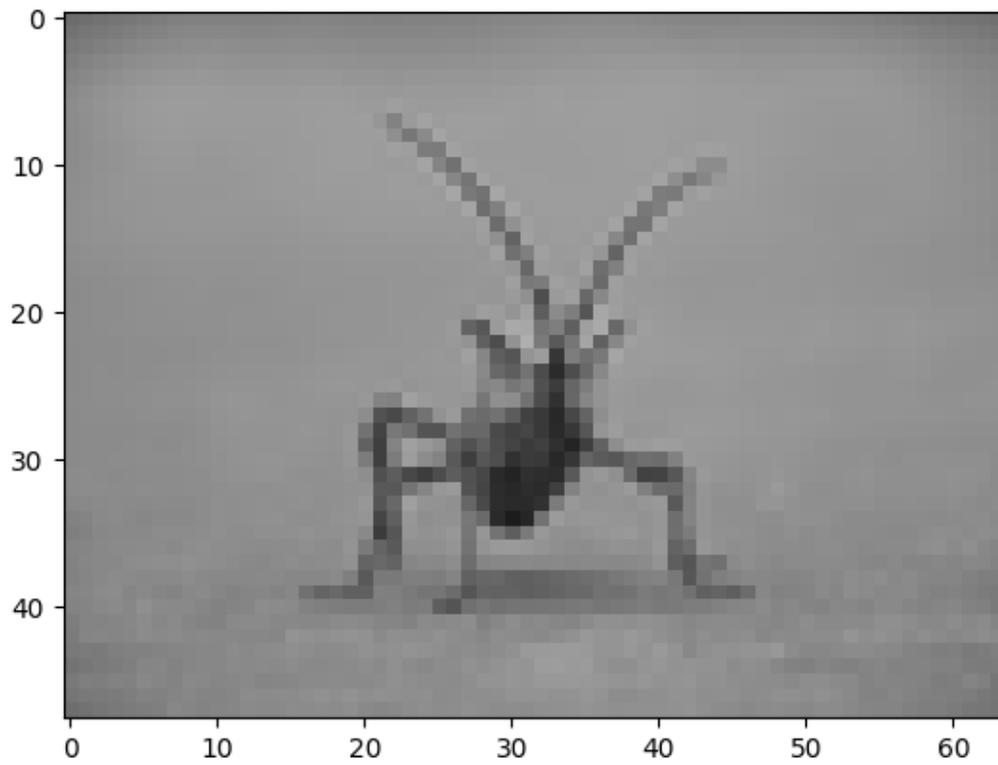
img = Image.open('../../doc/_static/stinkbug.png')
img.thumbnail((64, 64), Image.ANTIALIAS) # resizes image in-place
imgplot = plt.imshow(img)
```



Here we have the default interpolation, bilinear, since we did not give `imshow()` any interpolation argument.

Let's try some others. Here's "nearest", which does no interpolation.

```
imgplot = plt.imshow(img, interpolation="nearest")
```



and bicubic:

```
imgplot = plt.imshow(img, interpolation="bicubic")
```



Bicubic interpolation is often used when blowing up photos - people tend to prefer blurry over pixelated.

**Total running time of the script:** ( 0 minutes 1.185 seconds)

---

**Note:** Click [here](#) to download the full example code

---

### 2.1.5 The Lifecycle of a Plot

This tutorial aims to show the beginning, middle, and end of a single visualization using Matplotlib. We'll begin with some raw data and end by saving a figure of a customized visualization. Along the way we'll try to highlight some neat features and best-practices using Matplotlib.

---

**Note:** This tutorial is based off of [this excellent blog post](#) by Chris Moffitt. It was transformed into this tutorial by Chris Holdgraf.

---

## A note on the Object-Oriented API vs Pyplot

Matplotlib has two interfaces. The first is an object-oriented (OO) interface. In this case, we utilize an instance of `axes.Axes` in order to render visualizations on an instance of `figure.Figure`.

The second is based on MATLAB and uses a state-based interface. This is encapsulated in the `pyplot` module. See the *pyplot tutorials* for a more in-depth look at the `pyplot` interface.

Most of the terms are straightforward but the main thing to remember is that:

- The Figure is the final image that may contain 1 or more Axes.
- The Axes represent an individual plot (don't confuse this with the word "axis", which refers to the x/y axis of a plot).

We call methods that do the plotting directly from the Axes, which gives us much more flexibility and power in customizing our plot.

---

**Note:** In general, try to use the object-oriented interface over the `pyplot` interface.

---

## Our data

We'll use the data from the post from which this tutorial was derived. It contains sales information for a number of companies.

```
# sphinx_gallery_thumbnail_number = 10
import numpy as np
import matplotlib.pyplot as plt
from matplotlib.ticker import FuncFormatter

data = {'Barton LLC': 109438.50,
        'Frami, Hills and Schmidt': 103569.59,
        'Fritsch, Russel and Anderson': 112214.71,
        'Jerde-Hilpert': 112591.43,
        'Keeling LLC': 100934.30,
        'Koepp Ltd': 103660.54,
        'Kulas Inc': 137351.96,
        'Trantow-Barrows': 123381.38,
        'White-Trantow': 135841.99,
        'Will LLC': 104437.60}
group_data = list(data.values())
group_names = list(data.keys())
group_mean = np.mean(group_data)
```

## Getting started

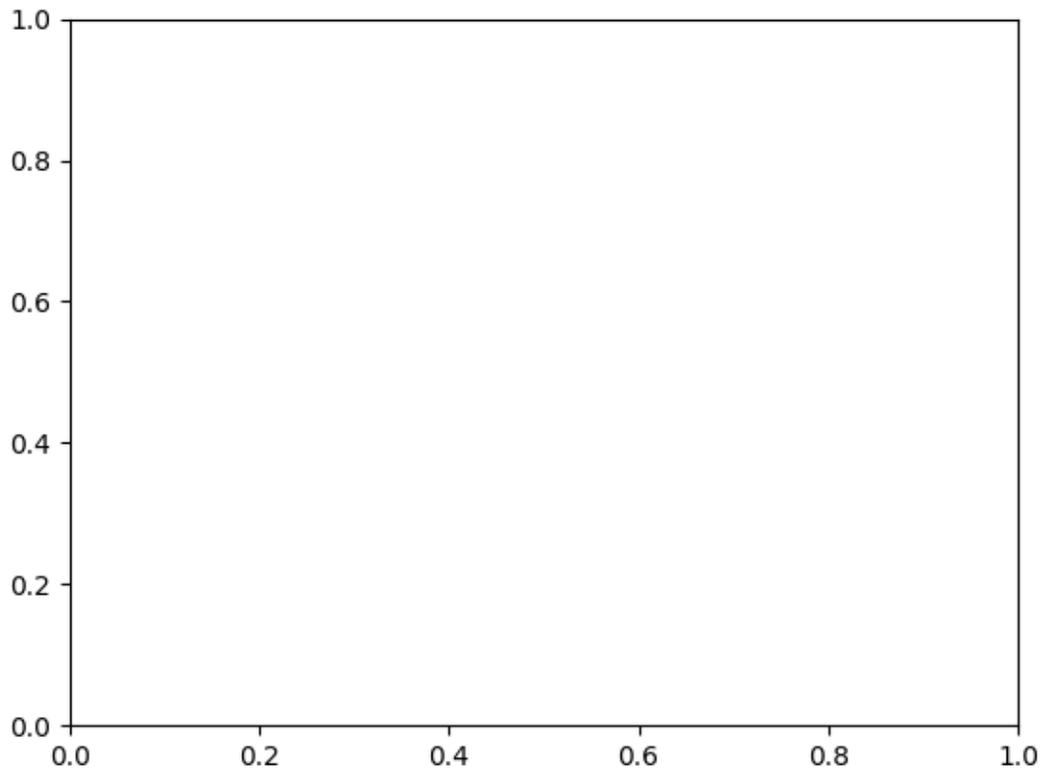
This data is naturally visualized as a barplot, with one bar per group. To do this with the object-oriented approach, we'll first generate an instance of `figure.Figure` and `axes.Axes`. The Figure is like a canvas, and the Axes is a part of that canvas on which we will make a particular visualization.

---

**Note:** Figures can have multiple axes on them. For information on how to do this, see the *Tight Layout tutorial*.

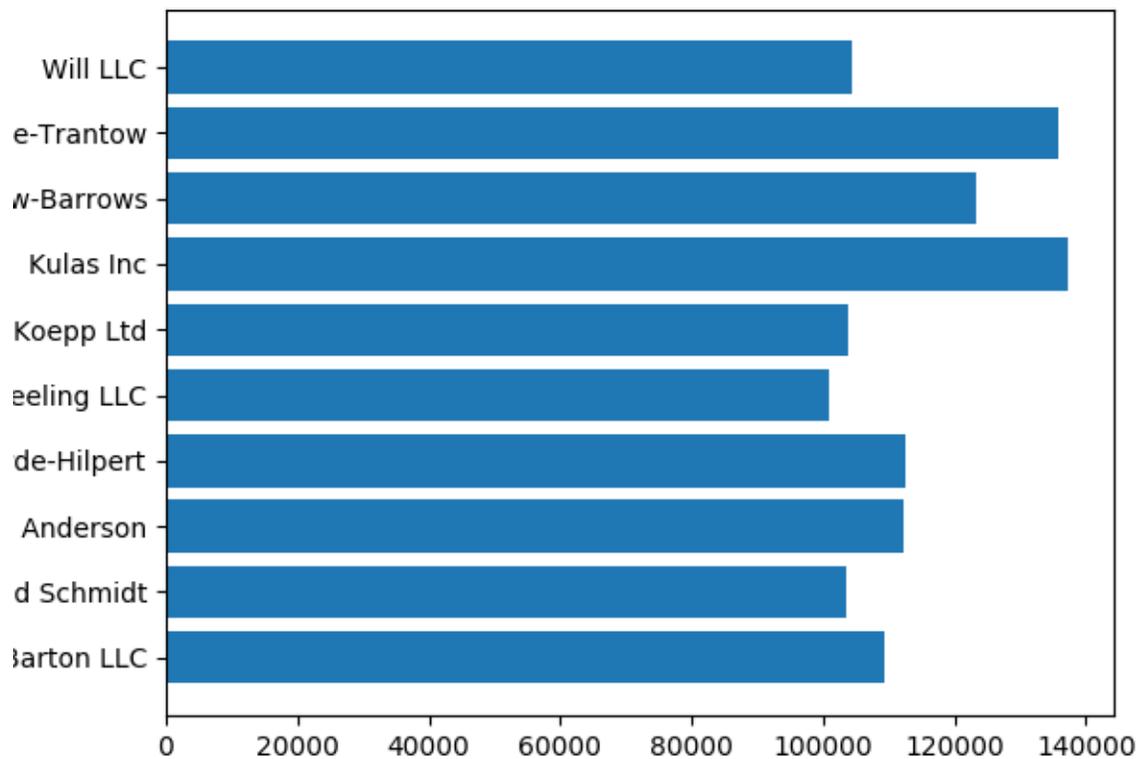
---

```
fig, ax = plt.subplots()
```



Now that we have an Axes instance, we can plot on top of it.

```
fig, ax = plt.subplots()
ax.barh(group_names, group_data)
```



### Controlling the style

There are many styles available in Matplotlib in order to let you tailor your visualization to your needs. To see a list of styles, we can use `pyplot.style`.

```
print(plt.style.available)
```

Out:

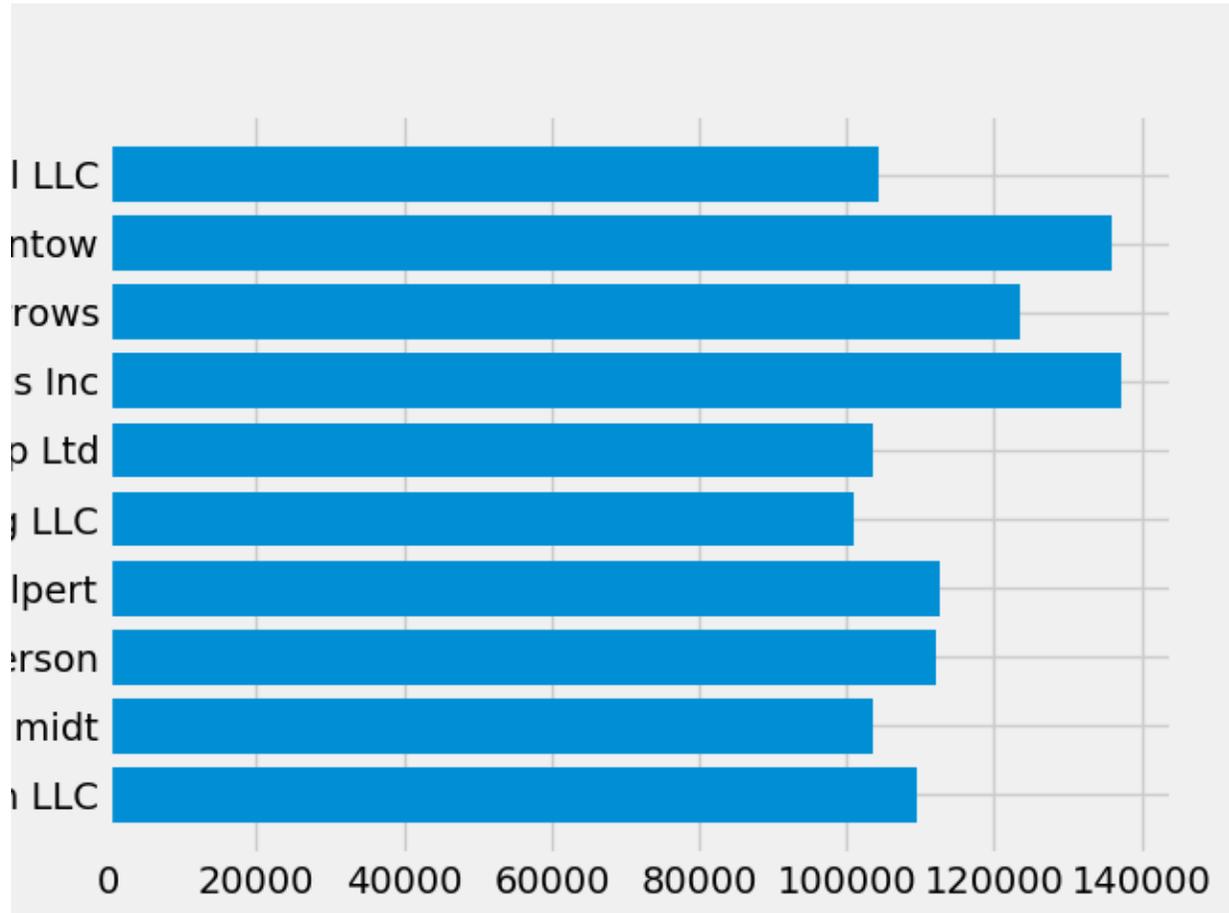
```
['seaborn-talk', 'seaborn-darkgrid', 'seaborn-whitegrid', 'grayscale', 'seaborn-pastel',
 ↪ 'seaborn', 'seaborn-muted', 'seaborn-ticks', 'fivethirtyeight', 'seaborn-dark',
 ↪ 'seaborn-deep', 'seaborn-poster', 'classic', 'ggplot', 'seaborn-bright', '_classic_test
 ↪ ', 'seaborn-white', 'Solarize_Light2', 'bmh', 'dark_background', 'seaborn-paper',
 ↪ 'seaborn-dark-palette', 'seaborn-colorblind', 'seaborn-notebook', 'tableau-colorblind10
 ↪ ', 'fast']
```

You can activate a style with the following:

```
plt.style.use('fivethirtyeight')
```

Now let's remake the above plot to see how it looks:

```
fig, ax = plt.subplots()
ax.barh(group_names, group_data)
```

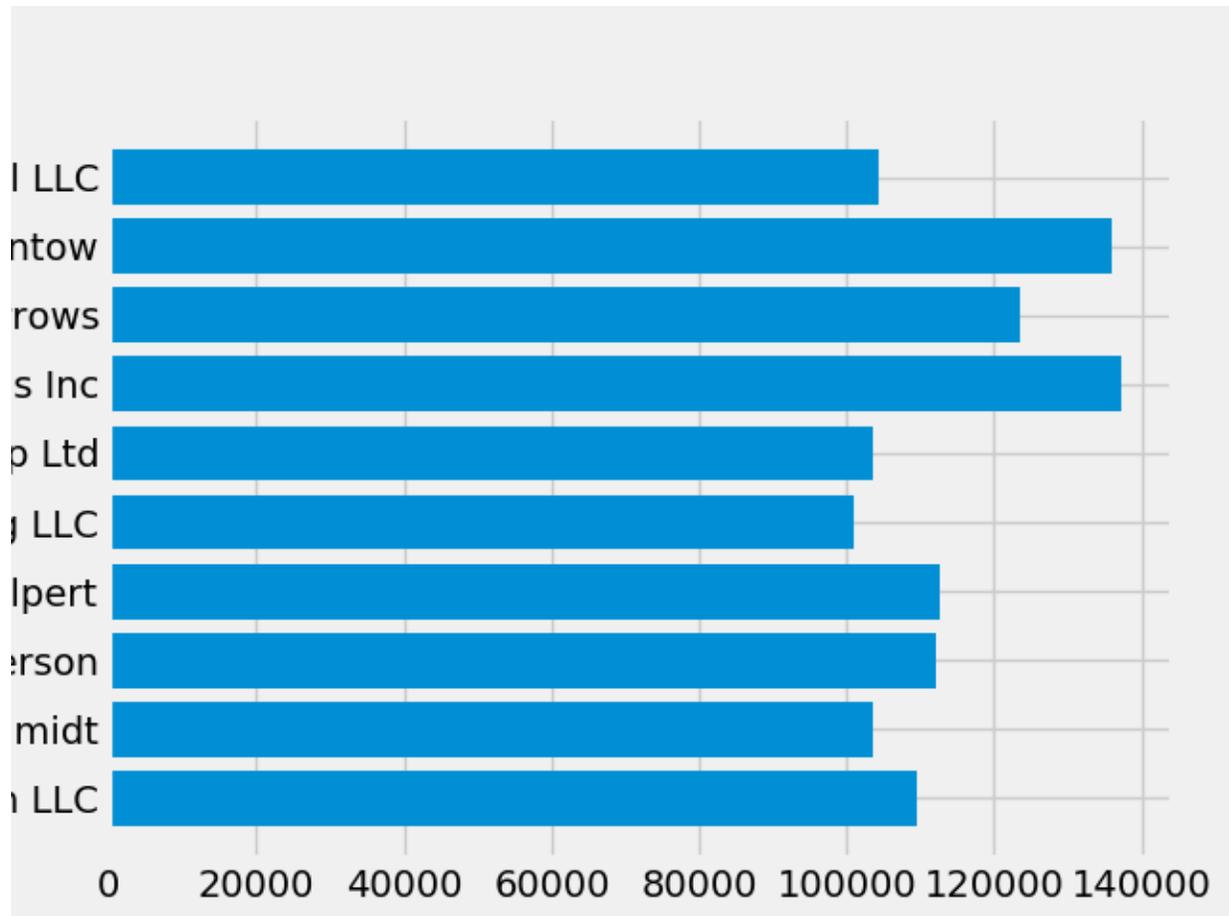


The style controls many things, such as color, linewidths, backgrounds, etc.

### Customizing the plot

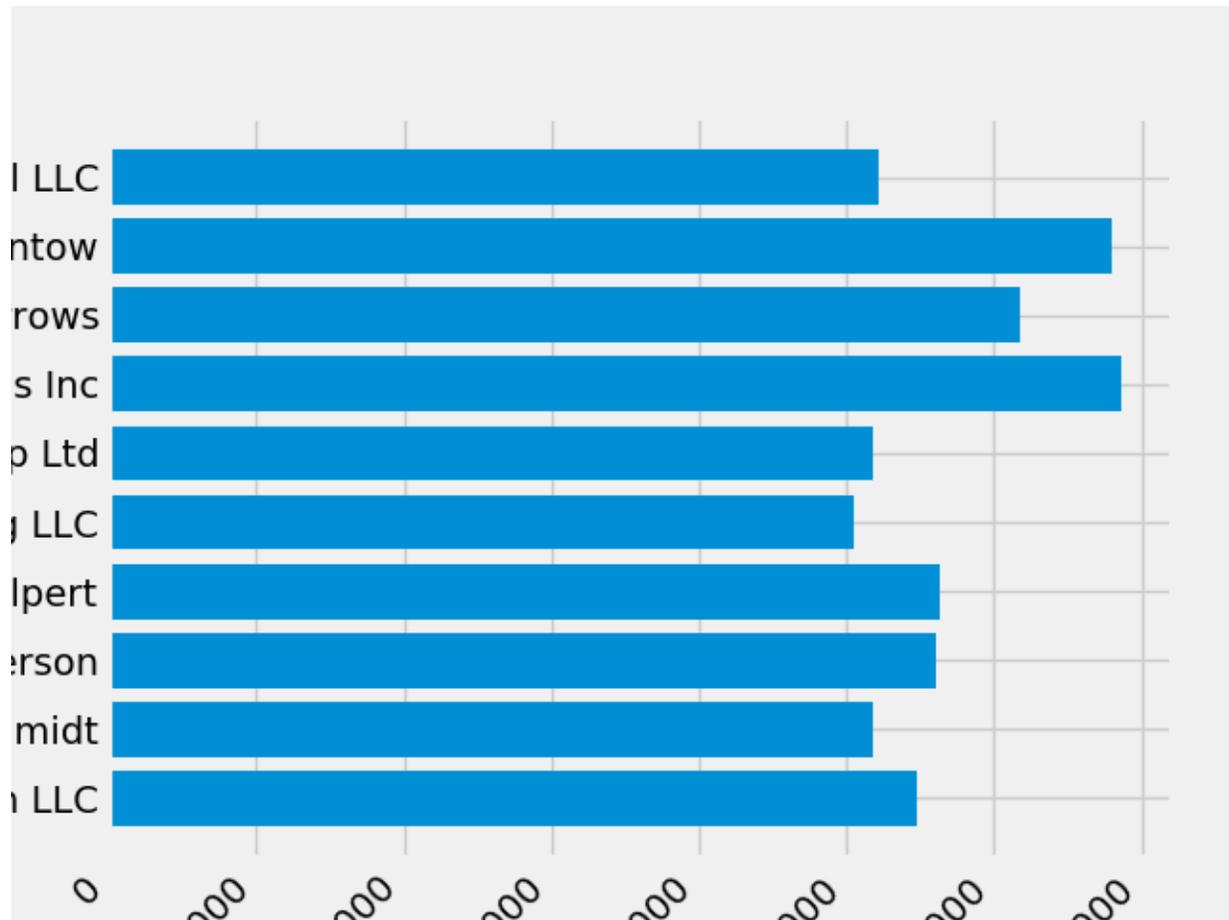
Now we've got a plot with the general look that we want, so let's fine-tune it so that it's ready for print. First let's rotate the labels on the x-axis so that they show up more clearly. We can gain access to these labels with the `axes.Axes.get_xticklabels()` method:

```
fig, ax = plt.subplots()
ax.barh(group_names, group_data)
labels = ax.get_xticklabels()
```



If we'd like to set the property of many items at once, it's useful to use the `pyplot.setp()` function. This will take a list (or many lists) of Matplotlib objects, and attempt to set some style element of each one.

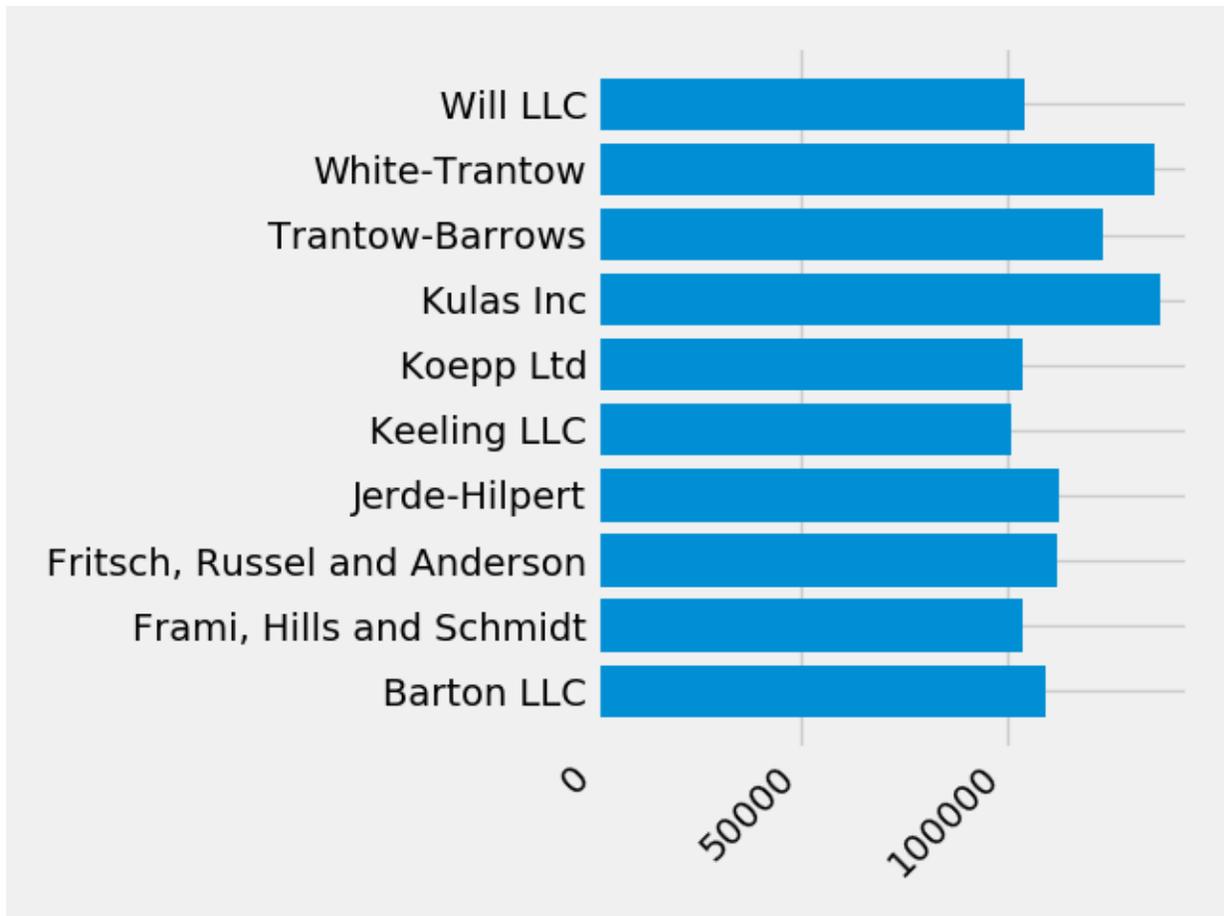
```
fig, ax = plt.subplots()
ax.barh(group_names, group_data)
labels = ax.get_xticklabels()
plt.setp(labels, rotation=45, horizontalalignment='right')
```



It looks like this cut off some of the labels on the bottom. We can tell Matplotlib to automatically make room for elements in the figures that we create. To do this we'll set the `autolayout` value of our `rcParams`. For more information on controlling the style, layout, and other features of plots with `rcParams`, see *Customizing Matplotlib with style sheets and `rcParams`*.

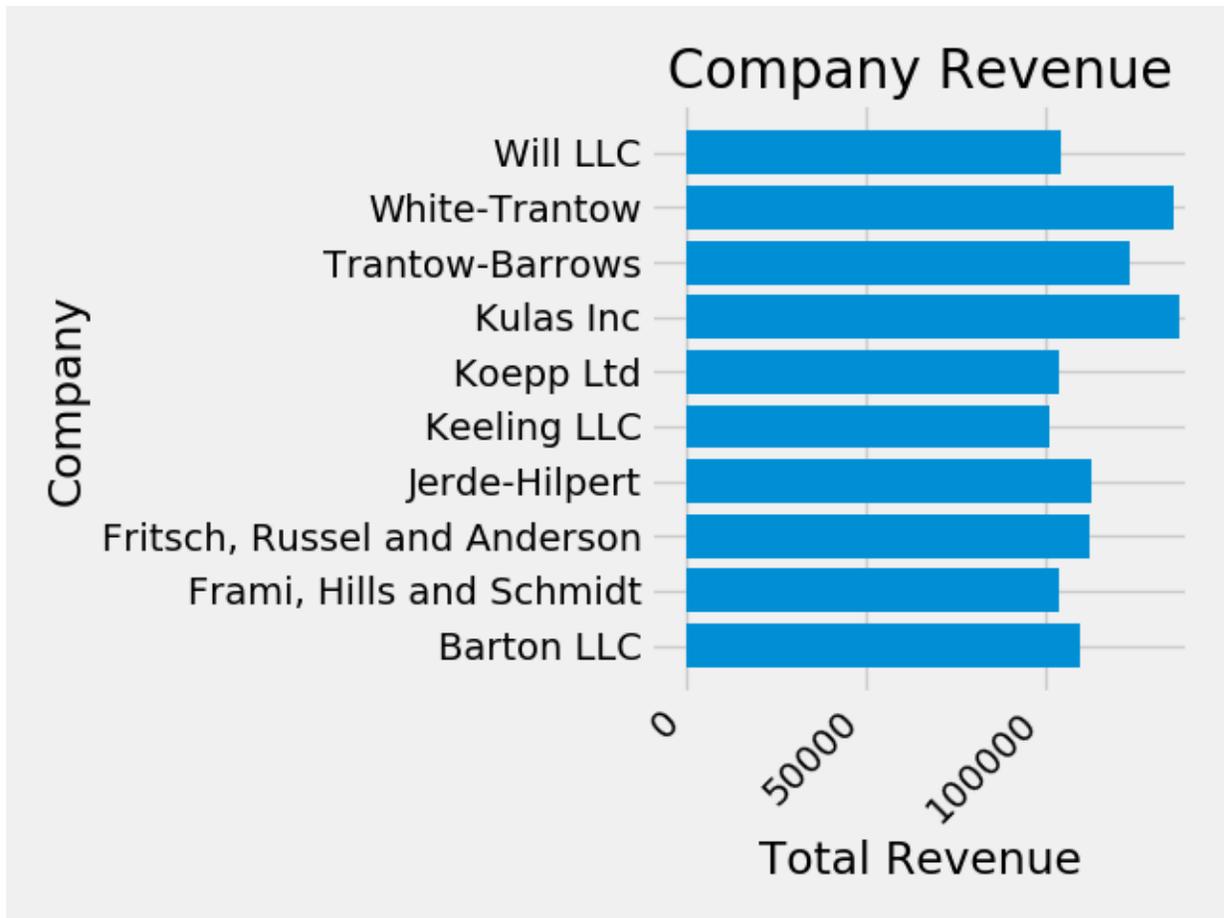
```
plt.rcParams.update({'figure.autolayout': True})

fig, ax = plt.subplots()
ax.barh(group_names, group_data)
labels = ax.get_xticklabels()
plt.setp(labels, rotation=45, horizontalalignment='right')
```



Next, we'll add labels to the plot. To do this with the OO interface, we can use the `axes.Axes.set()` method to set properties of this Axes object.

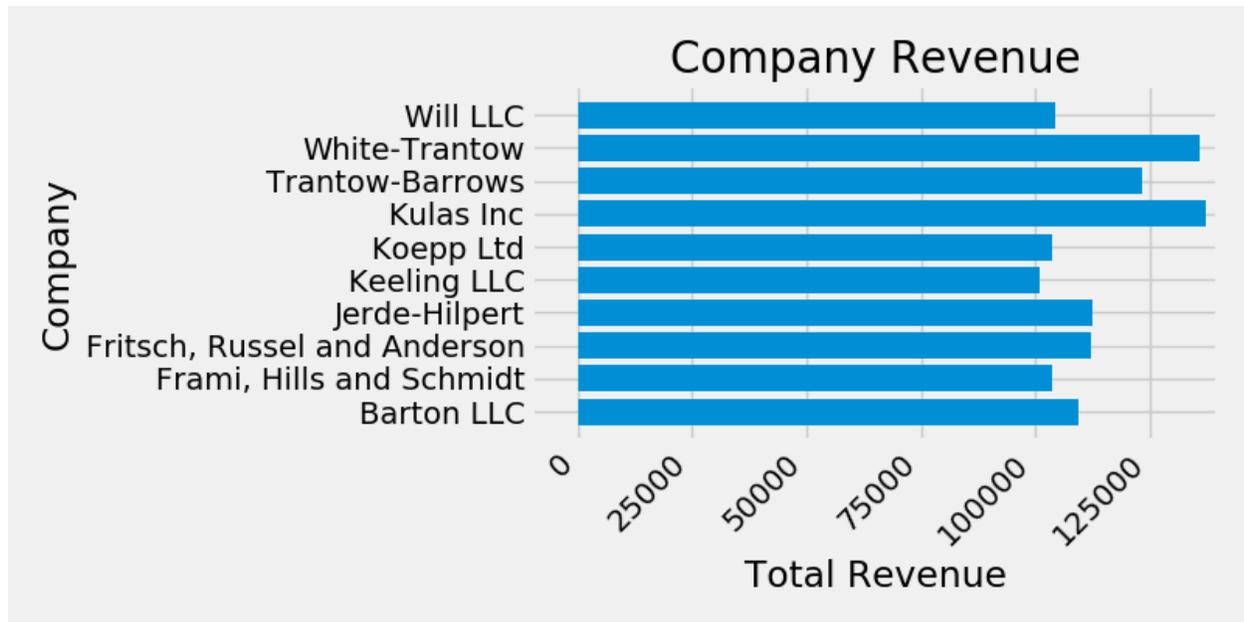
```
fig, ax = plt.subplots()
ax.barh(group_names, group_data)
labels = ax.get_xticklabels()
plt.setp(labels, rotation=45, horizontalalignment='right')
ax.set(xlim=[-10000, 140000], xlabel='Total Revenue', ylabel='Company',
       title='Company Revenue')
```



We can also adjust the size of this plot using the `pyplot.subplots()` function. We can do this with the `figsize` kwarg.

**Note:** While indexing in NumPy follows the form (row, column), the `figsize` kwarg follows the form (width, height). This follows conventions in visualization, which unfortunately are different from those of linear algebra.

```
fig, ax = plt.subplots(figsize=(8, 4))
ax.barh(group_names, group_data)
labels = ax.get_xticklabels()
plt.setp(labels, rotation=45, horizontalalignment='right')
ax.set(xlim=[-10000, 140000], xlabel='Total Revenue', ylabel='Company',
       title='Company Revenue')
```



For labels, we can specify custom formatting guidelines in the form of functions by using the `ticker.FuncFormatter` class. Below we'll define a function that takes an integer as input, and returns a string as an output.

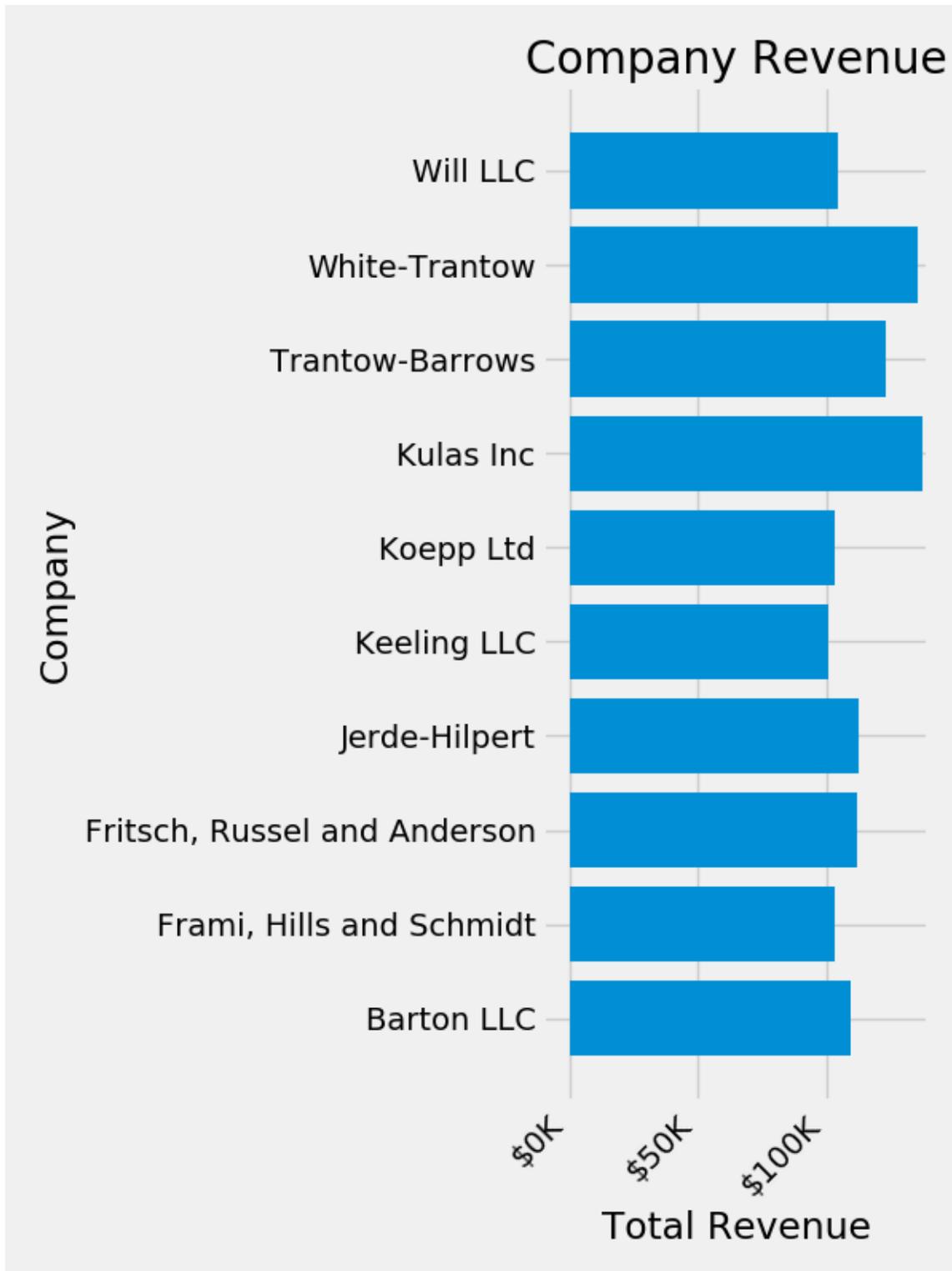
```
def currency(x, pos):
    """The two args are the value and tick position"""
    if x >= 1e6:
        s = '${:1.1f}M'.format(x*1e-6)
    else:
        s = '${:1.0f}K'.format(x*1e-3)
    return s
```

```
formatter = FuncFormatter(currency)
```

We can then apply this formatter to the labels on our plot. To do this, we'll use the `xaxis` attribute of our axis. This lets you perform actions on a specific axis on our plot.

```
fig, ax = plt.subplots(figsize=(6, 8))
ax.barh(group_names, group_data)
labels = ax.get_xticklabels()
plt.setp(labels, rotation=45, horizontalalignment='right')

ax.set(xlim=[-10000, 140000], xlabel='Total Revenue', ylabel='Company',
       title='Company Revenue')
ax.xaxis.set_major_formatter(formatter)
```



### Combining multiple visualizations

It is possible to draw multiple plot elements on the same instance of `axes.Axes`. To do this we simply need to call another one of the plot methods on that axes object.

```
fig, ax = plt.subplots(figsize=(8, 8))
ax.barh(group_names, group_data)
labels = ax.get_xticklabels()
plt.setp(labels, rotation=45, horizontalalignment='right')

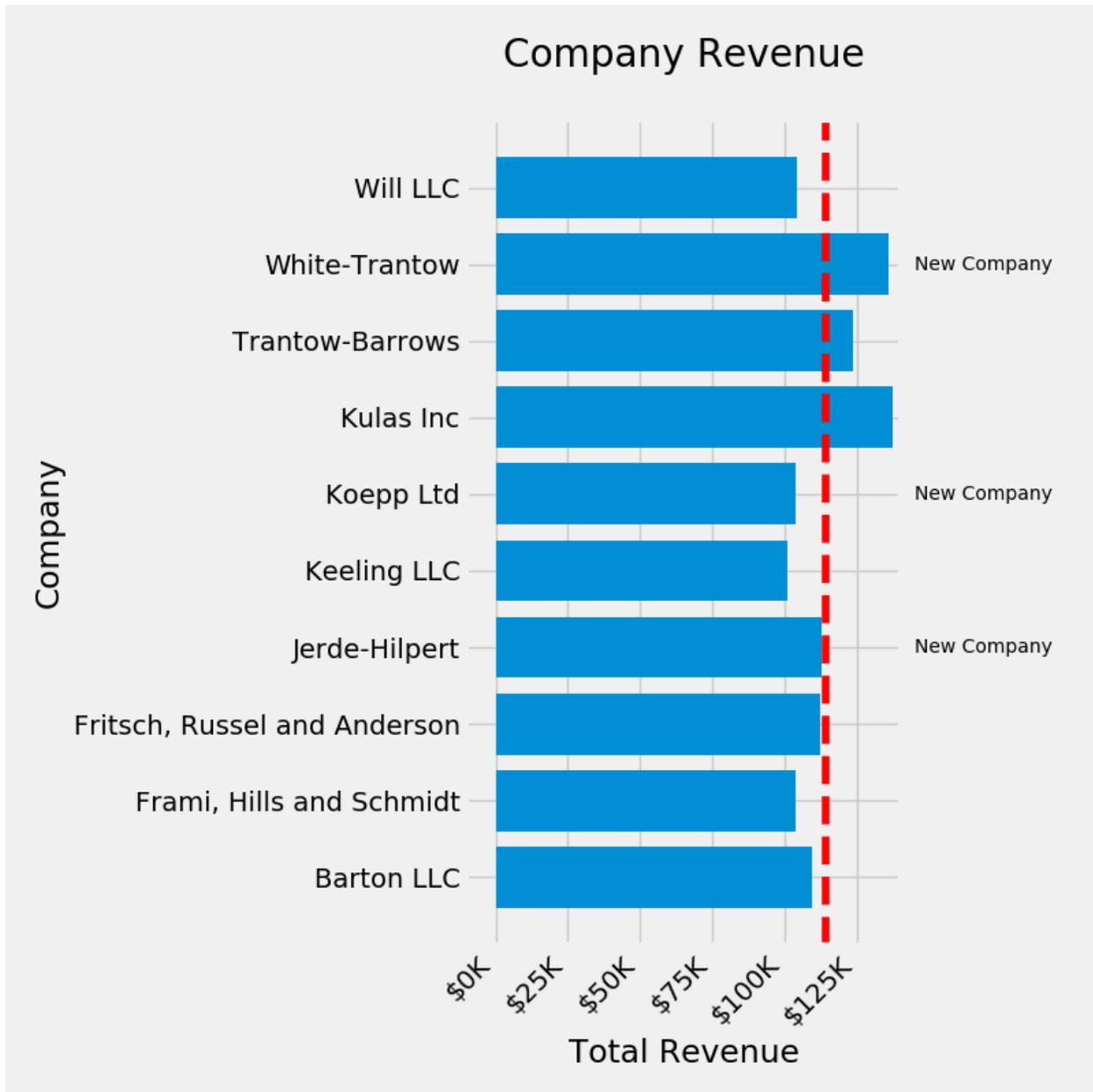
# Add a vertical line, here we set the style in the function call
ax.axvline(group_mean, ls='--', color='r')

# Annotate new companies
for group in [3, 5, 8]:
    ax.text(145000, group, "New Company", fontsize=10,
           verticalalignment="center")

# Now we'll move our title up since it's getting a little cramped
ax.title.set(y=1.05)

ax.set(xlim=[-10000, 140000], xlabel='Total Revenue', ylabel='Company',
       title='Company Revenue')
ax.xaxis.set_major_formatter(formatter)
ax.set_xticks([0, 25e3, 50e3, 75e3, 100e3, 125e3])
fig.subplots_adjust(right=.1)

plt.show()
```



### Saving our plot

Now that we're happy with the outcome of our plot, we want to save it to disk. There are many file formats we can save to in Matplotlib. To see a list of available options, use:

```
print(fig.canvas.get_supported_filetypes())
```

Out:

```
{'ps': 'Postscript', 'eps': 'Encapsulated Postscript', 'pdf': 'Portable Document Format',
↳ 'pgf': 'PGF code for LaTeX', 'png': 'Portable Network Graphics', 'raw': 'Raw RGBA
↳ bitmap', 'rgba': 'Raw RGBA bitmap', 'svg': 'Scalable Vector Graphics', 'svgz':
↳ 'Scalable Vector Graphics', 'jpg': 'Joint Photographic Experts Group', 'jpeg': 'Joint
↳ Photographic Experts Group', 'tif': 'Tagged Image File Format', 'tiff': 'Tagged Image
↳ File Format'}
```

We can then use the `figure.Figure.savefig()` in order to save the figure to disk. Note that there are several useful flags we'll show below:

- `transparent=True` makes the background of the saved figure transparent if the format supports it.
- `dpi=80` controls the resolution (dots per square inch) of the output.
- `bbox_inches="tight"` fits the bounds of the figure to our plot.

```
# Uncomment this line to save the figure.  
# fig.savefig('sales.png', transparent=False, dpi=80, bbox_inches="tight")
```

**Note:** Click [here](#) to download the full example code

## 2.1.6 Customizing Matplotlib with style sheets and rcParams

Tips for customizing the properties and default styles of Matplotlib.

### Using style sheets

The style package adds support for easy-to-switch plotting “styles” with the same parameters as a `matplotlib rc` file (which is read at startup to configure matplotlib).

There are a number of pre-defined styles [provided by Matplotlib](#). For example, there's a pre-defined style called “ggplot”, which emulates the aesthetics of `ggplot` (a popular plotting package for R). To use this style, just add:

```
import numpy as np  
import matplotlib.pyplot as plt  
import matplotlib as mpl  
plt.style.use('ggplot')  
data = np.random.randn(50)
```

To list all available styles, use:

```
print(plt.style.available)
```

Out:

```
['seaborn-talk', 'seaborn-darkgrid', 'seaborn-whitegrid', 'grayscale', 'seaborn-pastel',  
↪ 'seaborn', 'seaborn-muted', 'seaborn-ticks', 'fivethirtyeight', 'seaborn-dark',  
↪ 'seaborn-deep', 'seaborn-poster', 'classic', 'ggplot', 'seaborn-bright', '_classic_test',  
↪ 'seaborn-white', 'Solarize_Light2', 'bmh', 'dark_background', 'seaborn-paper',  
↪ 'seaborn-dark-palette', 'seaborn-colorblind', 'seaborn-notebook', 'tableau-colorblind10',  
↪ 'fast']
```

## Defining your own style

You can create custom styles and use them by calling `style.use` with the path or URL to the style sheet. Additionally, if you add your `<style-name>.mplstyle` file to `mpl_configdir/stylelib`, you can reuse your custom style sheet with a call to `style.use(<style-name>)`. By default `mpl_configdir` should be `~/.config/matplotlib`, but you can check where yours is with `matplotlib.get_configdir()`; you may need to create this directory. You also can change the directory where matplotlib looks for the `stylelib/` folder by setting the `MPLCONFIGDIR` environment variable, see *matplotlib configuration and cache directory locations*.

Note that a custom style sheet in `mpl_configdir/stylelib` will override a style sheet defined by matplotlib if the styles have the same name.

For example, you might want to create `mpl_configdir/stylelib/presentation.mplstyle` with the following:

```
axes.titlesize : 24
axes.labelsize : 20
lines.linewidth : 3
lines.markersize : 10
xtick.labelsize : 16
ytick.labelsize : 16
```

Then, when you want to adapt a plot designed for a paper to one that looks good in a presentation, you can just add:

```
>>> import matplotlib.pyplot as plt
>>> plt.style.use('presentation')
```

## Composing styles

Style sheets are designed to be composed together. So you can have a style sheet that customizes colors and a separate style sheet that alters element sizes for presentations. These styles can easily be combined by passing a list of styles:

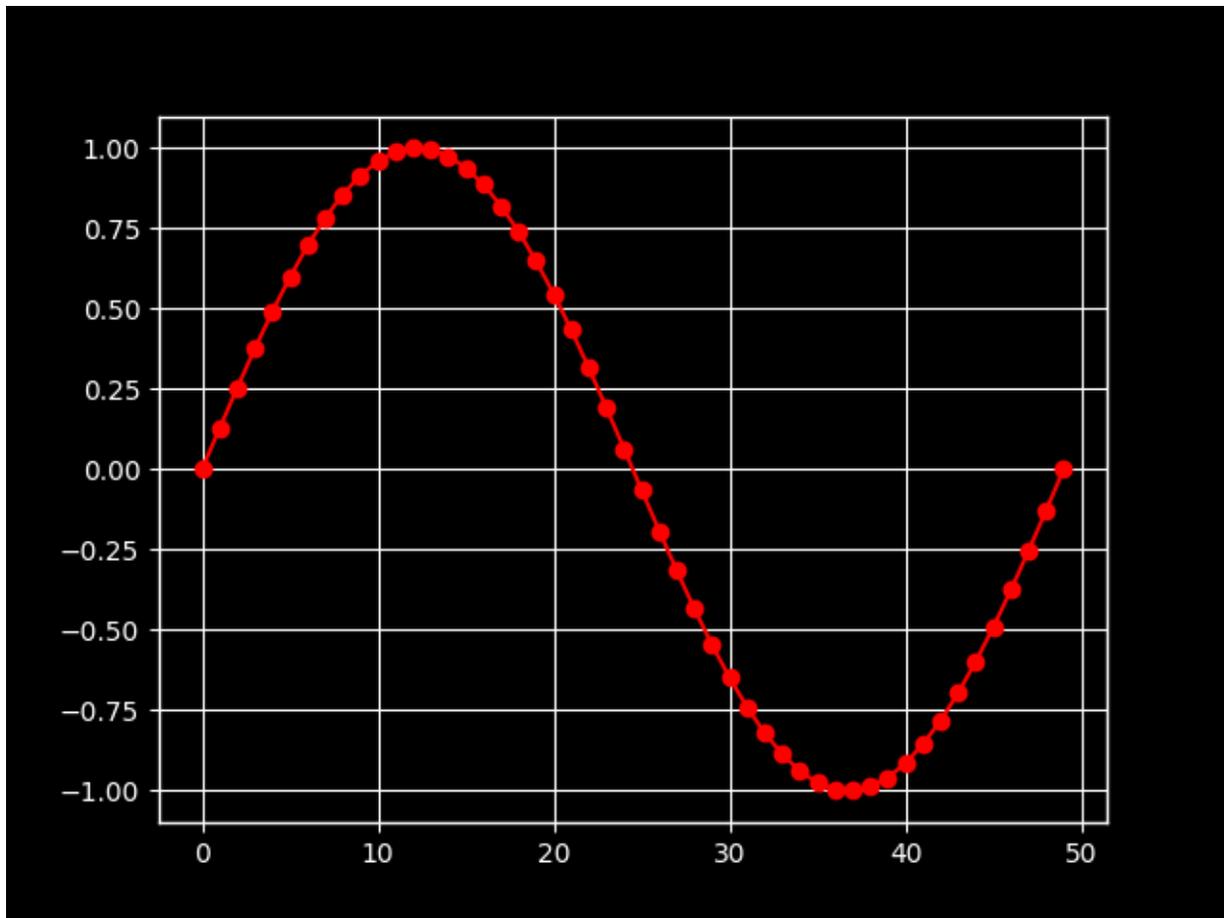
```
>>> import matplotlib.pyplot as plt
>>> plt.style.use(['dark_background', 'presentation'])
```

Note that styles further to the right will overwrite values that are already defined by styles on the left.

## Temporary styling

If you only want to use a style for a specific block of code but don't want to change the global styling, the style package provides a context manager for limiting your changes to a specific scope. To isolate your styling changes, you can write something like the following:

```
with plt.style.context('dark_background'):
    plt.plot(np.sin(np.linspace(0, 2 * np.pi)), 'r-o')
plt.show()
```

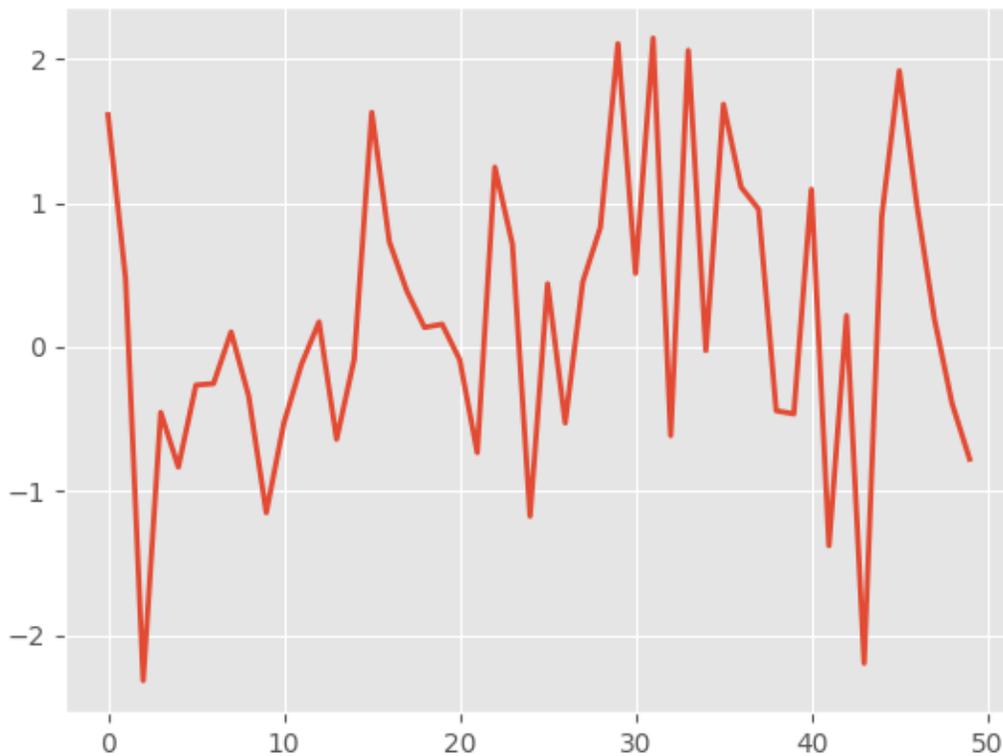


## 2.1.7 matplotlib rcParams

### Dynamic rc settings

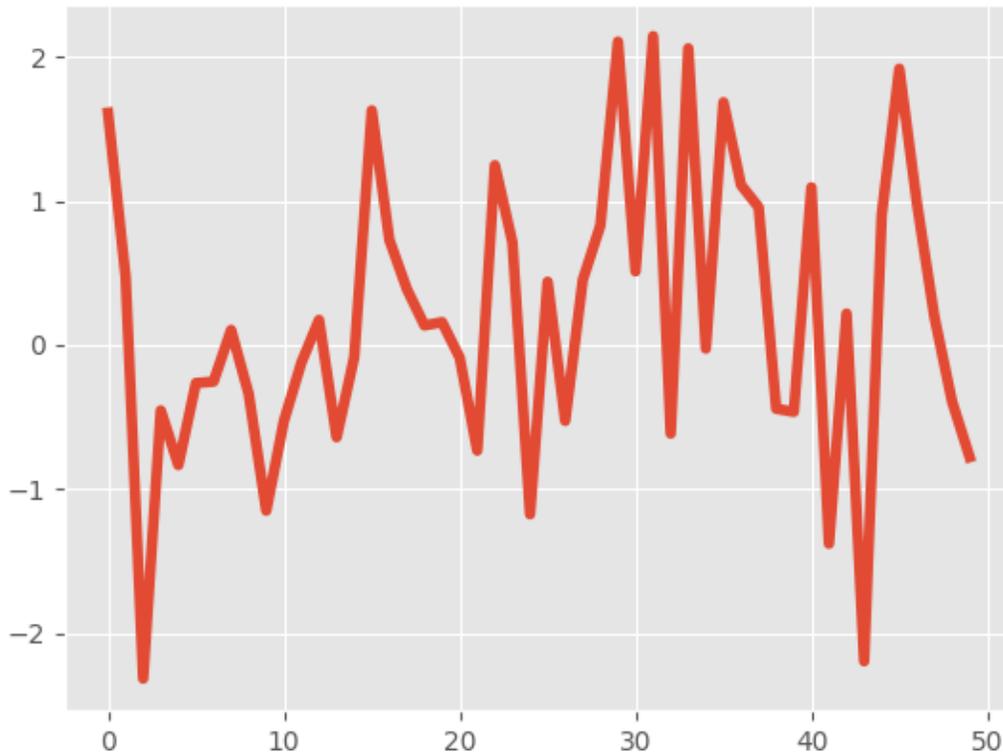
You can also dynamically change the default rc settings in a python script or interactively from the python shell. All of the rc settings are stored in a dictionary-like variable called *matplotlib.rcParams*, which is global to the matplotlib package. *rcParams* can be modified directly, for example:

```
mpl.rcParams['lines.linewidth'] = 2
mpl.rcParams['lines.color'] = 'r'
plt.plot(data)
```



Matplotlib also provides a couple of convenience functions for modifying rc settings. The `matplotlib.rc()` command can be used to modify multiple settings in a single group at once, using keyword arguments:

```
mpl.rc('lines', linewidth=4, color='g')
plt.plot(data)
```



The `matplotlib.rcParamsDefaults()` command will restore the standard matplotlib default settings. There is some degree of validation when setting the values of rcParams, see `matplotlib.rcParamsSetup` for details.

### The matplotlibrc file

matplotlib uses `matplotlibrc` configuration files to customize all kinds of properties, which we call rc settings or rc parameters. You can control the defaults of almost every property in matplotlib: figure size and dpi, line width, color and style, axes, axis and grid properties, text and font properties and so on. matplotlib looks for `matplotlibrc` in four locations, in the following order:

1. `matplotlibrc` in the current working directory, usually used for specific customizations that you do not want to apply elsewhere.
2. `$MATPLOTLIBRC` if it is a file, else `$MATPLOTLIBRC/matplotlibrc`.
3. It next looks in a user-specific place, depending on your platform:
  - On Linux and FreeBSD, it looks in `.config/matplotlib/matplotlibrc` (or `$XDG_CONFIG_HOME/matplotlib/matplotlibrc`) if you've customized your environment.
  - On other platforms, it looks in `.matplotlib/matplotlibrc`.

See *matplotlib configuration and cache directory locations*.

4. `INSTALL/matplotlib/mpl-data/matplotlibrc`, where `INSTALL` is something like `/usr/lib/python3.7/site-packages` on Linux, and maybe `C:\Python37\Lib\site-packages` on Windows. Every time you install matplotlib, this file will be overwritten, so if you want your customizations to be saved, please move this file to your user-specific matplotlib directory.

Once a `matplotlibrc` file has been found, it will *not* search any of the other paths.

To display where the currently active `matplotlibrc` file was loaded from, one can do the following:

```
>>> import matplotlib
>>> matplotlib.matplotlib_fname()
'/home/foo/.config/matplotlib/matplotlibrc'
```

See below for a sample `matplotlibrc` file.

### A sample `matplotlibrc` file

```
##### MATPLOTLIBRC FORMAT

## This is a sample matplotlib configuration file - you can find a copy
## of it on your system in
## site-packages/matplotlib/mpl-data/matplotlibrc. If you edit it
## there, please note that it will be overwritten in your next install.
## If you want to keep a permanent local copy that will not be
## overwritten, place it in the following location:
## unix/linux:
##     $HOME/.config/matplotlib/matplotlibrc or
##     $XDG_CONFIG_HOME/matplotlib/matplotlibrc (if $XDG_CONFIG_HOME is set)
## other platforms:
##     $HOME/.matplotlib/matplotlibrc
##
## See http://matplotlib.org/users/customizing.html#the-matplotlibrc-file for
## more details on the paths which are checked for the configuration file.
##
## This file is best viewed in a editor which supports python mode
## syntax highlighting. Blank lines, or lines starting with a comment
## symbol, are ignored, as are trailing comments. Other lines must
## have the format
##     key : val ## optional comment
##
## Colors: for the color values below, you can either use - a
## matplotlib color string, such as r, k, or b - an rgb tuple, such as
## (1.0, 0.5, 0.0) - a hex string, such as ff00ff - a scalar
## grayscale intensity such as 0.75 - a legal html color name, e.g., red,
## blue, darkslategray

##### CONFIGURATION BEGINS HERE

## The default backend. If you omit this parameter, the first
## working backend from the following list is used:
## MacOSX Qt5Agg Qt4Agg Gtk3Agg TkAgg WxAgg Agg
```

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```

##
## Other choices include:
## Qt5Cairo Qt4Cairo GTK3Cairo TkCairo WxCairo Cairo Wx PS PDF SVG Template.
##
## You can also deploy your own backend outside of matplotlib by
## referring to the module name (which must be in the PYTHONPATH) as
## 'module://my_backend'.
#backend      : Agg

## Note that this can be overridden by the environment variable
## QT_API used by Enthought Tool Suite (ETS); valid values are
## "pyqt" and "pyside". The "pyqt" setting has the side effect of
## forcing the use of Version 2 API for QString and QVariant.

## The port to use for the web server in the WebAgg backend.
#webagg.port  : 8988

## The address on which the WebAgg web server should be reachable
#webagg.address : 127.0.0.1

## If webagg.port is unavailable, a number of other random ports will
## be tried until one that is available is found.
#webagg.port_retries : 50

## When True, open the webbrowser to the plot that is shown
#webagg.open_in_browser : True

## if you are running pyplot inside a GUI and your backend choice
## conflicts, we will automatically try to find a compatible one for
## you if backend_fallback is True
#backend_fallback: True

#interactive  : False
#toolbar      : toolbar2    ## None | toolbar2 ("classic" is deprecated)
#timezone     : UTC         ## a pytz timezone string, e.g., US/Central or Europe/Paris

## Where your matplotlib data lives if you installed to a non-default
## location. This is where the matplotlib fonts, bitmaps, etc reside
#datapath    : /home/jdhunter/mpldata

#### LINES
## See http://matplotlib.org/api/artist\_api.html#module-matplotlib.lines for more
## information on line properties.
#lines.linewidth  : 1.5    ## line width in points
#lines.linestyle  : -      ## solid line
#lines.color      : C0     ## has no affect on plot(); see axes.prop_cycle
#lines.marker     : None   ## the default marker
#lines.markerfacecolor : auto ## the default markerfacecolor
#lines.markeredgecolor : auto ## the default markeredgecolor
#lines.markeredgewidth : 1.0 ## the line width around the marker symbol
#lines.markersize  : 6     ## markersize, in points

```

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```

#lines.dash_joinstyle : round      ## miter/round/bevel
#lines.dash_capstyle  : butt       ## butt/round/projecting
#lines.solid_joinstyle : round     ## miter/round/bevel
#lines.solid_capstyle : projecting ## butt/round/projecting
#lines.antialiased   : True        ## render lines in antialiased (no jaggies)

## The three standard dash patterns. These are scaled by the linewidth.
#lines.dashed_pattern : 3.7, 1.6
#lines.dashdot_pattern : 6.4, 1.6, 1, 1.6
#lines.dotted_pattern : 1, 1.65
#lines.scale_dashes   : True

#markers.fillstyle: full ## full/left/right/bottom/top/none

#### PATCHES
## Patches are graphical objects that fill 2D space, like polygons or
## circles. See
## http://matplotlib.org/api/artist\_api.html#module-matplotlib.patches
## information on patch properties
#patch.linewidth      : 1          ## edge width in points.
#patch.facecolor      : CO
#patch.edgecolor      : black     ## if forced, or patch is not filled
#patch.force_edgecolor : False    ## True to always use edgecolor
#patch.antialiased    : True      ## render patches in antialiased (no jaggies)

#### HATCHES
#hatch.color          : black
#hatch.linewidth     : 1.0

#### Boxplot
#boxplot.notch       : False
#boxplot.vertical    : True
#boxplot.whiskers    : 1.5
#boxplot.bootstrap   : None
#boxplot.patchartist : False
#boxplot.showmeans   : False
#boxplot.showcaps    : True
#boxplot.showbox     : True
#boxplot.showfliers  : True
#boxplot.meanline    : False

#boxplot.flierprops.color      : black
#boxplot.flierprops.marker     : o
#boxplot.flierprops.markerfacecolor : none
#boxplot.flierprops.markeredgecolor : black
#boxplot.flierprops.markeredgewidth : 1.0
#boxplot.flierprops.markersize  : 6
#boxplot.flierprops.linestyle   : none
#boxplot.flierprops.linewidth  : 1.0

#boxplot.boxprops.color      : black
#boxplot.boxprops.linewidth  : 1.0

```

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```

#boxplot.boxprops.linestyle : -

#boxplot.whiskerprops.color      : black
#boxplot.whiskerprops.linewidth : 1.0
#boxplot.whiskerprops.linestyle : -

#boxplot.capprops.color         : black
#boxplot.capprops.linewidth    : 1.0
#boxplot.capprops.linestyle    : -

#boxplot.medianprops.color     : C1
#boxplot.medianprops.linewidth : 1.0
#boxplot.medianprops.linestyle : -

#boxplot.meanprops.color       : C2
#boxplot.meanprops.marker      : ^
#boxplot.meanprops.markerfacecolor : C2
#boxplot.meanprops.markeredgecolor : C2
#boxplot.meanprops.markersize  : 6
#boxplot.meanprops.linestyle   : --
#boxplot.meanprops.linewidth   : 1.0

#### FONT

## font properties used by text.Text. See
## http://matplotlib.org/api/font\_manager\_api.html for more
## information on font properties. The 6 font properties used for font
## matching are given below with their default values.
##
## The font.family property has five values: 'serif' (e.g., Times),
## 'sans-serif' (e.g., Helvetica), 'cursive' (e.g., Zapf-Chancery),
## 'fantasy' (e.g., Western), and 'monospace' (e.g., Courier). Each of
## these font families has a default list of font names in decreasing
## order of priority associated with them. When text.usetex is False,
## font.family may also be one or more concrete font names.
##
## The font.style property has three values: normal (or roman), italic
## or oblique. The oblique style will be used for italic, if it is not
## present.
##
## The font.variant property has two values: normal or small-caps. For
## TrueType fonts, which are scalable fonts, small-caps is equivalent
## to using a font size of 'smaller', or about 83% of the current font
## size.
##
## The font.weight property has effectively 13 values: normal, bold,
## bolder, lighter, 100, 200, 300, ..., 900. Normal is the same as
## 400, and bold is 700. bolder and lighter are relative values with
## respect to the current weight.
##
## The font.stretch property has 11 values: ultra-condensed,

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```

## extra-condensed, condensed, semi-condensed, normal, semi-expanded,
## expanded, extra-expanded, ultra-expanded, wider, and narrower. This
## property is not currently implemented.
##
## The font.size property is the default font size for text, given in pts.
## 10 pt is the standard value.

#font.family          : sans-serif
#font.style           : normal
#font.variant         : normal
#font.weight          : normal
#font.stretch         : normal
## note that font.size controls default text sizes. To configure
## special text sizes tick labels, axes, labels, title, etc, see the rc
## settings for axes and ticks. Special text sizes can be defined
## relative to font.size, using the following values: xx-small, x-small,
## small, medium, large, x-large, xx-large, larger, or smaller
#font.size            : 10.0
#font.serif           : DejaVu Serif, Bitstream Vera Serif, Computer Modern Roman, New
↳Century Schoolbook, Century Schoolbook L, Utopia, ITC Bookman, Bookman, Nimbus Roman
↳No9 L, Times New Roman, Times, Palatino, Charter, serif
#font.sans-serif      : DejaVu Sans, Bitstream Vera Sans, Computer Modern Sans Serif,
↳Lucida Grande, Verdana, Geneva, Lucid, Arial, Helvetica, Avant Garde, sans-serif
#font.cursive         : Apple Chancery, Textile, Zapf Chancery, Sand, Script MT, Felipa,
↳cursive
#font.fantasy         : Comic Sans MS, Chicago, Charcoal, ImpactWestern, Humor Sans, xkcd,
↳fantasy
#font.monospace       : DejaVu Sans Mono, Bitstream Vera Sans Mono, Computer Modern
↳Typewriter, Andale Mono, Nimbus Mono L, Courier New, Courier, Fixed, Terminal,
↳monospace

#### TEXT
## text properties used by text.Text. See
## http://matplotlib.org/api/artist_api.html#module-matplotlib.text for more
## information on text properties
#text.color           : black

#### LaTeX customizations. See http://wiki.scipy.org/Cookbook/Matplotlib/UsingTex
#text.usetex          : False ## use latex for all text handling. The following fonts
## are supported through the usual rc parameter settings:
## new century schoolbook, bookman, times, palatino,
## zapf chancery, charter, serif, sans-serif, helvetica,
## avant garde, courier, monospace, computer modern roman,
## computer modern sans serif, computer modern typewriter
## If another font is desired which can loaded using the
## LaTeX \usepackage command, please inquire at the
## matplotlib mailing list
#text.latex.preamble : ## IMPROPER USE OF THIS FEATURE WILL LEAD TO LATEX FAILURES
## AND IS THEREFORE UNSUPPORTED. PLEASE DO NOT ASK FOR HELP
## IF THIS FEATURE DOES NOT DO WHAT YOU EXPECT IT TO.
## text.latex.preamble is a single line of LaTeX code that
## will be passed on to the LaTeX system. It may contain

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    ## any code that is valid for the LaTeX "preamble", i.e.
    ## between the "\documentclass" and "\begin{document}"
    ## statements.
    ## Note that it has to be put on a single line, which may
    ## become quite long.
    ## The following packages are always loaded with usetex, so
    ## beware of package collisions: color, geometry, graphicx,
    ## type1cm, textcomp.
    ## Adobe Postscript (PSSNFS) font packages may also be
    ## loaded, depending on your font settings.

text.latex.preview : False

text.hinting : auto    ## May be one of the following:
    ## none: Perform no hinting
    ## auto: Use FreeType's autohinter
    ## native: Use the hinting information in the
    ##           font file, if available, and if your
    ##           FreeType library supports it
    ## either: Use the native hinting information,
    ##           or the autohinter if none is available.
    ## For backward compatibility, this value may also be
    ## True == 'auto' or False == 'none'.

text.hinting_factor : 8 ## Specifies the amount of softness for hinting in the
    ## horizontal direction. A value of 1 will hint to full
    ## pixels. A value of 2 will hint to half pixels etc.

text.antialiased : True ## If True (default), the text will be antialiased.
    ## This only affects the Agg backend.

## The following settings allow you to select the fonts in math mode.
## They map from a TeX font name to a fontconfig font pattern.
## These settings are only used if mathtext.fontset is 'custom'.
## Note that this "custom" mode is unsupported and may go away in the
## future.
mathtext.cal : cursive
mathtext.rm : sans
mathtext.tt : monospace
mathtext.it : sans:italic
mathtext.bf : sans:bold
mathtext.sf : sans
mathtext.fontset : dejavusans ## Should be 'dejavusans' (default),
    ## 'dejavuserif', 'cm' (Computer Modern), 'stix',
    ## 'stixsans' or 'custom'

mathtext.fallback_to_cm : True ## When True, use symbols from the Computer Modern
    ## fonts when a symbol can not be found in one of
    ## the custom math fonts.

mathtext.default : it ## The default font to use for math.
    ## Can be any of the LaTeX font names, including
    ## the special name "regular" for the same font
    ## used in regular text.

#### AXES
## default face and edge color, default tick sizes,

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## default fontsize for ticklabels, and so on. See
## http://matplotlib.org/api/axes_api.html#module-matplotlib.axes
#axes.facecolor      : white    ## axes background color
#axes.edgecolor     : black    ## axes edge color
#axes.linewidth     : 0.8     ## edge linewidth
#axes.grid          : False    ## display grid or not
#axes.grid.axis     : both     ## which axis the grid should apply to
#axes.grid.which    : major    ## gridlines at major, minor or both ticks
#axes.titlesize     : large    ## fontsize of the axes title
#axes.titleweight   : normal   ## font weight of title
#axes.titlepad      : 6.0     ## pad between axes and title in points
#axes.labelsize     : medium   ## fontsize of the x any y labels
#axes.labelpad      : 4.0     ## space between label and axis
#axes.labelweight   : normal   ## weight of the x and y labels
#axes.labelcolor    : black
#axes.axisbelow     : line     ## draw axis gridlines and ticks below
                                ## patches (True); above patches but below
                                ## lines ('line'); or above all (False)
#axes.formatter.limits : -7, 7 ## use scientific notation if log10
                                ## of the axis range is smaller than the
                                ## first or larger than the second
#axes.formatter.use_locale : False ## When True, format tick labels
                                ## according to the user's locale.
                                ## For example, use ',' as a decimal
                                ## separator in the fr_FR locale.
#axes.formatter.use_mathtext : False ## When True, use mathtext for scientific
                                ## notation.
#axes.formatter.min_exponent: 0 ## minimum exponent to format in scientific notation
#axes.formatter.useoffset   : True  ## If True, the tick label formatter
                                ## will default to labeling ticks relative
                                ## to an offset when the data range is
                                ## small compared to the minimum absolute
                                ## value of the data.
#axes.formatter.offset_threshold : 4 ## When useoffset is True, the offset
                                ## will be used when it can remove
                                ## at least this number of significant
                                ## digits from tick labels.

#axes.spines.left   : True     ## display axis spines
#axes.spines.bottom : True
#axes.spines.top    : True
#axes.spines.right  : True
#axes.unicode_minus : True     ## use unicode for the minus symbol
                                ## rather than hyphen. See
                                ## http://en.wikipedia.org/wiki/Plus_and_minus_signs
↪ #Character_codes
#axes.prop_cycle    : cycler('color', ['1f77b4', 'ff7f0e', '2ca02c', 'd62728', '9467bd',
↪ '8c564b', 'e377c2', '7f7f7f', 'bcbd22', '17becf'])
                                ## color cycle for plot lines as list of string
                                ## colorspecs: single letter, long name, or web-style hex
                                ## Note the use of string escapes here ('1f77b4
↪ ', instead of 1f77b4)
                                ## as opposed to the rest of this file.

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#axes.autolimit_mode : data ## How to scale axes limits to the data.
                        ## Use "data" to use data limits, plus some margin
                        ## Use "round_number" move to the nearest "round" number
#axes.xmargin        : .05 ## x margin. See `axes.Axes.margins`
#axes.ymargin        : .05 ## y margin See `axes.Axes.margins`
#polaraxes.grid      : True  ## display grid on polar axes
#axes3d.grid         : True  ## display grid on 3d axes

#### DATES
## These control the default format strings used in AutoDateFormatter.
## Any valid format datetime format string can be used (see the python
## `datetime` for details). For example using '%x' will use the locale date
↳ representation
## '%X' will use the locale time representation and '%c' will use the full locale
↳ datetime
## representation.
## These values map to the scales:
##   {'year': 365, 'month': 30, 'day': 1, 'hour': 1/24, 'minute': 1 / (24 * 60)}

#date.autoformatter.year      : %Y
#date.autoformatter.month    : %Y-%m
#date.autoformatter.day      : %Y-%m-%d
#date.autoformatter.hour     : %m-%d %H
#date.autoformatter.minute   : %d %H:%M
#date.autoformatter.second   : %H:%M:%S
#date.autoformatter.microsecond : %M:%S.%f

#### TICKS
## see http://matplotlib.org/api/axis\_api.html#matplotlib.axis.Tick
#xtick.top                  : False ## draw ticks on the top side
#xtick.bottom               : True  ## draw ticks on the bottom side
#xtick.labeltop             : False ## draw label on the top
#xtick.labelbottom         : True  ## draw label on the bottom
#xtick.major.size           : 3.5  ## major tick size in points
#xtick.minor.size           : 2    ## minor tick size in points
#xtick.major.width          : 0.8  ## major tick width in points
#xtick.minor.width          : 0.6  ## minor tick width in points
#xtick.major.pad            : 3.5  ## distance to major tick label in points
#xtick.minor.pad            : 3.4  ## distance to the minor tick label in points
#xtick.color                 : black ## color of the tick labels
#xtick.labelsize            : medium ## fontsize of the tick labels
#xtick.direction            : out   ## direction: in, out, or inout
#xtick.minor.visible        : False ## visibility of minor ticks on x-axis
#xtick.major.top            : True  ## draw x axis top major ticks
#xtick.major.bottom        : True  ## draw x axis bottom major ticks
#xtick.minor.top            : True  ## draw x axis top minor ticks
#xtick.minor.bottom        : True  ## draw x axis bottom minor ticks
#xtick.alignment            : center ## alignment of xticks

#ytick.left                 : True  ## draw ticks on the left side
#ytick.right                : False ## draw ticks on the right side
#ytick.labelleft            : True  ## draw tick labels on the left side

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#ytick.labelright      : False  ## draw tick labels on the right side
#ytick.major.size     : 3.5    ## major tick size in points
#ytick.minor.size     : 2      ## minor tick size in points
#ytick.major.width    : 0.8    ## major tick width in points
#ytick.minor.width    : 0.6    ## minor tick width in points
#ytick.major.pad      : 3.5    ## distance to major tick label in points
#ytick.minor.pad      : 3.4    ## distance to the minor tick label in points
#ytick.color          : black   ## color of the tick labels
#ytick.labelsize      : medium  ## fontsize of the tick labels
#ytick.direction      : out     ## direction: in, out, or inout
#ytick.minor.visible  : False   ## visibility of minor ticks on y-axis
#ytick.major.left     : True    ## draw y axis left major ticks
#ytick.major.right    : True    ## draw y axis right major ticks
#ytick.minor.left     : True    ## draw y axis left minor ticks
#ytick.minor.right    : True    ## draw y axis right minor ticks
#ytick.alignment      : center_baseline ## alignment of yticks

#### GRIDS
#grid.color           : b0b0b0  ## grid color
#grid.linestyle       : -        ## solid
#grid.linewidth       : 0.8     ## in points
#grid.alpha           : 1.0     ## transparency, between 0.0 and 1.0

#### Legend
#legend.loc           : best
#legend.frameon      : True     ## if True, draw the legend on a background patch
#legend.framealpha    : 0.8     ## legend patch transparency
#legend.facecolor     : inherit  ## inherit from axes.facecolor; or color spec
#legend.edgecolor     : 0.8     ## background patch boundary color
#legend.fancybox      : True     ## if True, use a rounded box for the
                                ## legend background, else a rectangle
#legend.shadow        : False    ## if True, give background a shadow effect
#legend.numpoints     : 1        ## the number of marker points in the legend line
#legend.scatterpoints : 1        ## number of scatter points
#legend.markerscale   : 1.0     ## the relative size of legend markers vs. original
#legend.fontsize      : medium
#legend.title_fontsize : None    ## None sets to the same as the default axes.
## Dimensions as fraction of fontsize:
#legend.borderpad     : 0.4     ## border whitespace
#legend.labelspacing  : 0.5     ## the vertical space between the legend entries
#legend.handlelength  : 2.0     ## the length of the legend lines
#legend.handleheight  : 0.7     ## the height of the legend handle
#legend.handletextpad : 0.8     ## the space between the legend line and legend text
#legend.borderaxespad : 0.5     ## the border between the axes and legend edge
#legend.columnspacing : 2.0     ## column separation

#### FIGURE
## See http://matplotlib.org/api/figure\_api.html#matplotlib.figure.Figure
#figure.titlesize    : large     ## size of the figure title (Figure.suptitle())
#figure.titleweight   : normal   ## weight of the figure title
#figure.figsize       : 6.4, 4.8 ## figure size in inches
#figure.dpi           : 100     ## figure dots per inch

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#figure.facecolor : white      ## figure facecolor
#figure.edgecolor : white     ## figure edgecolor
#figure.frameon : True        ## enable figure frame
#figure.max_open_warning : 20 ## The maximum number of figures to open through
                             ## the pyplot interface before emitting a warning.
                             ## If less than one this feature is disabled.

## The figure subplot parameters. All dimensions are a fraction of the
#figure.subplot.left : 0.125  ## the left side of the subplots of the figure
#figure.subplot.right : 0.9    ## the right side of the subplots of the figure
#figure.subplot.bottom : 0.11  ## the bottom of the subplots of the figure
#figure.subplot.top : 0.88     ## the top of the subplots of the figure
#figure.subplot.wspace : 0.2   ## the amount of width reserved for space between
↳subplots,
                             ## expressed as a fraction of the average axis width
#figure.subplot.hspace : 0.2   ## the amount of height reserved for space between
↳subplots,
                             ## expressed as a fraction of the average axis height

## Figure layout
#figure.autolayout : False     ## When True, automatically adjust subplot
                             ## parameters to make the plot fit the figure
                             ## using `tight_layout`
#figure.constrained_layout.use: False ## When True, automatically make plot
                             ## elements fit on the figure. (Not compatible
                             ## with `autolayout`, above).
#figure.constrained_layout.h_pad : 0.04167 ## Padding around axes objects. Float
↳representing
#figure.constrained_layout.w_pad : 0.04167 ## inches. Default is 3./72. inches (3 pts)
#figure.constrained_layout.hspace : 0.02   ## Space between subplot groups. Float
↳representing
#figure.constrained_layout.wspace : 0.02   ## a fraction of the subplot widths being
↳separated.

#### IMAGES
#image.aspect : equal          ## equal | auto | a number
#image.interpolation : nearest ## see help(imshow) for options
#image.cmap : viridis          ## A colormap name, gray etc...
#image.lut : 256               ## the size of the colormap lookup table
#image.origin : upper          ## lower | upper
#image.resample : True
#image.composite_image : True  ## When True, all the images on a set of axes are
                             ## combined into a single composite image before
                             ## saving a figure as a vector graphics file,
                             ## such as a PDF.

#### CONTOUR PLOTS
#contour.negative_linestyle : dashed ## string or on-off ink sequence
#contour.corner_mask : True      ## True | False | legacy

#### ERRORBAR PLOTS
#errorbar.capsize : 0          ## length of end cap on error bars in pixels

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##### HISTOGRAM PLOTS
#hist.bins : 10                ## The default number of histogram bins.
                                ## If Numpy 1.11 or later is
                                ## installed, may also be `auto`

##### SCATTER PLOTS
#scatter.marker : o           ## The default marker type for scatter plots.
#scatter.edgecolors : face    ## The default edgecolors for scatter plots.

##### Agg rendering
##### Warning: experimental, 2008/10/10
#agg.path.chunksize : 0      ## 0 to disable; values in the range
                                ## 10000 to 100000 can improve speed slightly
                                ## and prevent an Agg rendering failure
                                ## when plotting very large data sets,
                                ## especially if they are very gappy.
                                ## It may cause minor artifacts, though.
                                ## A value of 20000 is probably a good
                                ## starting point.

##### PATHS
#path.simplify : True        ## When True, simplify paths by removing "invisible"
                                ## points to reduce file size and increase rendering
                                ## speed
#path.simplify_threshold : 0.111111111111 ## The threshold of similarity below which
                                ## vertices will be removed in the
                                ## simplification process
#path.snap : True           ## When True, rectilinear axis-aligned paths will be snapped to
                                ## the nearest pixel when certain criteria are met. When False,
                                ## paths will never be snapped.
#path.sketch : None         ## May be none, or a 3-tuple of the form (scale, length,
                                ## randomness).
                                ## *scale* is the amplitude of the wiggle
                                ## perpendicular to the line (in pixels). *length*
                                ## is the length of the wiggle along the line (in
                                ## pixels). *randomness* is the factor by which
                                ## the length is randomly scaled.
#path.effects : []         ##

##### SAVING FIGURES
## the default savefig params can be different from the display params
## e.g., you may want a higher resolution, or to make the figure
## background white
#savefig.dpi          : figure  ## figure dots per inch or 'figure'
#savefig.facecolor    : white   ## figure facecolor when saving
#savefig.edgecolor    : white   ## figure edgecolor when saving
#savefig.format       : png     ## png, ps, pdf, svg
#savefig.bbox         : standard ## 'tight' or 'standard'.
                                ## 'tight' is incompatible with pipe-based animation
                                ## backends but will workd with temporary file based
↪ ones:
                                ## e.g. setting animation.writer to ffmpeg will not work,
                                ## use ffmpeg_file instead

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#savefig.pad_inches : 0.1      ## Padding to be used when bbox is set to 'tight'
#savefig.jpeg_quality: 95      ## when a jpeg is saved, the default quality parameter.
#savefig.directory  : ~        ## default directory in savefig dialog box,
                                ## leave empty to always use current working directory
#savefig.transparent : False    ## setting that controls whether figures are saved with a
                                ## transparent background by default
#savefig.orientation : portrait ## Orientation of saved figure

### tk backend params
#tk.window_focus   : False     ## Maintain shell focus for TkAgg

### ps backend params
#ps.papersize      : letter    ## auto, letter, legal, ledger, A0-A10, B0-B10
#ps.useafm         : False     ## use of afm fonts, results in small files
#ps.usedistiller   : False     ## can be: None, ghostscript or xpdf
                                ## Experimental: may produce smaller files.
                                ## xpdf intended for production of publication_
→quality files,
                                ## but requires ghostscript, xpdf and ps2eps
#ps.distiller.res  : 6000      ## dpi
#ps.fonttype       : 3         ## Output Type 3 (Type3) or Type 42 (TrueType)

### pdf backend params
#pdf.compression   : 6        ## integer from 0 to 9
                                ## 0 disables compression (good for debugging)
#pdf.fonttype      : 3         ## Output Type 3 (Type3) or Type 42 (TrueType)
#pdf.use14corefonts : False
#pdf.inheritcolor  : False

### svg backend params
#svg.image_inline : True      ## write raster image data directly into the svg file
#svg.fonttype     : path      ## How to handle SVG fonts:
    ## none: Assume fonts are installed on the machine where the SVG will be viewed.
    ## path: Embed characters as paths -- supported by most SVG renderers
#svg.hashsalt     : None      ## if not None, use this string as hash salt
                                ## instead of uuid4

### pgf parameter
#pgf.rcfonts      : True
#pgf.preamble     :           ## see text.latex.preamble for documentation
#pgf.texsystem    : xelatex

### docstring params
##docstring.hardcopy = False ## set this when you want to generate hardcopy docstring

## Event keys to interact with figures/plots via keyboard.
## Customize these settings according to your needs.
## Leave the field(s) empty if you don't need a key-map. (i.e., fullscreen : '')
#keymap.fullscreen : f, ctrl+f ## toggling
#keymap.home       : h, r, home ## home or reset mnemonic
#keymap.back       : left, c, backspace, MouseButton.BACK ## forward / backward keys
#keymap.forward    : right, v, MouseButton.FORWARD ## for quick navigation
#keymap.pan        : p         ## pan mnemonic

```

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#keymap.zoom : o                ## zoom mnemonic
#keymap.save : s, ctrl+s        ## saving current figure
#keymap.help : f1              ## display help about active tools
#keymap.quit : ctrl+w, cmd+w, q ## close the current figure
#keymap.quit_all : W, cmd+W, Q ## close all figures
#keymap.grid : g               ## switching on/off major grids in current axes
#keymap.grid_minor : G        ## switching on/off minor grids in current axes
#keymap.yscale : l             ## toggle scaling of y-axes ('log'/'linear')
#keymap.xscale : k, L          ## toggle scaling of x-axes ('log'/'linear')
#keymap.all_axes : a           ## enable all axes
#keymap.copy : ctrl+c, cmd+c   ## Copy figure to clipboard

###ANIMATION settings
#animation.html : none         ## How to display the animation as HTML in
                               ## the IPython notebook. 'html5' uses
                               ## HTML5 video tag; 'jshtml' creates a
                               ## Javascript animation
#animation.writer : ffmpeg     ## MovieWriter 'backend' to use
#animation.codec : h264        ## Codec to use for writing movie
#animation.bitrate: -1         ## Controls size/quality tradeoff for movie.
                               ## -1 implies let utility auto-determine
#animation.frame_format: png   ## Controls frame format used by temp files
#animation.html_args:          ## Additional arguments to pass to html writer
#animation.ffmpeg_path: ffmpeg ## Path to ffmpeg binary. Without full path
                               ## $PATH is searched
#animation.ffmpeg_args:        ## Additional arguments to pass to ffmpeg
#animation.avconv_path: avconv ## Path to avconv binary. Without full path
                               ## $PATH is searched
#animation.avconv_args:        ## Additional arguments to pass to avconv
#animation.convert_path: convert ## Path to ImageMagick's convert binary.
                               ## On Windows use the full path since convert
                               ## is also the name of a system tool.
#animation.convert_args:       ## Additional arguments to pass to convert
#animation.embed_limit : 20.0   ## Limit, in MB, of size of base64 encoded
                               ## animation in HTML (i.e. IPython notebook)

```

## 2.2 Intermediate

These tutorials cover some of the more complicated classes and functions in Matplotlib. They can be useful for particular custom and complex visualizations.

---

**Note:** Click [here](#) to download the full example code

---

### 2.2.1 Artist tutorial

Using Artist objects to render on the canvas.

There are three layers to the matplotlib API.

- the `matplotlib.backend_bases.FigureCanvas` is the area onto which the figure is drawn
- the `matplotlib.backend_bases.Renderer` is the object which knows how to draw on the `FigureCanvas`
- and the `matplotlib.artist.Artist` is the object that knows how to use a renderer to paint onto the canvas.

The `FigureCanvas` and `Renderer` handle all the details of talking to user interface toolkits like `wxPython` or drawing languages like `PostScript®`, and the `Artist` handles all the high level constructs like representing and laying out the figure, text, and lines. The typical user will spend 95% of their time working with the `Artists`.

There are two types of `Artists`: primitives and containers. The primitives represent the standard graphical objects we want to paint onto our canvas: `Line2D`, `Rectangle`, `Text`, `AxesImage`, etc., and the containers are places to put them (`Axis`, `Axes` and `Figure`). The standard use is to create a `Figure` instance, use the `Figure` to create one or more `Axes` or `Subplot` instances, and use the `Axes` instance helper methods to create the primitives. In the example below, we create a `Figure` instance using `matplotlib.pyplot.figure()`, which is a convenience method for instantiating `Figure` instances and connecting them with your user interface or drawing toolkit `FigureCanvas`. As we will discuss below, this is not necessary - you can work directly with `PostScript`, `PDF` `Gtk+`, or `wxPython` `FigureCanvas` instances, instantiate your `Figures` directly and connect them yourselves - but since we are focusing here on the `Artist` API we'll let `pyplot` handle some of those details for us:

```
import matplotlib.pyplot as plt
fig = plt.figure()
ax = fig.add_subplot(2, 1, 1) # two rows, one column, first plot
```

The `Axes` is probably the most important class in the `matplotlib` API, and the one you will be working with most of the time. This is because the `Axes` is the plotting area into which most of the objects go, and the `Axes` has many special helper methods (`plot()`, `text()`, `hist()`, `imshow()`) to create the most common graphics primitives (`Line2D`, `Text`, `Rectangle`, `Image`, respectively). These helper methods will take your data (e.g., `numpy` arrays and strings) and create primitive `Artist` instances as needed (e.g., `Line2D`), add them to the relevant containers, and draw them when requested. Most of you are probably familiar with the `Subplot`, which is just a special case of an `Axes` that lives on a regular rows by columns grid of `Subplot` instances. If you want to create an `Axes` at an arbitrary location, simply use the `add_axes()` method which takes a list of [left, bottom, width, height] values in 0-1 relative figure coordinates:

```
fig2 = plt.figure()
ax2 = fig2.add_axes([0.15, 0.1, 0.7, 0.3])
```

Continuing with our example:

```
import numpy as np
t = np.arange(0.0, 1.0, 0.01)
s = np.sin(2*np.pi*t)
line, = ax.plot(t, s, color='blue', lw=2)
```

In this example, `ax` is the `Axes` instance created by the `fig.add_subplot` call above (remember `Subplot` is just a subclass of `Axes`) and when you call `ax.plot`, it creates a `Line2D` instance and adds it to the `Axes.lines` list. In the interactive `ipython` session below, you can see that the `Axes.lines` list is length one and contains the same line that was returned by the `line, = ax.plot...` call:

```
In [101]: ax.lines[0]
Out[101]: <matplotlib.lines.Line2D instance at 0x19a95710>

In [102]: line
Out[102]: <matplotlib.lines.Line2D instance at 0x19a95710>
```

If you make subsequent calls to `ax.plot` (and the hold state is “on” which is the default) then additional lines will be added to the list. You can remove lines later simply by calling the list methods; either of these will work:

```
del ax.lines[0]
ax.lines.remove(line) # one or the other, not both!
```

The Axes also has helper methods to configure and decorate the x-axis and y-axis tick, tick labels and axis labels:

```
xtext = ax.set_xlabel('my xdata') # returns a Text instance
ytext = ax.set_ylabel('my ydata')
```

When you call `ax.set_xlabel`, it passes the information on the `Text` instance of the `XAxis`. Each Axes instance contains an `XAxis` and a `YAxis` instance, which handle the layout and drawing of the ticks, tick labels and axis labels.

Try creating the figure below.

```
import numpy as np
import matplotlib.pyplot as plt

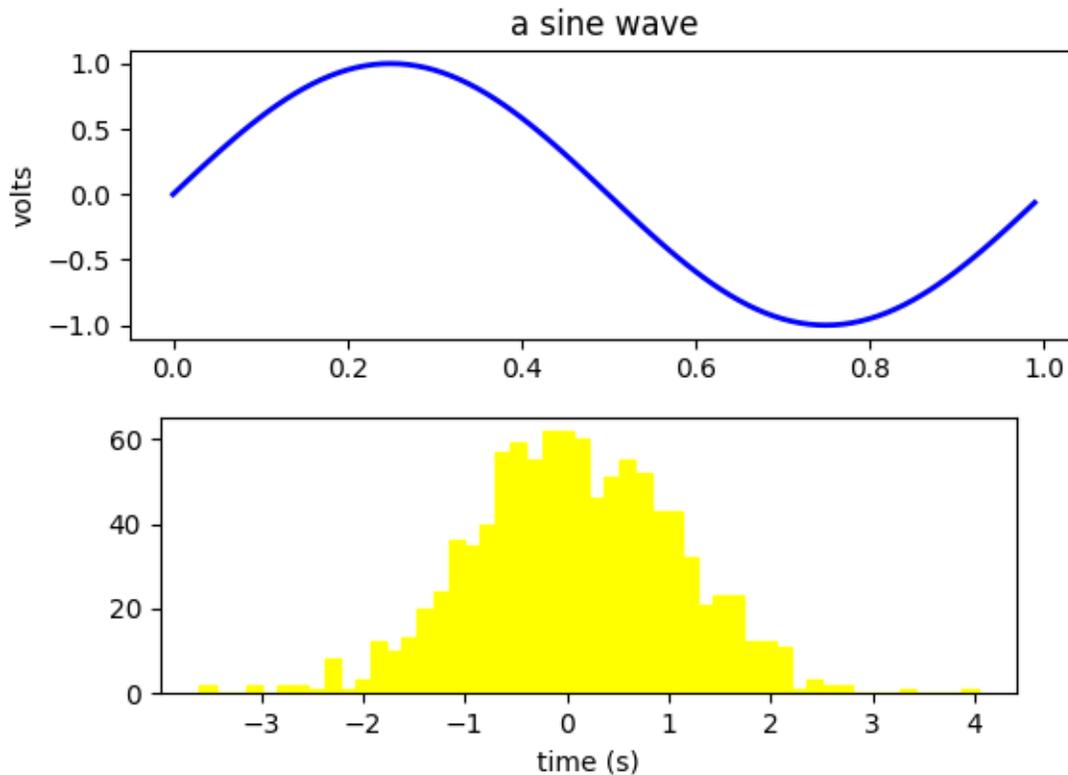
fig = plt.figure()
fig.subplots_adjust(top=0.8)
ax1 = fig.add_subplot(211)
ax1.set_ylabel('volts')
ax1.set_title('a sine wave')

t = np.arange(0.0, 1.0, 0.01)
s = np.sin(2*np.pi*t)
line, = ax1.plot(t, s, color='blue', lw=2)

# Fixing random state for reproducibility
np.random.seed(19680801)

ax2 = fig.add_axes([0.15, 0.1, 0.7, 0.3])
n, bins, patches = ax2.hist(np.random.randn(1000), 50,
                            facecolor='yellow', edgecolor='yellow')
ax2.set_xlabel('time (s)')

plt.show()
```



### Customizing your objects

Every element in the figure is represented by a matplotlib *Artist*, and each has an extensive list of properties to configure its appearance. The figure itself contains a *Rectangle* exactly the size of the figure, which you can use to set the background color and transparency of the figures. Likewise, each *Axes* bounding box (the standard white box with black edges in the typical matplotlib plot, has a *Rectangle* instance that determines the color, transparency, and other properties of the Axes. These instances are stored as member variables `Figure.patch` and `Axes.patch` ("Patch" is a name inherited from MATLAB, and is a 2D "patch" of color on the figure, e.g., rectangles, circles and polygons). Every matplotlib *Artist* has the following properties

Property	Description
alpha	The transparency - a scalar from 0-1
animated	A boolean that is used to facilitate animated drawing
axes	The axes that the Artist lives in, possibly None
clip_box	The bounding box that clips the Artist
clip_on	Whether clipping is enabled
clip_path	The path the artist is clipped to
contains	A picking function to test whether the artist contains the pick point
figure	The figure instance the artist lives in, possibly None
label	A text label (e.g., for auto-labeling)
picker	A python object that controls object picking
trans-form	The transformation
visible	A boolean whether the artist should be drawn
zorder	A number which determines the drawing order
raster-ized	Boolean; Turns vectors into raster graphics (for compression & eps transparency)

Each of the properties is accessed with an old-fashioned setter or getter (yes we know this irritates Pythonistas and we plan to support direct access via properties or traits but it hasn't been done yet). For example, to multiply the current alpha by a half:

```
a = o.get_alpha()
o.set_alpha(0.5*a)
```

If you want to set a number of properties at once, you can also use the `set` method with keyword arguments. For example:

```
o.set(alpha=0.5, zorder=2)
```

If you are working interactively at the python shell, a handy way to inspect the Artist properties is to use the `matplotlib.artist.getp()` function (simply `getp()` in pyplot), which lists the properties and their values. This works for classes derived from Artist as well, e.g., Figure and Rectangle. Here are the Figure rectangle properties mentioned above:

```
In [149]: matplotlib.artist.getp(fig.patch)
alpha = 1.0
animated = False
antialiased or aa = True
axes = None
clip_box = None
clip_on = False
clip_path = None
contains = None
edgecolor or ec = w
facecolor or fc = 0.75
figure = Figure(8.125x6.125)
fill = 1
hatch = None
height = 1
label =
linewidth or lw = 1.0
```

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```

picker = None
transform = <Affine object at 0x134cca84>
verts = ((0, 0), (0, 1), (1, 1), (1, 0))
visible = True
width = 1
window_extent = <Bbox object at 0x134acb2c>
x = 0
y = 0
zorder = 1

```

The docstrings for all of the classes also contain the `Artist` properties, so you can consult the interactive “help” or the `matplotlib.artist` for a listing of properties for a given object.

## Object containers

Now that we know how to inspect and set the properties of a given object we want to configure, we need to know how to get at that object. As mentioned in the introduction, there are two kinds of objects: primitives and containers. The primitives are usually the things you want to configure (the font of a `Text` instance, the width of a `Line2D`) although the containers also have some properties as well – for example the `Axes Artist` is a container that contains many of the primitives in your plot, but it also has properties like the `xscale` to control whether the xaxis is ‘linear’ or ‘log’. In this section we’ll review where the various container objects store the `Artists` that you want to get at.

## Figure container

The top level container `Artist` is the `matplotlib.figure.Figure`, and it contains everything in the figure. The background of the figure is a `Rectangle` which is stored in `Figure.patch`. As you add subplots (`add_subplot()`) and axes (`add_axes()`) to the figure these will be appended to the `Figure.axes`. These are also returned by the methods that create them:

```

In [156]: fig = plt.figure()

In [157]: ax1 = fig.add_subplot(211)

In [158]: ax2 = fig.add_axes([0.1, 0.1, 0.7, 0.3])

In [159]: ax1
Out[159]: <matplotlib.axes.Subplot instance at 0xd54b26c>

In [160]: print(fig.axes)
[<matplotlib.axes.Subplot instance at 0xd54b26c>, <matplotlib.axes.Axes instance at 0xd3f0b2c>]

```

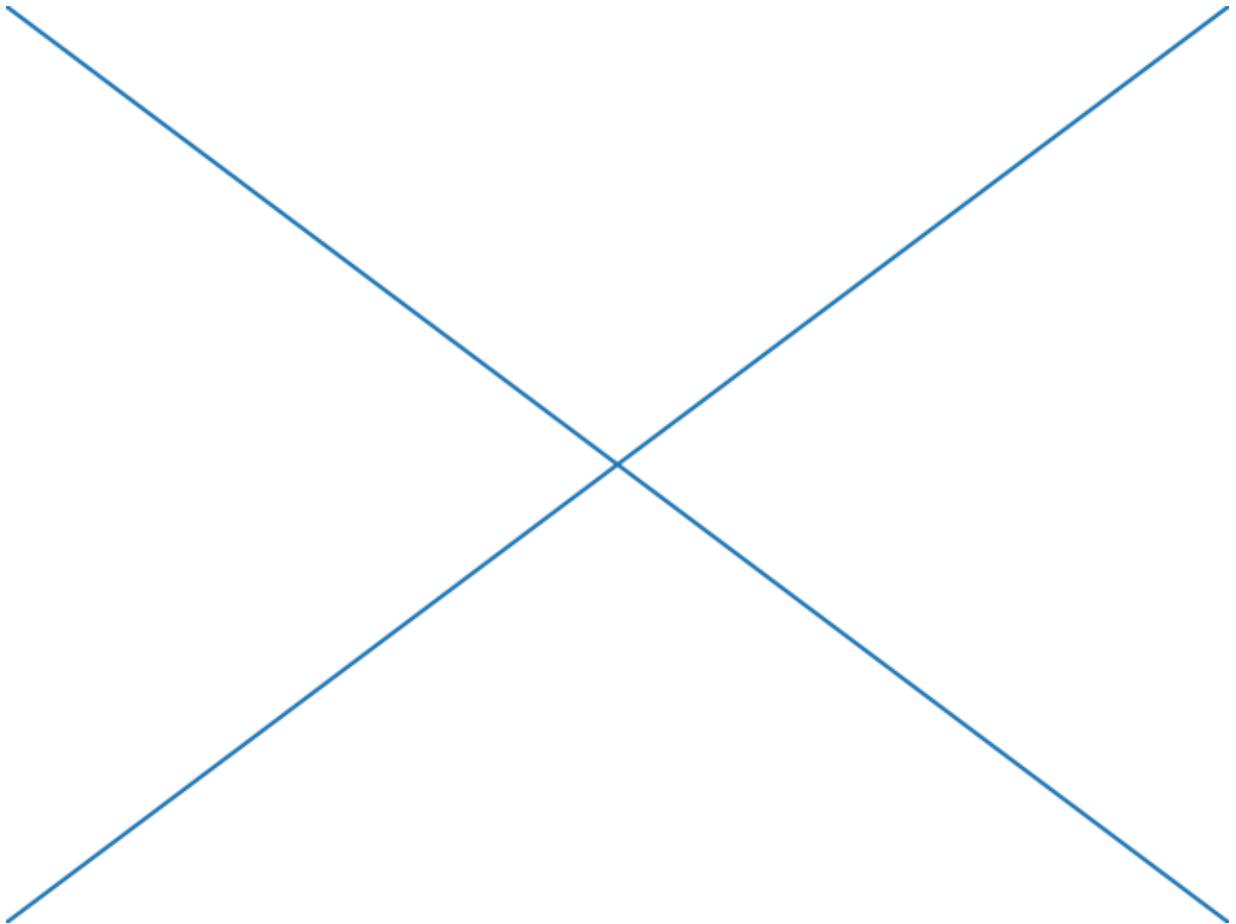
Because the figure maintains the concept of the “current axes” (see `Figure.gca` and `Figure.sca`) to support the pylab/pyplot state machine, you should not insert or remove axes directly from the axes list, but rather use the `add_subplot()` and `add_axes()` methods to insert, and the `delaxes()` method to delete. You are free however, to iterate over the list of axes or index into it to get access to `Axes` instances you want to customize. Here is an example which turns all the axes grids on:

```
for ax in fig.axes:  
    ax.grid(True)
```

The figure also has its own text, lines, patches and images, which you can use to add primitives directly. The default coordinate system for the `Figure` will simply be in pixels (which is not usually what you want) but you can control this by setting the transform property of the `Artist` you are adding to the figure.

More useful is "figure coordinates" where (0, 0) is the bottom-left of the figure and (1, 1) is the top-right of the figure which you can obtain by setting the `Artist` transform to `fig.transFigure`:

```
import matplotlib.lines as lines  
  
fig = plt.figure()  
  
l1 = lines.Line2D([0, 1], [0, 1], transform=fig.transFigure, figure=fig)  
l2 = lines.Line2D([0, 1], [1, 0], transform=fig.transFigure, figure=fig)  
fig.lines.extend([l1, l2])  
  
plt.show()
```



Here is a summary of the Artists the figure contains

Figure attribute	Description
<code>axes</code>	A list of Axes instances (includes Subplot)
<code>patch</code>	The Rectangle background
<code>images</code>	A list of FigureImages patches - useful for raw pixel display
<code>legends</code>	A list of Figure Legend instances (different from Axes.legends)
<code>lines</code>	A list of Figure Line2D instances (rarely used, see Axes.lines)
<code>patches</code>	A list of Figure patches (rarely used, see Axes.patches)
<code>texts</code>	A list Figure Text instances

### Axes container

The `matplotlib.axes.Axes` is the center of the matplotlib universe - it contains the vast majority of all the Artists used in a figure with many helper methods to create and add these Artists to itself, as well as helper methods to access and customize the Artists it contains. Like the *Figure*, it contains a *Patch* patch which is a *Rectangle* for Cartesian coordinates and a *Circle* for polar coordinates; this patch determines the shape, background and border of the plotting region:

```
ax = fig.add_subplot(111)
rect = ax.patch # a Rectangle instance
rect.set_facecolor('green')
```

When you call a plotting method, e.g., the canonical `plot()` and pass in arrays or lists of values, the method will create a `matplotlib.lines.Line2D()` instance, update the line with all the Line2D properties passed as keyword arguments, add the line to the `Axes.lines` container, and returns it to you:

```
In [213]: x, y = np.random.rand(2, 100)
In [214]: line, = ax.plot(x, y, '-', color='blue', linewidth=2)
```

`plot` returns a list of lines because you can pass in multiple x, y pairs to plot, and we are unpacking the first element of the length one list into the line variable. The line has been added to the `Axes.lines` list:

```
In [229]: print(ax.lines)
[<matplotlib.lines.Line2D instance at 0xd378b0c>]
```

Similarly, methods that create patches, like `bar()` creates a list of rectangles, will add the patches to the `Axes.patches` list:

```
In [233]: n, bins, rectangles = ax.hist(np.random.randn(1000), 50, facecolor='yellow')
In [234]: rectangles
Out[234]: <a list of 50 Patch objects>
In [235]: print(len(ax.patches))
```

You should not add objects directly to the `Axes.lines` or `Axes.patches` lists unless you know exactly what you are doing, because the Axes needs to do a few things when it creates and adds an object. It sets the figure and axes property of the Artist, as well as the default Axes transformation (unless a transformation is set). It also inspects the data contained in the

Artist to update the data structures controlling auto-scaling, so that the view limits can be adjusted to contain the plotted data. You can, nonetheless, create objects yourself and add them directly to the Axes using helper methods like `add_line()` and `add_patch()`. Here is an annotated interactive session illustrating what is going on:

```
In [262]: fig, ax = plt.subplots()

# create a rectangle instance
In [263]: rect = matplotlib.patches.Rectangle( (1,1), width=5, height=12)

# by default the axes instance is None
In [264]: print(rect.get_axes())
None

# and the transformation instance is set to the "identity transform"
In [265]: print(rect.get_transform())
<Affine object at 0x13695544>

# now we add the Rectangle to the Axes
In [266]: ax.add_patch(rect)

# and notice that the ax.add_patch method has set the axes
# instance
In [267]: print(rect.get_axes())
Axes(0.125,0.1;0.775x0.8)

# and the transformation has been set too
In [268]: print(rect.get_transform())
<Affine object at 0x15009ca4>

# the default axes transformation is ax.transData
In [269]: print(ax.transData)
<Affine object at 0x15009ca4>

# notice that the xlims of the Axes have not been changed
In [270]: print(ax.get_xlim())
(0.0, 1.0)

# but the data limits have been updated to encompass the rectangle
In [271]: print(ax.dataLim.bounds)
(1.0, 1.0, 5.0, 12.0)

# we can manually invoke the auto-scaling machinery
In [272]: ax.autoscale_view()

# and now the xlim are updated to encompass the rectangle
In [273]: print(ax.get_xlim())
(1.0, 6.0)

# we have to manually force a figure draw
In [274]: ax.figure.canvas.draw()
```

There are many, many Axes helper methods for creating primitive Artists and adding them to their respective containers. The table below summarizes a small sampling of them, the kinds

of Artist they create, and where they store them

Helper method	Artist	Container
ax.annotate - text annotations	Annotate	ax.texts
ax.bar - bar charts	Rectangle	ax.patches
ax.errorbar - error bar plots	Line2D and Rectangle	ax.lines and ax.patches
ax.fill - shared area	Polygon	ax.patches
ax.hist - histograms	Rectangle	ax.patches
ax.imshow - image data	AxesImage	ax.images
ax.legend - axes legends	Legend	ax.legend
ax.plot - xy plots	Line2D	ax.lines
ax.scatter - scatter charts	PolygonCollection	ax.collections
ax.text - text	Text	ax.texts

In addition to all of these Artists, the Axes contains two important Artist containers: the *XAxis* and *YAxis*, which handle the drawing of the ticks and labels. These are stored as instance variables `xaxis` and `yaxis`. The *XAxis* and *YAxis* containers will be detailed below, but note that the Axes contains many helper methods which forward calls on to the *Axis* instances so you often do not need to work with them directly unless you want to. For example, you can set the font color of the *XAxis* ticklabels using the Axes helper method:

```
for label in ax.get_xticklabels():
    label.set_color('orange')
```

Below is a summary of the Artists that the Axes contains

Axes attribute	Description
artists	A list of Artist instances
patch	Rectangle instance for Axes background
collections	A list of Collection instances
images	A list of AxesImage
legends	A list of Legend instances
lines	A list of Line2D instances
patches	A list of Patch instances
texts	A list of Text instances
xaxis	matplotlib.axis.XAxis instance
yaxis	matplotlib.axis.YAxis instance

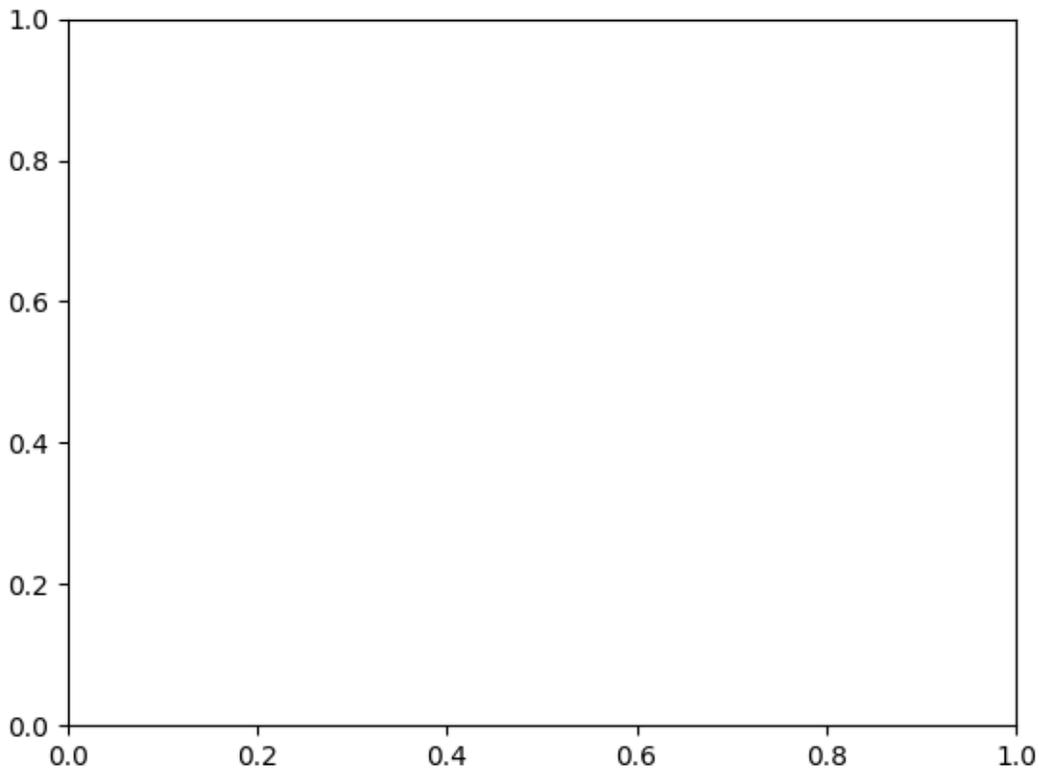
### Axis containers

The `matplotlib.axis.Axis` instances handle the drawing of the tick lines, the grid lines, the tick labels and the axis label. You can configure the left and right ticks separately for the y-axis, and the upper and lower ticks separately for the x-axis. The *Axis* also stores the data and view intervals used in auto-scaling, panning and zooming, as well as the *Locator* and *Formatter* instances which control where the ticks are placed and how they are represented as strings.

Each *Axis* object contains a `label` attribute (this is what *pyplot* modifies in calls to `xlabel()` and `ylabel()`) as well as a list of major and minor ticks. The ticks are *XTick* and *YTick* instances, which contain the actual line and text primitives that render the ticks and ticklabels. Because the ticks are dynamically created as needed (e.g., when panning and zooming), you should access the lists of major and minor ticks through their accessor methods `get_major_ticks()`

and `get_minor_ticks()`. Although the ticks contain all the primitives and will be covered below, `Axis` instances have accessor methods that return the tick lines, tick labels, tick locations etc.:

```
fig, ax = plt.subplots()
axis = ax.xaxis
axis.get_ticklocs()
```



```
axis.get_ticklabels()
```

**note there are twice as many ticklines as labels because by default there are tick lines at the top and bottom but only tick labels below the axis; this can be customized**

```
axis.get_ticklines()
```

by default you get the major ticks back

```
axis.get_ticklines()
```

but you can also ask for the minor ticks

```
axis.get_ticklines(minor=True)
```

```
# Here is a summary of some of the useful accessor methods of the ``Axis``
# (these have corresponding setters where useful, such as
```

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```

# set_major_formatter)
#
# =====
# Accessor method      Description
# =====
# get_scale            The scale of the axis, e.g., 'log' or 'linear'
# get_view_interval    The interval instance of the axis view limits
# get_data_interval    The interval instance of the axis data limits
# get_gridlines        A list of grid lines for the Axis
# get_label            The axis label - a Text instance
# get_ticklabels       A list of Text instances - keyword minor=True/False
# get_ticklines        A list of Line2D instances - keyword minor=True/False
# get_ticklocs         A list of Tick locations - keyword minor=True/False
# get_major_locator    The matplotlib.ticker.Locator instance for major ticks
# get_major_formatter  The matplotlib.ticker.Formatter instance for major ticks
# get_minor_locator    The matplotlib.ticker.Locator instance for minor ticks
# get_minor_formatter  The matplotlib.ticker.Formatter instance for minor ticks
# get_major_ticks      A list of Tick instances for major ticks
# get_minor_ticks      A list of Tick instances for minor ticks
# grid                 Turn the grid on or off for the major or minor ticks
# =====
#
# Here is an example, not recommended for its beauty, which customizes
# the axes and tick properties

# plt.figure creates a matplotlib.figure.Figure instance
fig = plt.figure()
rect = fig.patch # a rectangle instance
rect.set_facecolor('lightgoldenrodyellow')

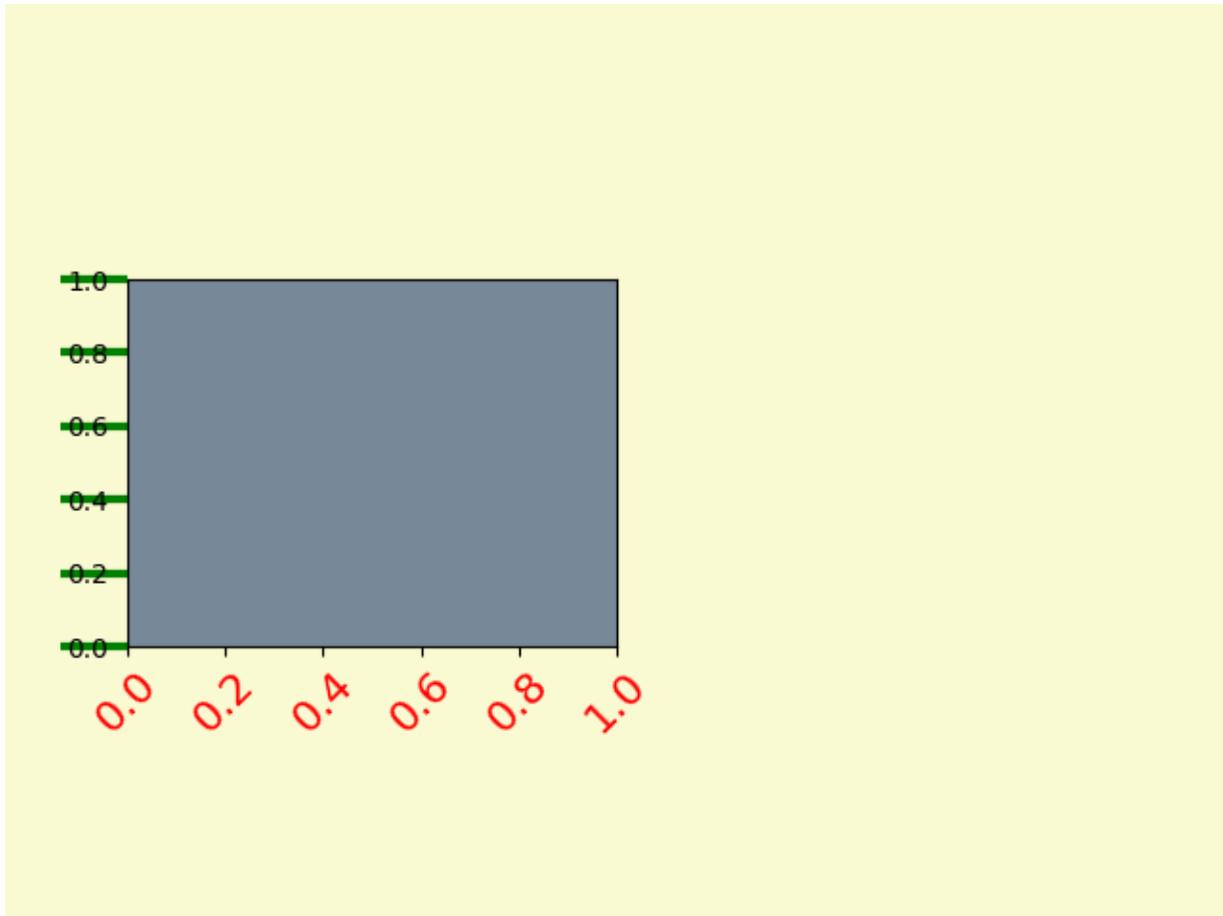
ax1 = fig.add_axes([0.1, 0.3, 0.4, 0.4])
rect = ax1.patch
rect.set_facecolor('lightslategray')

for label in ax1.xaxis.get_ticklabels():
    # label is a Text instance
    label.set_color('red')
    label.set_rotation(45)
    label.set_fontsize(16)

for line in ax1.yaxis.get_ticklines():
    # line is a Line2D instance
    line.set_color('green')
    line.set_markersize(25)
    line.set_markeredgewidth(3)

plt.show()

```



### Tick containers

The `matplotlib.axis.Tick` is the final container object in our descent from the *Figure* to the *Axes* to the *Axis* to the *Tick*. The *Tick* contains the tick and grid line instances, as well as the label instances for the upper and lower ticks. Each of these is accessible directly as an attribute of the *Tick*.

Tick attribute	Description
<code>tick1line</code>	Line2D instance
<code>tick2line</code>	Line2D instance
<code>gridline</code>	Line2D instance
<code>label1</code>	Text instance
<code>label2</code>	Text instance

Here is an example which sets the formatter for the right side ticks with dollar signs and colors them green on the right side of the axis

```
import matplotlib.ticker as ticker

# Fixing random state for reproducibility
np.random.seed(19680801)
```

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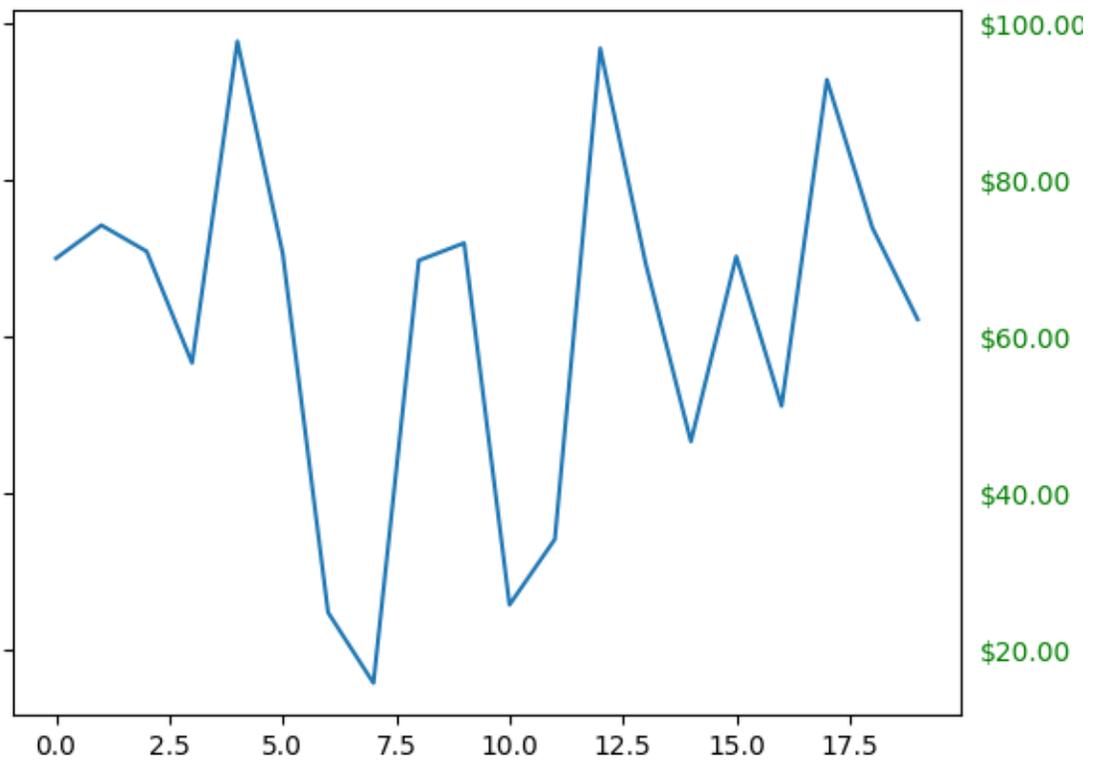
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```
fig, ax = plt.subplots()
ax.plot(100*np.random.rand(20))

formatter = ticker.FormatStrFormatter('${1.2f}')
ax.yaxis.set_major_formatter(formatter)

for tick in ax.yaxis.get_major_ticks():
    tick.label1.set_visible(False)
    tick.label2.set_visible(True)
    tick.label2.set_color('green')

plt.show()
```



---

**Note:** Click [here](#) to download the full example code

---

## 2.2.2 Legend guide

Generating legends flexibly in Matplotlib.

This legend guide is an extension of the documentation available at `legend()` - please ensure you are familiar with contents of that documentation before proceeding with this guide.

This guide makes use of some common terms, which are documented here for clarity:

**legend entry** A legend is made up of one or more legend entries. An entry is made up of exactly one key and one label.

**legend key** The colored/patterned marker to the left of each legend label.

**legend label** The text which describes the handle represented by the key.

**legend handle** The original object which is used to generate an appropriate entry in the legend.

### Controlling the legend entries

Calling `legend()` with no arguments automatically fetches the legend handles and their associated labels. This functionality is equivalent to:

```
handles, labels = ax.get_legend_handles_labels()
ax.legend(handles, labels)
```

The `get_legend_handles_labels()` function returns a list of handles/artists which exist on the Axes which can be used to generate entries for the resulting legend - it is worth noting however that not all artists can be added to a legend, at which point a "proxy" will have to be created (see *Creating artists specifically for adding to the legend (aka. Proxy artists)* for further details).

For full control of what is being added to the legend, it is common to pass the appropriate handles directly to `legend()`:

```
line_up, = plt.plot([1,2,3], label='Line 2')
line_down, = plt.plot([3,2,1], label='Line 1')
plt.legend(handles=[line_up, line_down])
```

In some cases, it is not possible to set the label of the handle, so it is possible to pass through the list of labels to `legend()`:

```
line_up, = plt.plot([1,2,3], label='Line 2')
line_down, = plt.plot([3,2,1], label='Line 1')
plt.legend([line_up, line_down], ['Line Up', 'Line Down'])
```

### Creating artists specifically for adding to the legend (aka. Proxy artists)

Not all handles can be turned into legend entries automatically, so it is often necessary to create an artist which *can*. Legend handles don't have to exist on the Figure or Axes in order to be used.

Suppose we wanted to create a legend which has an entry for some data which is represented by a red color:

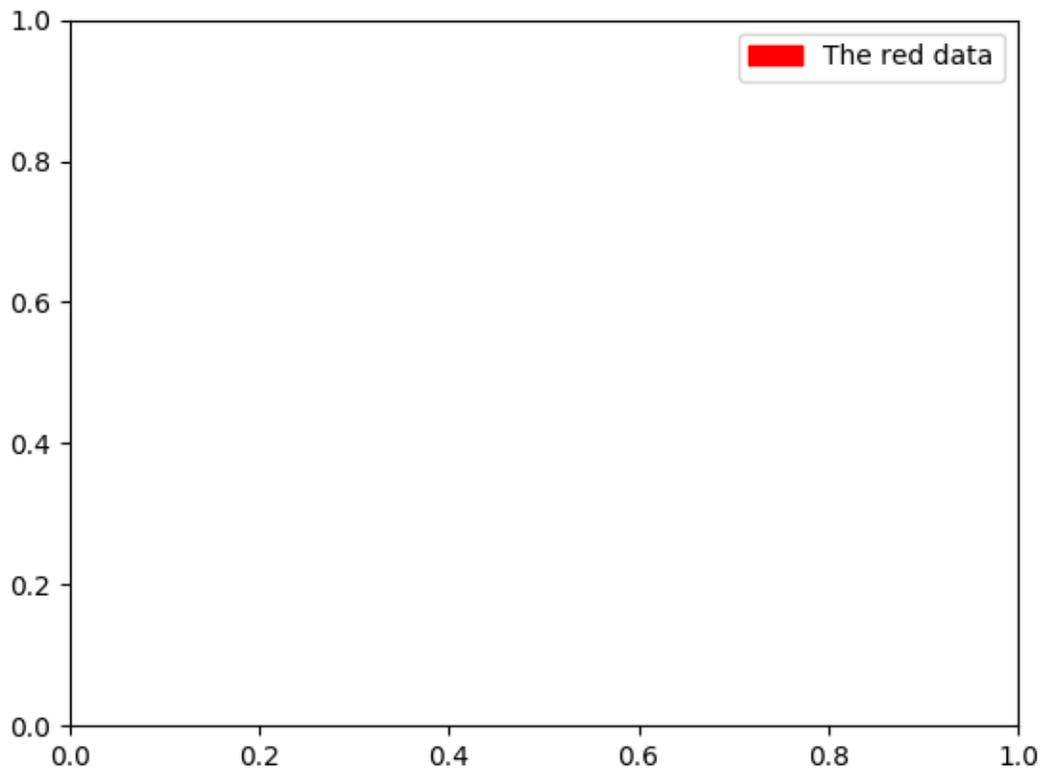
```
import matplotlib.patches as mpatches
import matplotlib.pyplot as plt
```

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```
red_patch = mpatches.Patch(color='red', label='The red data')
plt.legend(handles=[red_patch])

plt.show()
```

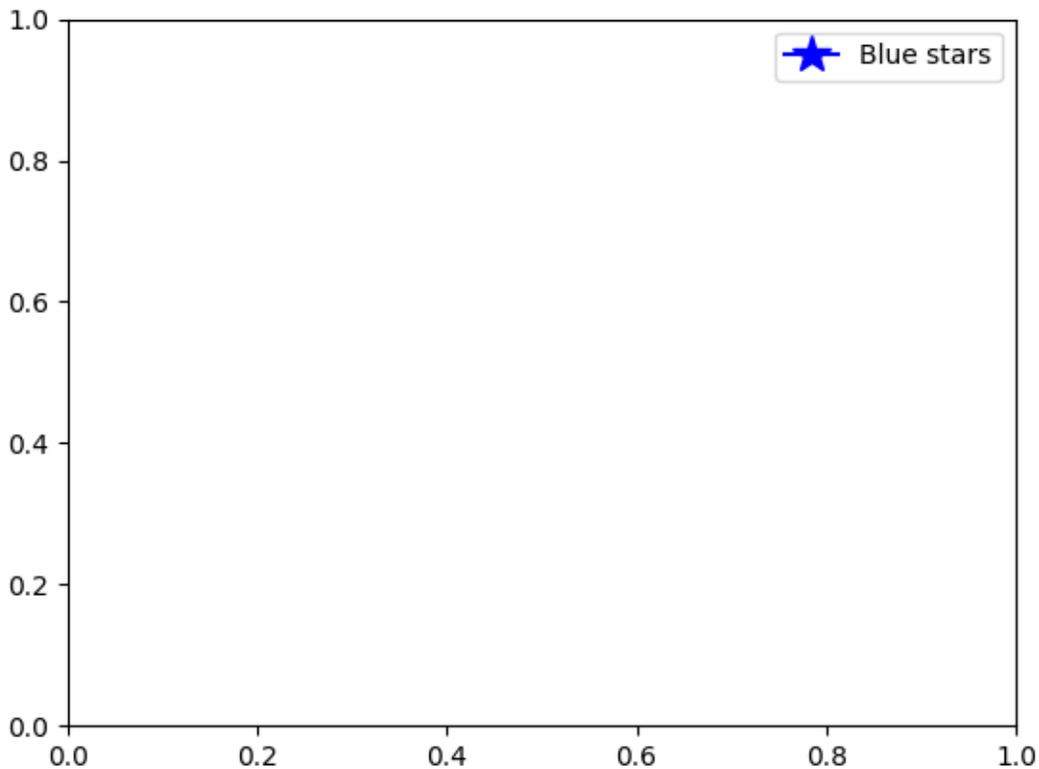


There are many supported legend handles, instead of creating a patch of color we could have created a line with a marker:

```
import matplotlib.lines as mlines

blue_line = mlines.Line2D([], [], color='blue', marker='*',
                           markersize=15, label='Blue stars')
plt.legend(handles=[blue_line])

plt.show()
```



### Legend location

The location of the legend can be specified by the keyword argument *loc*. Please see the documentation at *legend()* for more details.

The *bbox\_to\_anchor* keyword gives a great degree of control for manual legend placement. For example, if you want your axes legend located at the figure's top right-hand corner instead of the axes' corner, simply specify the corner's location, and the coordinate system of that location:

```
plt.legend(bbox_to_anchor=(1, 1),
           bbox_transform=plt.gcf().transFigure)
```

More examples of custom legend placement:

```
plt.subplot(211)
plt.plot([1, 2, 3], label="test1")
plt.plot([3, 2, 1], label="test2")

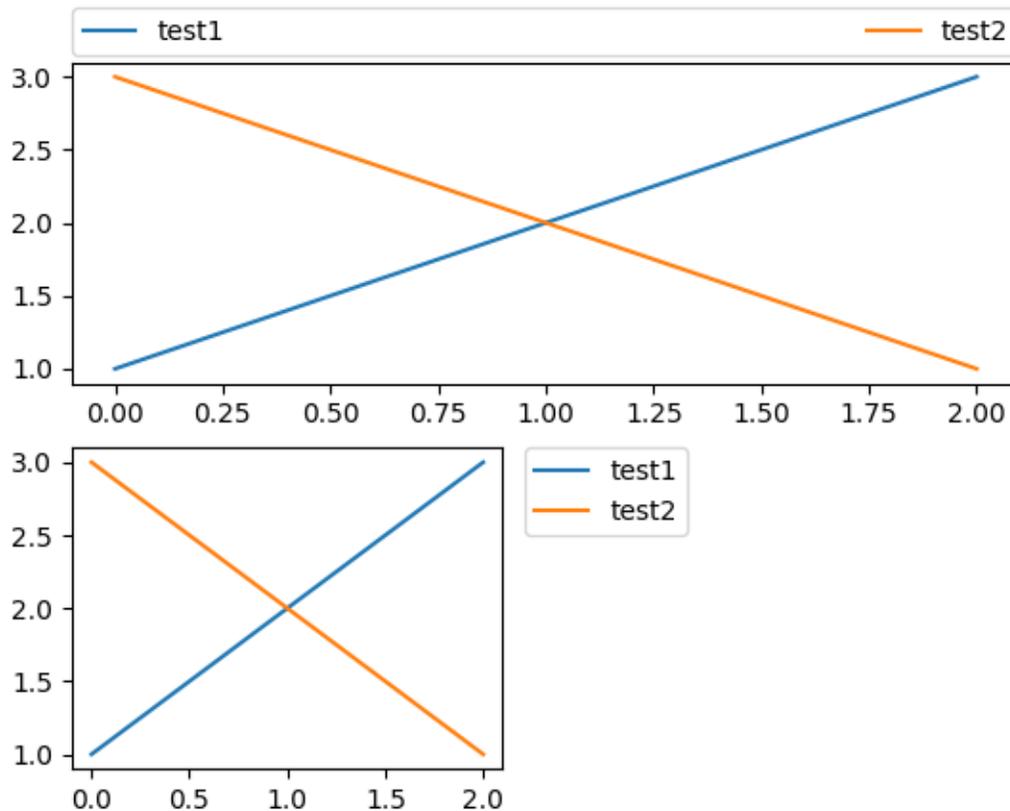
# Place a legend above this subplot, expanding itself to
# fully use the given bounding box.
plt.legend(bbox_to_anchor=(0., 1.02, 1., .102), loc='lower left',
           ncol=2, mode="expand", borderaxespad=0.)
```

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```
plt.subplot(223)
plt.plot([1, 2, 3], label="test1")
plt.plot([3, 2, 1], label="test2")
# Place a legend to the right of this smaller subplot.
plt.legend(bbox_to_anchor=(1.05, 1), loc='upper left', borderaxespad=0.)

plt.show()
```



### Multiple legends on the same Axes

Sometimes it is more clear to split legend entries across multiple legends. Whilst the instinctive approach to doing this might be to call the `legend()` function multiple times, you will find that only one legend ever exists on the Axes. This has been done so that it is possible to call `legend()` repeatedly to update the legend to the latest handles on the Axes, so to persist old legend instances, we must add them manually to the Axes:

```
line1, = plt.plot([1, 2, 3], label="Line 1", linestyle='--')
line2, = plt.plot([3, 2, 1], label="Line 2", linewidth=4)

# Create a legend for the first line.
```

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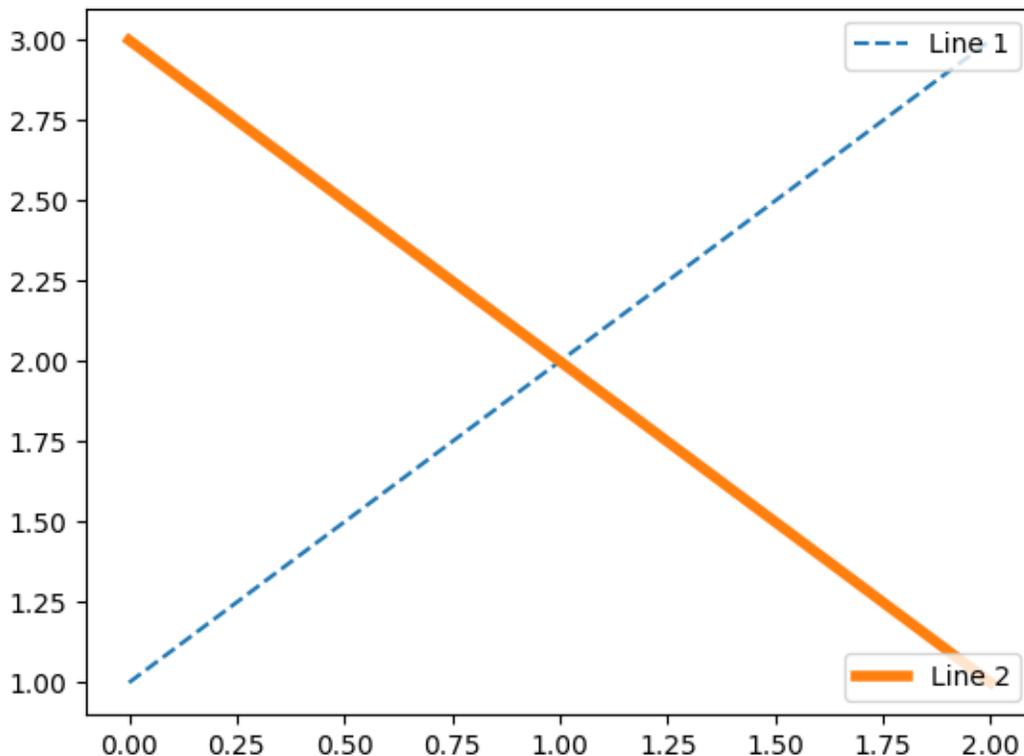
(continued from previous page)

```
first_legend = plt.legend(handles=[line1], loc='upper right')

# Add the legend manually to the current Axes.
ax = plt.gca().add_artist(first_legend)

# Create another legend for the second line.
plt.legend(handles=[line2], loc='lower right')

plt.show()
```



## Legend Handlers

In order to create legend entries, handles are given as an argument to an appropriate *HandlerBase* subclass. The choice of handler subclass is determined by the following rules:

1. Update `get_legend_handler_map()` with the value in the `handler_map` keyword.
2. Check if the `handle` is in the newly created `handler_map`.
3. Check if the type of `handle` is in the newly created `handler_map`.
4. Check if any of the types in the `handle`'s `mro` is in the newly created `handler_map`.

For completeness, this logic is mostly implemented in `get_legend_handler()`.

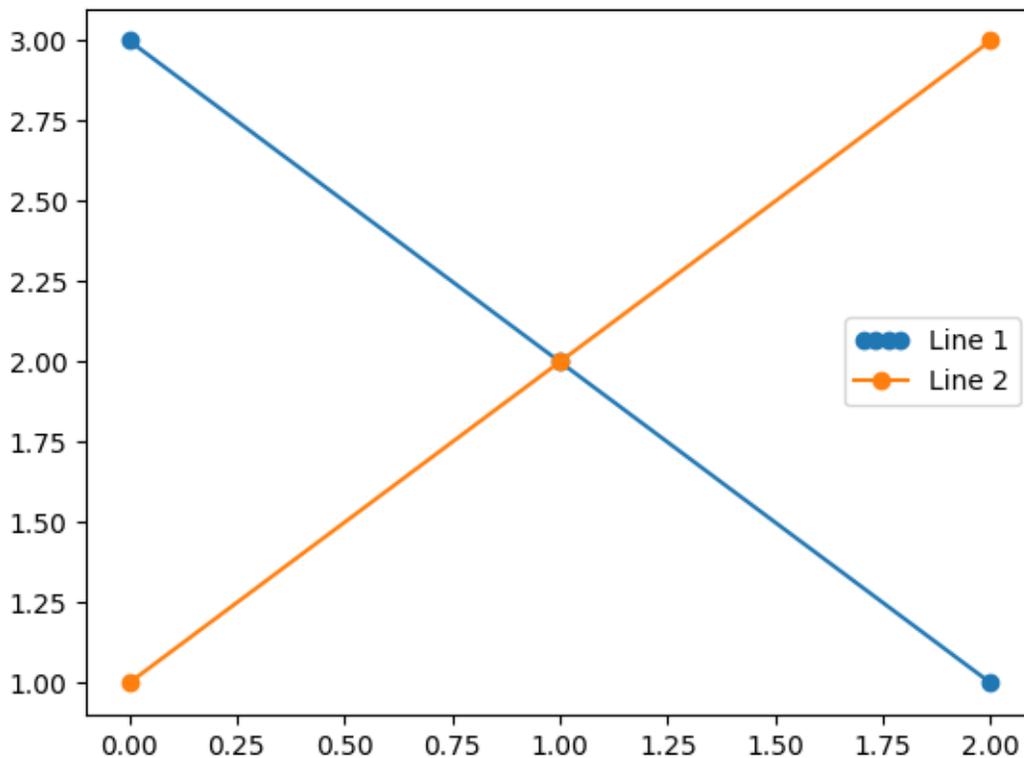
All of this flexibility means that we have the necessary hooks to implement custom handlers for our own type of legend key.

The simplest example of using custom handlers is to instantiate one of the existing *HandlerBase* subclasses. For the sake of simplicity, let's choose *matplotlib.legend\_handler.HandlerLine2D* which accepts a *numpoints* argument (note *numpoints* is a keyword on the *legend()* function for convenience). We can then pass the mapping of instance to Handler as a keyword to *legend*.

```
from matplotlib.legend_handler import HandlerLine2D

line1, = plt.plot([3, 2, 1], marker='o', label='Line 1')
line2, = plt.plot([1, 2, 3], marker='o', label='Line 2')

plt.legend(handler_map={line1: HandlerLine2D(numpoints=4)})
```



As you can see, "Line 1" now has 4 marker points, where "Line 2" has 2 (the default). Try the above code, only change the map's key from *line1* to *type(line1)*. Notice how now both *Line2D* instances get 4 markers.

Along with handlers for complex plot types such as errorbars, stem plots and histograms, the default *handler\_map* has a special tuple handler (*HandlerTuple*) which simply plots the handles on top of one another for each item in the given tuple. The following example demonstrates combining two legend keys on top of one another:

```
from numpy.random import randn
```

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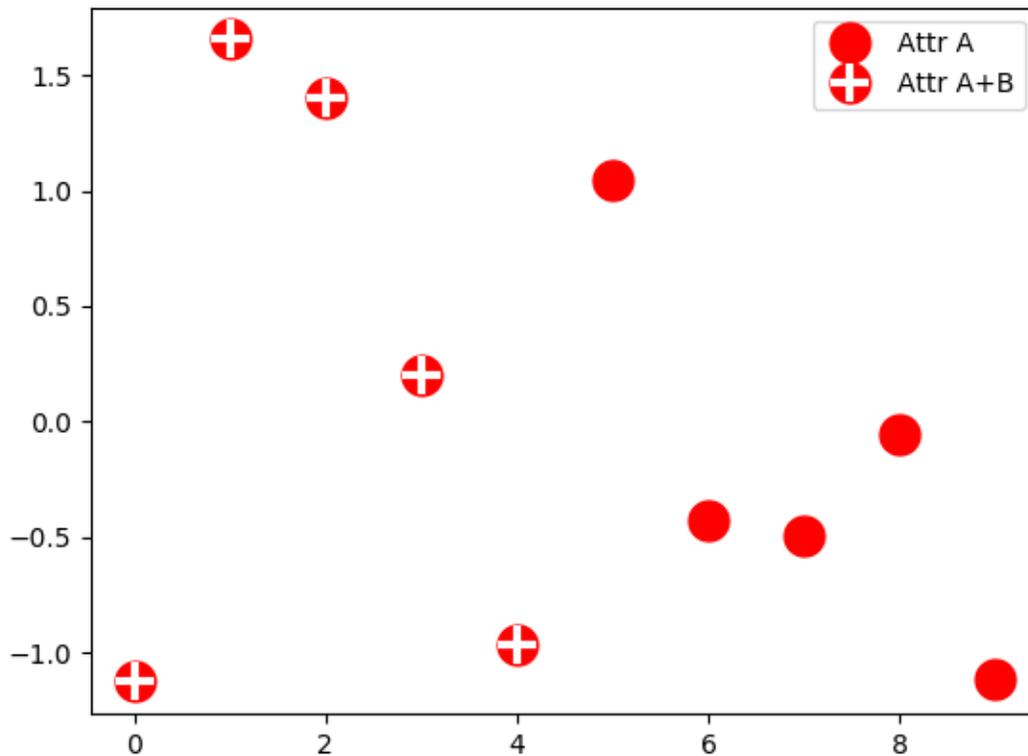
```

z = randn(10)

red_dot, = plt.plot(z, "ro", markersize=15)
# Put a white cross over some of the data.
white_cross, = plt.plot(z[:5], "w+", markeredgewidth=3, markersize=15)

plt.legend([red_dot, (red_dot, white_cross)], ["Attr A", "Attr A+B"])

```



The *HandlerTuple* class can also be used to assign several legend keys to the same entry:

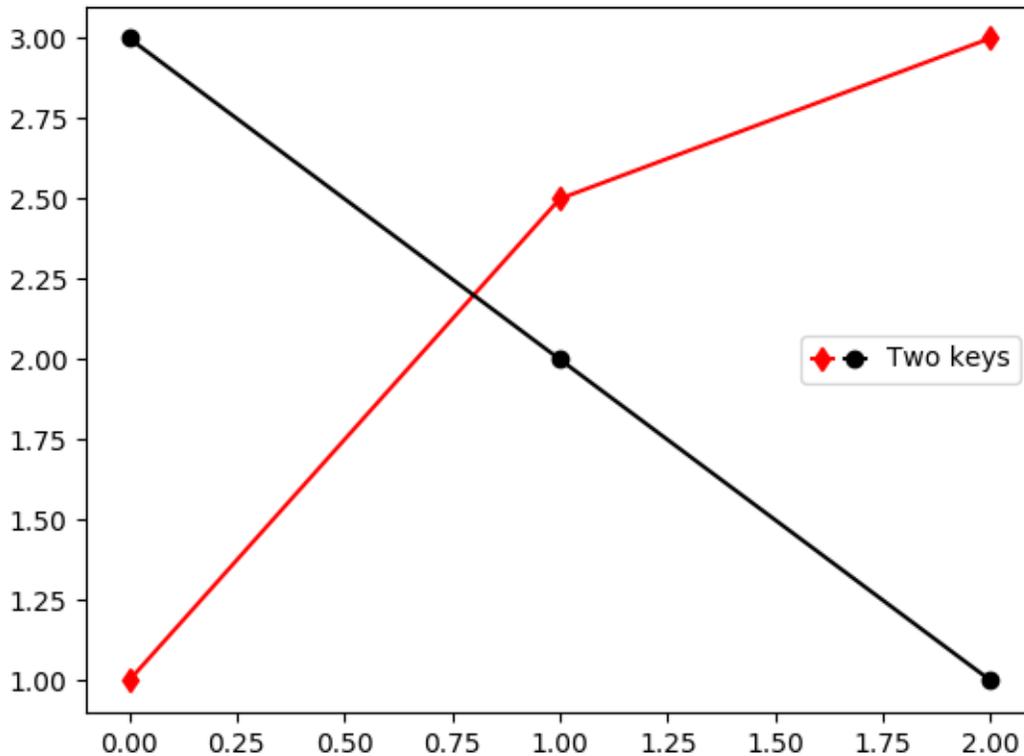
```

from matplotlib.legend_handler import HandlerLine2D, HandlerTuple

p1, = plt.plot([1, 2.5, 3], 'r-d')
p2, = plt.plot([3, 2, 1], 'k-o')

l = plt.legend([(p1, p2)], ['Two keys'], numpoints=1,
               handler_map={tuple: HandlerTuple(ndivide=None)})

```



### Implementing a custom legend handler

A custom handler can be implemented to turn any handle into a legend key (handles don't necessarily need to be matplotlib artists). The handler must implement a "legend\_artist" method which returns a single artist for the legend to use. Signature details about the "legend\_artist" are documented at `legend_artist()`.

```
import matplotlib.patches as mpatches

class AnyObject(object):
    pass

class AnyObjectHandler(object):
    def legend_artist(self, legend, orig_handle, fontsize, handlebox):
        x0, y0 = handlebox.xdescent, handlebox.ydescent
        width, height = handlebox.width, handlebox.height
        patch = mpatches.Rectangle([x0, y0], width, height, facecolor='red',
                                   edgecolor='black', hatch='xx', lw=3,
                                   transform=handlebox.get_transform())
        handlebox.add_artist(patch)
```

(continues on next page)

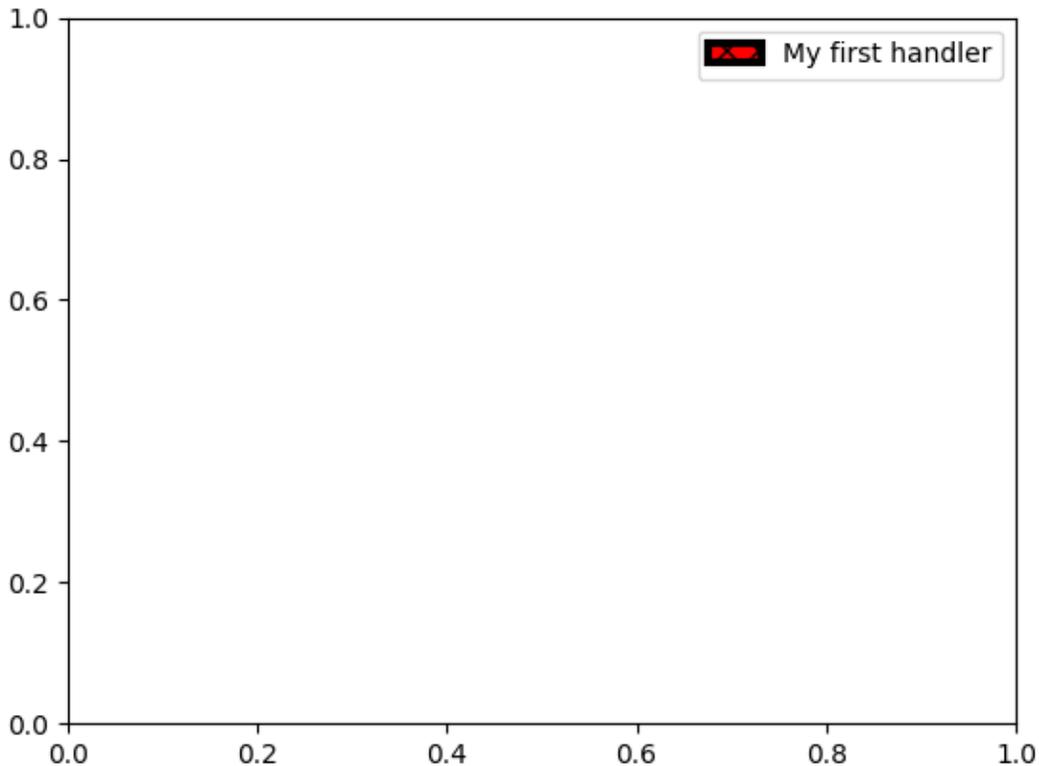
(continued from previous page)

```

return patch

plt.legend([AnyObject()], ['My first handler'],
           handler_map={AnyObject: AnyObjectHandler()})

```



Alternatively, had we wanted to globally accept `AnyObject` instances without needing to manually set the `handler_map` keyword all the time, we could have registered the new handler with:

```

from matplotlib.legend import Legend
Legend.update_default_handler_map({AnyObject: AnyObjectHandler()})

```

Whilst the power here is clear, remember that there are already many handlers implemented and what you want to achieve may already be easily possible with existing classes. For example, to produce elliptical legend keys, rather than rectangular ones:

```

from matplotlib.legend_handler import HandlerPatch

class HandlerEllipse(HandlerPatch):
    def create_artists(self, legend, orig_handle,
                      xdescent, ydescent, width, height, fontsize, trans):

```

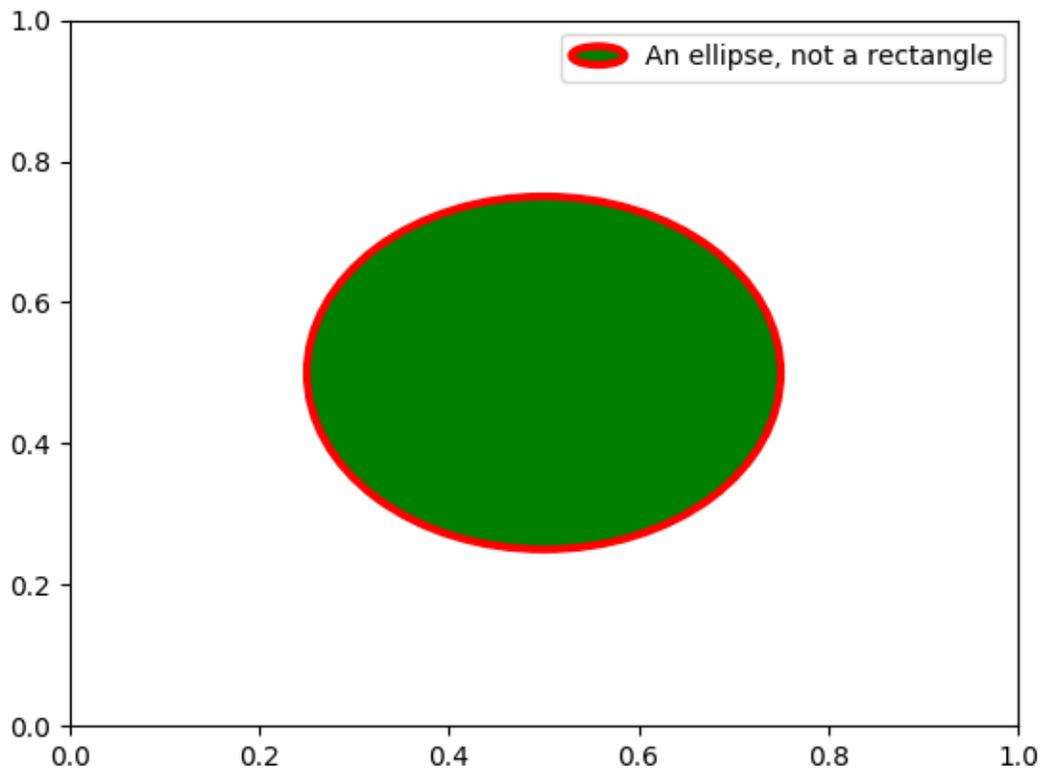
(continues on next page)

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```
center = 0.5 * width - 0.5 * xdescent, 0.5 * height - 0.5 * ydescent
p = mpatches.Ellipse(xy=center, width=width + xdescent,
                    height=height + ydescent)
self.update_prop(p, orig_handle, legend)
p.set_transform(trans)
return [p]

c = mpatches.Circle((0.5, 0.5), 0.25, facecolor="green",
                  edgecolor="red", linewidth=3)
plt.gca().add_patch(c)

plt.legend([c], ["An ellipse, not a rectangle"],
          handler_map={mpatches.Circle: HandlerEllipse()})
```



**Note:** Click [here](#) to download the full example code

### 2.2.3 Styling with `cycler`

Demo of custom property-cycle settings to control colors and other style properties for multi-line plots.

**Note:** More complete documentation of the `cycler` API can be found [here](#).

This example demonstrates two different APIs:

1. Setting the default `rc` parameter specifying the property cycle. This affects all subsequent axes (but not axes already created).
2. Setting the property cycle for a single pair of axes.

```
from cycler import cycler
import numpy as np
import matplotlib.pyplot as plt
```

First we'll generate some sample data, in this case, four offset sine curves.

```
x = np.linspace(0, 2 * np.pi, 50)
offsets = np.linspace(0, 2 * np.pi, 4, endpoint=False)
yy = np.transpose([np.sin(x + phi) for phi in offsets])
```

Now `yy` has shape

```
print(yy.shape)
```

Out:

```
(50, 4)
```

So `yy[:, i]` will give you the `i`-th offset sine curve. Let's set the default `prop_cycle` using `matplotlib.pyplot.rc()`. We'll combine a color `cycler` and a linestyle `cycler` by adding (+) two `cycler`'s together. See the bottom of this tutorial for more information about combining different `cycler`s.

```
default_cycler = (cycler(color=['r', 'g', 'b', 'y']) +
                  cycler(linestyle=['-', '--', ':', '-.']))

plt.rc('lines', linewidth=4)
plt.rc('axes', prop_cycle=default_cycler)
```

Now we'll generate a figure with two axes, one on top of the other. On the first axis, we'll plot with the default `cycler`. On the second axis, we'll set the `prop_cycler` using `matplotlib.axes.Axes.set_prop_cycle()` which will only set the `prop_cycle` for this `matplotlib.axes.Axes` instance. We'll use a second `cycler` that combines a color `cycler` and a linewidth `cycler`.

```
custom_cycler = (cycler(color=['c', 'm', 'y', 'k']) +
                 cycler(lw=[1, 2, 3, 4]))

fig, (ax0, ax1) = plt.subplots(nrows=2)
ax0.plot(yy)
ax0.set_title('Set default color cycle to rgby')
```

(continues on next page)

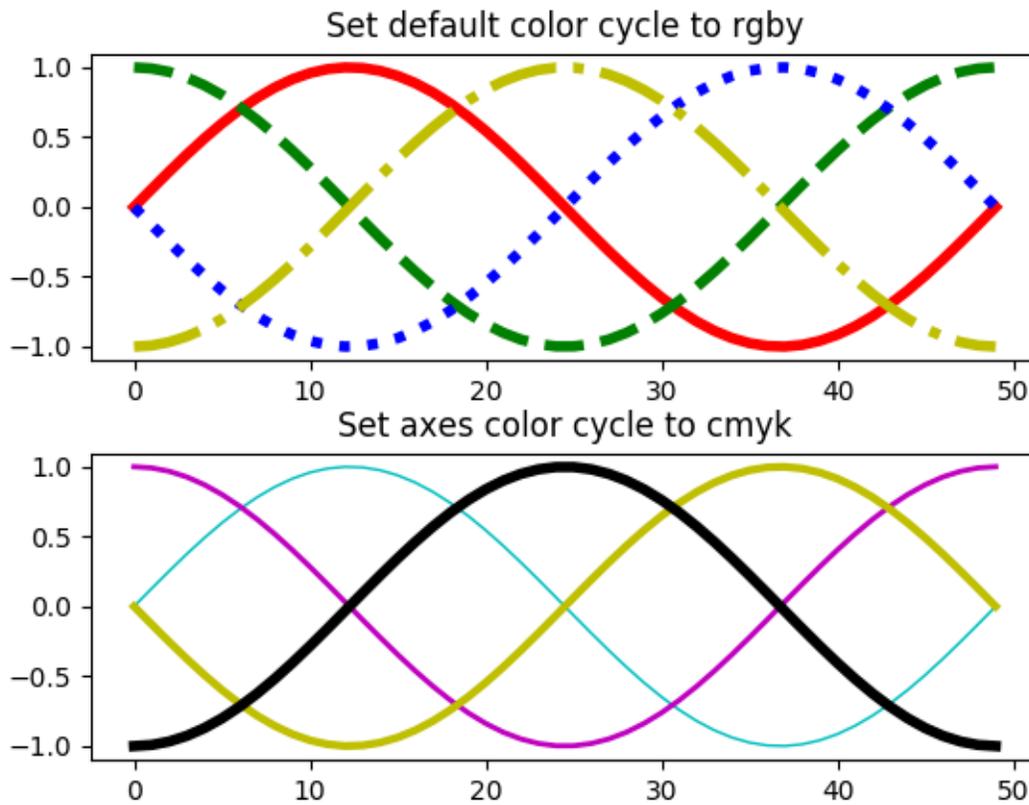
(continued from previous page)

```

ax1.set_prop_cycle(custom_cycler)
ax1.plot(yy)
ax1.set_title('Set axes color cycle to cmyk')

# Add a bit more space between the two plots.
fig.subplots_adjust(hspace=0.3)
plt.show()

```



### Setting `prop_cycler` in the `matplotlibrc` file or style files

Remember, if you want to set a custom `prop_cycler` in your `.matplotlibrc` file or a style file (`style.mplstyle`), you can set the `axes.prop_cycle` property:

```
axes.prop_cycle : cycler(color='bgrcmyk')
```

### Cycling through multiple properties

You can add cyclers:

```

from cycler import cycler
cc = (cyclor(color=list('rgb')) +
      cyclor(linestyle=['-', '---', '-.']))
for d in cc:
    print(d)

```

Results in:

```

{'color': 'r', 'linestyle': '-'}
{'color': 'g', 'linestyle': '---'}
{'color': 'b', 'linestyle': '-.'}

```

You can multiply cyclers:

```

from cycler import cycler
cc = (cyclor(color=list('rgb')) *
      cyclor(linestyle=['-', '---', '-.']))
for d in cc:
    print(d)

```

Results in:

```

{'color': 'r', 'linestyle': '-'}
{'color': 'r', 'linestyle': '---'}
{'color': 'r', 'linestyle': '-.'}
{'color': 'g', 'linestyle': '-'}
{'color': 'g', 'linestyle': '---'}
{'color': 'g', 'linestyle': '-.'}
{'color': 'b', 'linestyle': '-'}
{'color': 'b', 'linestyle': '---'}
{'color': 'b', 'linestyle': '-.'}

```

---

**Note:** Click [here](#) to download the full example code

---

## 2.2.4 Customizing Figure Layouts Using GridSpec and Other Functions

How to create grid-shaped combinations of axes.

*subplots()* Perhaps the primary function used to create figures and axes. It's also similar to *matplotlib.pyplot.subplot()*, but creates and places all axes on the figure at once. See also *matplotlib.Figure.subplots*.

*GridSpec* Specifies the geometry of the grid that a subplot will be placed. The number of rows and number of columns of the grid need to be set. Optionally, the subplot layout parameters (e.g., left, right, etc.) can be tuned.

*SubplotSpec* Specifies the location of the subplot in the given *GridSpec*.

*subplot2grid()* A helper function that is similar to *subplot()*, but uses 0-based indexing and let subplot to occupy multiple cells. This function is not covered in this tutorial.

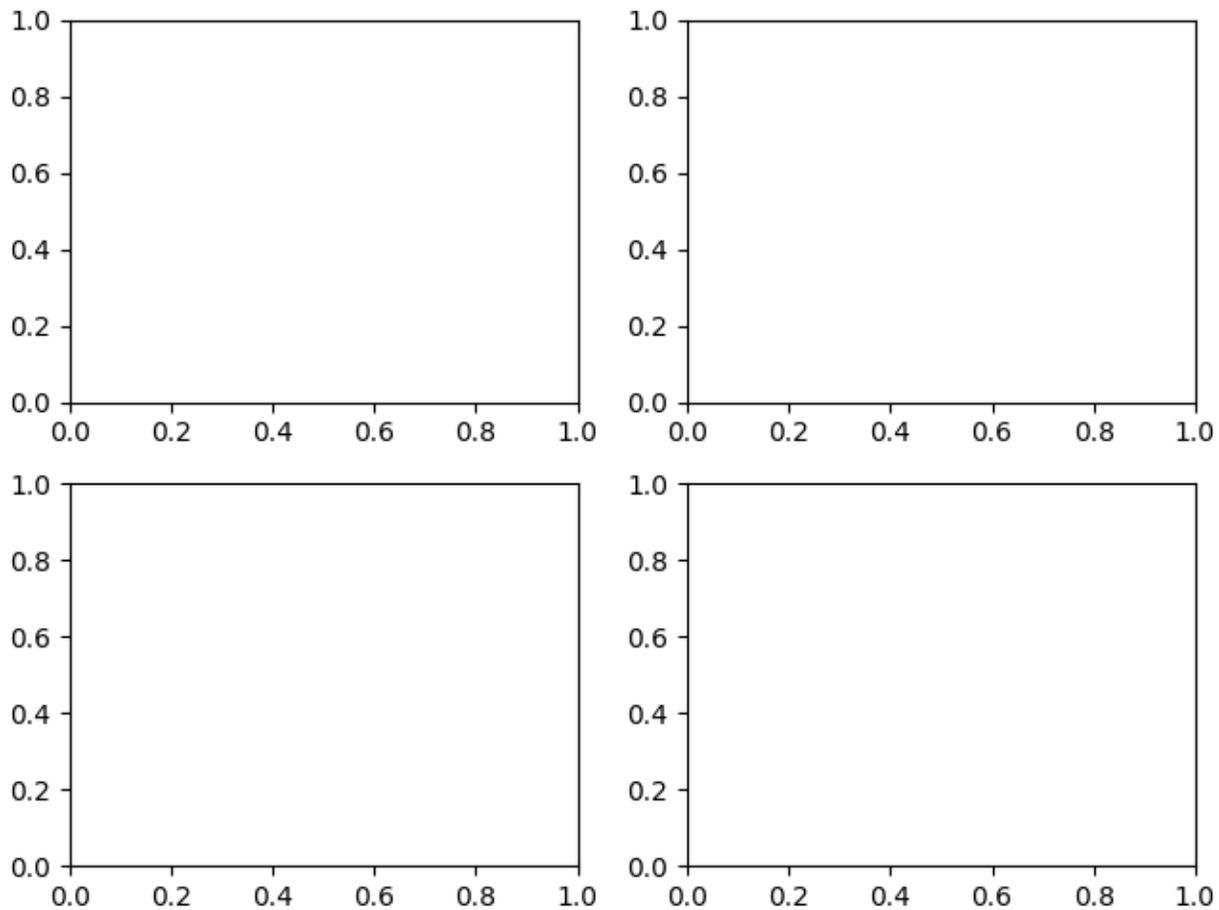
```
import matplotlib
import matplotlib.pyplot as plt
import matplotlib.gridspec as gridspec
```

## Basic Quickstart Guide

These first two examples show how to create a basic 2-by-2 grid using both `subplots()` and `gridspec`.

Using `subplots()` is quite simple. It returns a `Figure` instance and an array of `Axes` objects.

```
fig1, f1_axes = plt.subplots(ncols=2, nrows=2, constrained_layout=True)
```



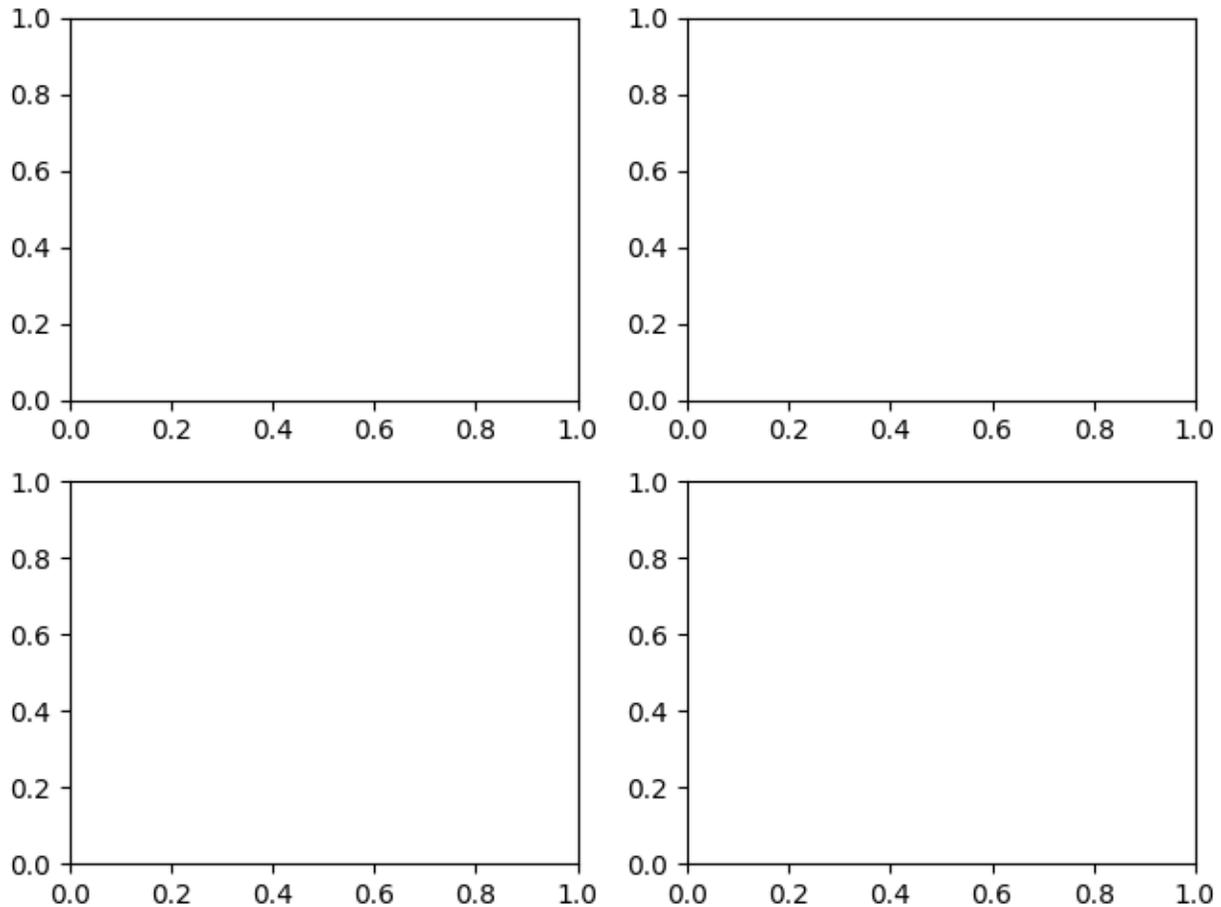
For a simple use case such as this, `gridspec` is perhaps overly verbose. You have to create the figure and `GridSpec` instance separately, then pass elements of `gridspec` instance to the `add_subplot()` method to create the axes objects. The elements of the `gridspec` are accessed in generally the same manner as numpy arrays.

```
fig2 = plt.figure(constrained_layout=True)
spec2 = gridspec.GridSpec(ncols=2, nrows=2, figure=fig2)
f2_ax1 = fig2.add_subplot(spec2[0, 0])
f2_ax2 = fig2.add_subplot(spec2[0, 1])
```

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(continued from previous page)

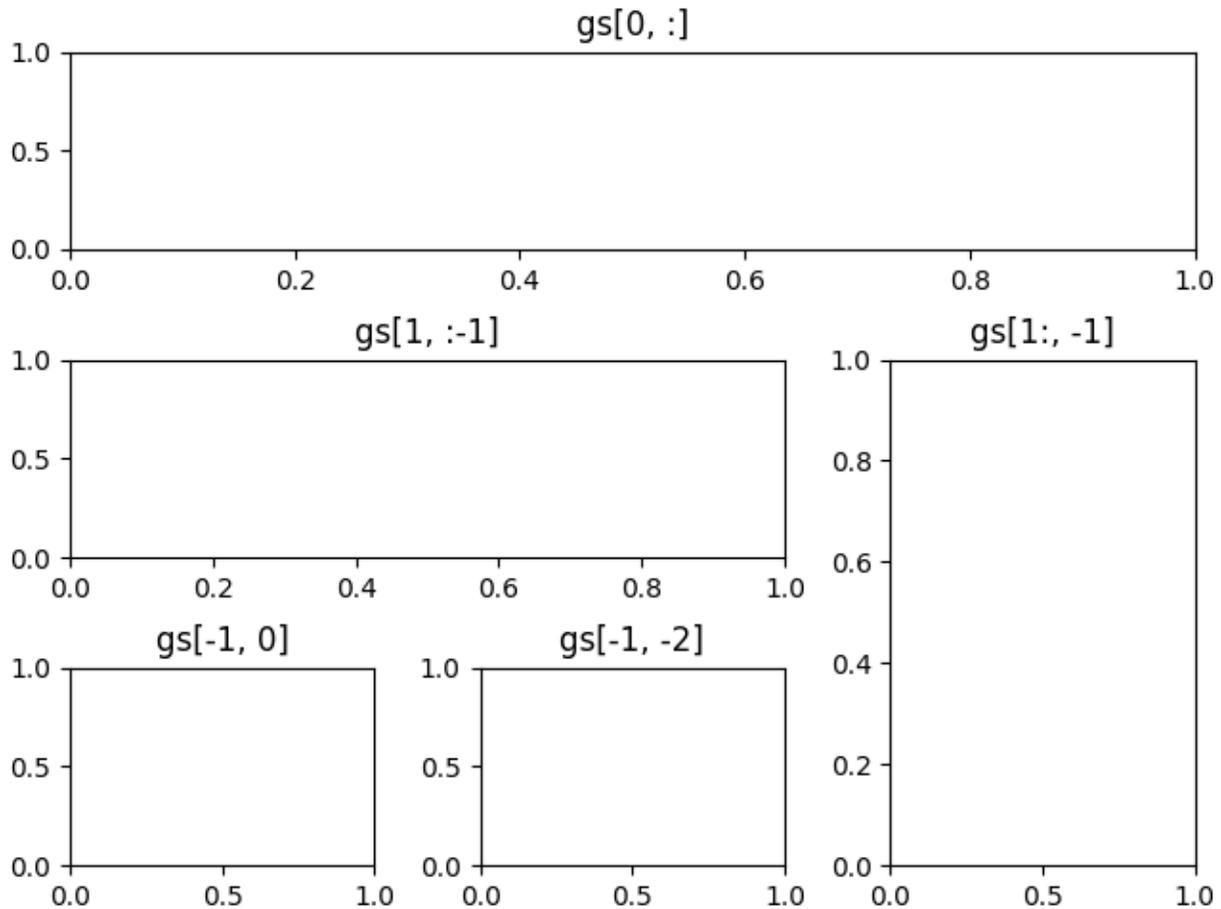
```
f2_ax3 = fig2.add_subplot(spec2[1, 0])
f2_ax4 = fig2.add_subplot(spec2[1, 1])
```



The power of `gridspec` comes in being able to create subplots that span rows and columns. Note the [Numpy slice](#) syntax for selecting the part of the `gridspec` each subplot will occupy.

Note that we have also used the convenience method `Figure.add_gridspec` instead of `gridspec.GridSpec`, potentially saving the user an import, and keeping the namespace cleaner.

```
fig3 = plt.figure(constrained_layout=True)
gs = fig3.add_gridspec(3, 3)
f3_ax1 = fig3.add_subplot(gs[0, :])
f3_ax1.set_title('gs[0, :]')
f3_ax2 = fig3.add_subplot(gs[1, :-1])
f3_ax2.set_title('gs[1, :-1]')
f3_ax3 = fig3.add_subplot(gs[1:, -1])
f3_ax3.set_title('gs[1:, -1]')
f3_ax4 = fig3.add_subplot(gs[-1, 0])
f3_ax4.set_title('gs[-1, 0]')
f3_ax5 = fig3.add_subplot(gs[-1, -2])
f3_ax5.set_title('gs[-1, -2]')
```

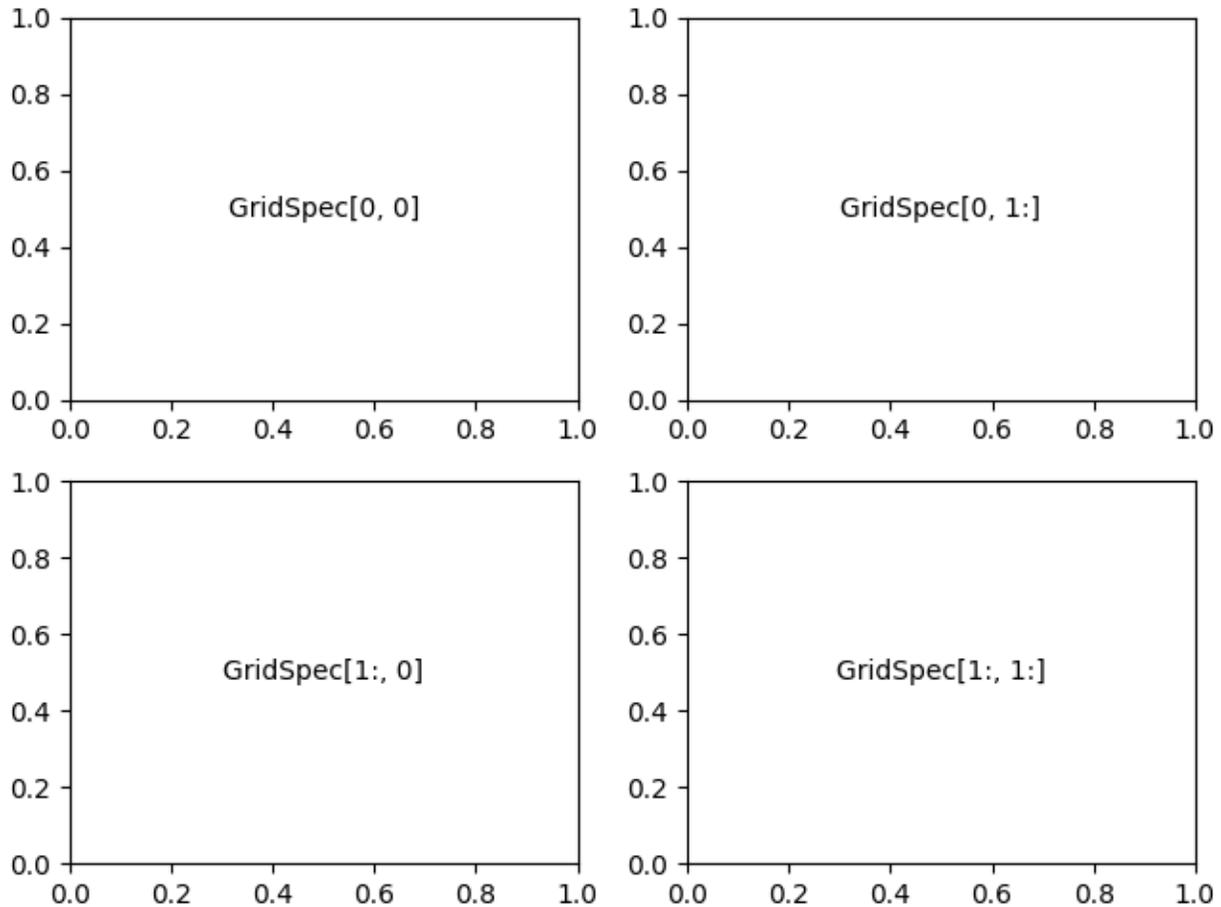


*gridspec* is also indispensable for creating subplots of different widths via a couple of methods.

The method shown here is similar to the one above and initializes a uniform grid specification, and then uses numpy indexing and slices to allocate multiple "cells" for a given subplot.

```
fig4 = plt.figure(constrained_layout=True)
spec4 = fig4.add_gridspec(ncols=2, rows=2)
anno_opts = dict(xy=(0.5, 0.5), xycoords='axes fraction',
                 va='center', ha='center')

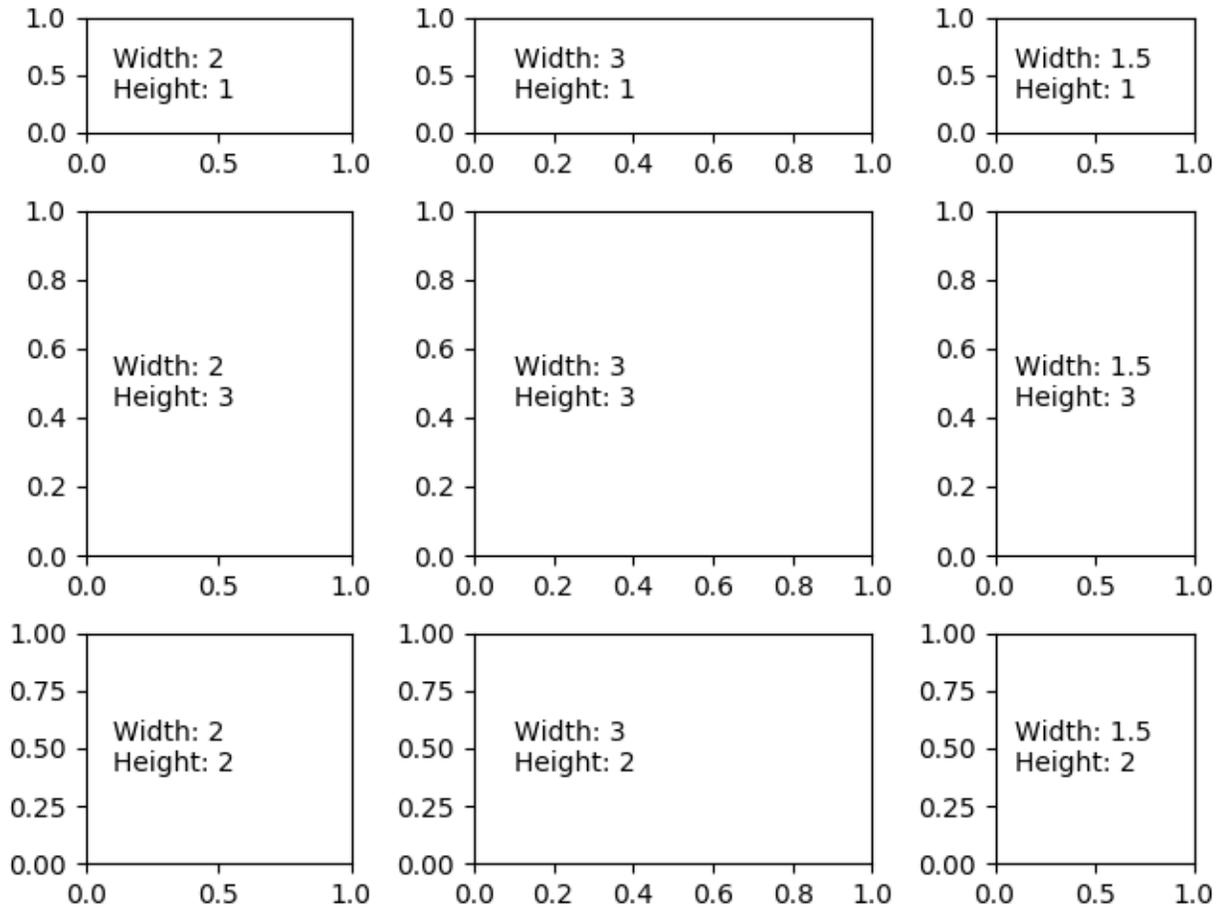
f4_ax1 = fig4.add_subplot(spec4[0, 0])
f4_ax1.annotate('GridSpec[0, 0]', **anno_opts)
fig4.add_subplot(spec4[0, 1]).annotate('GridSpec[0, 1:]', **anno_opts)
fig4.add_subplot(spec4[1, 0]).annotate('GridSpec[1:, 0]', **anno_opts)
fig4.add_subplot(spec4[1, 1]).annotate('GridSpec[1:, 1:]', **anno_opts)
```



Another option is to use the `width_ratios` and `height_ratios` parameters. These keyword arguments are lists of numbers. Note that absolute values are meaningless, only their relative ratios matter. That means that `width_ratios=[2, 4, 8]` is equivalent to `width_ratios=[1, 2, 4]` within equally wide figures. For the sake of demonstration, we'll blindly create the axes within `for` loops since we won't need them later.

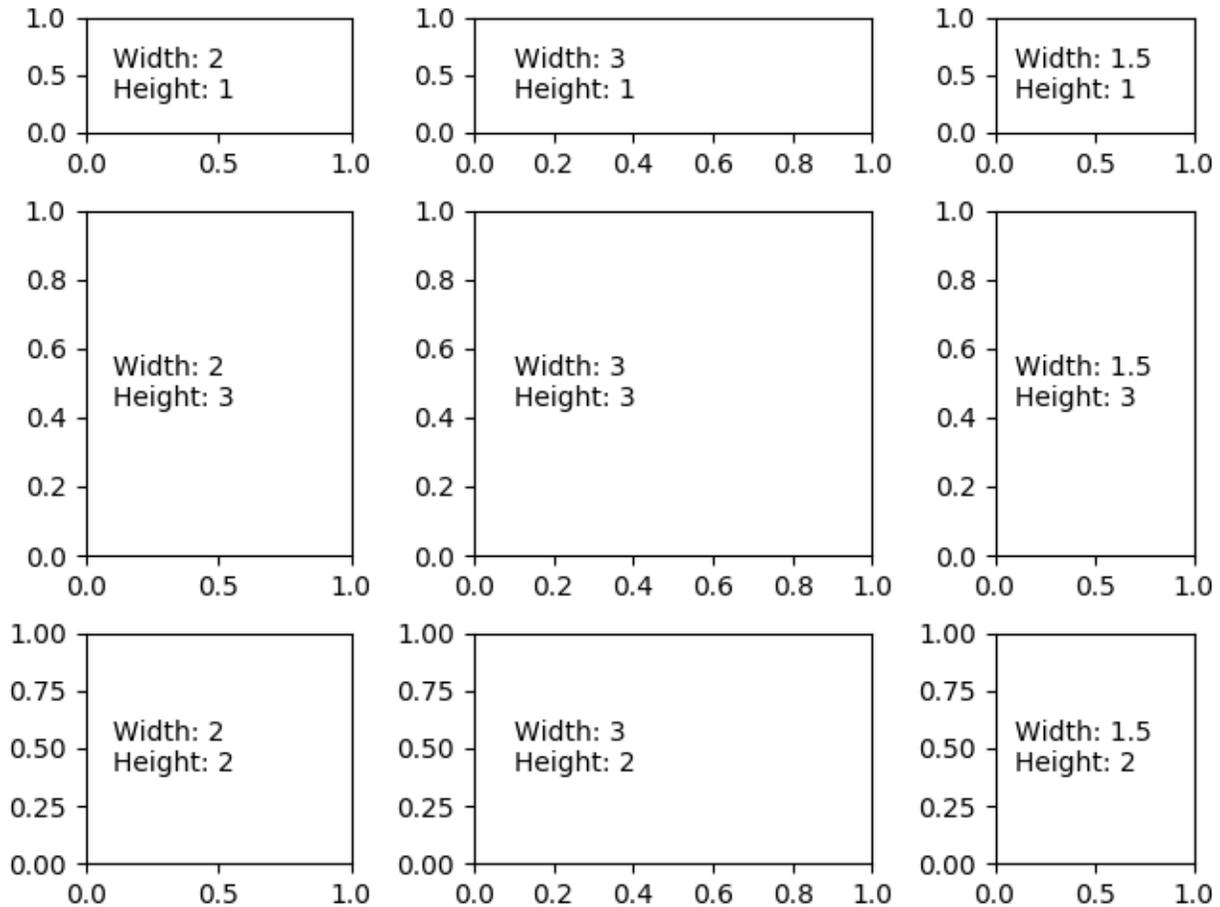
```
fig5 = plt.figure(constrained_layout=True)
widths = [2, 3, 1.5]
heights = [1, 3, 2]
spec5 = fig5.add_gridspec(ncols=3, rows=3, width_ratios=widths,
                          height_ratios=heights)

for row in range(3):
    for col in range(3):
        ax = fig5.add_subplot(spec5[row, col])
        label = 'Width: {} \n Height: {}'.format(widths[col], heights[row])
        ax.annotate(label, (0.1, 0.5), xycoords='axes fraction', va='center')
```



Learning to use `width_ratios` and `height_ratios` is particularly useful since the top-level function `subplots()` accepts them within the `gridspec_kw` parameter. For that matter, any parameter accepted by `GridSpec` can be passed to `subplots()` via the `gridspec_kw` parameter. This example recreates the previous figure without directly using a `gridspec` instance.

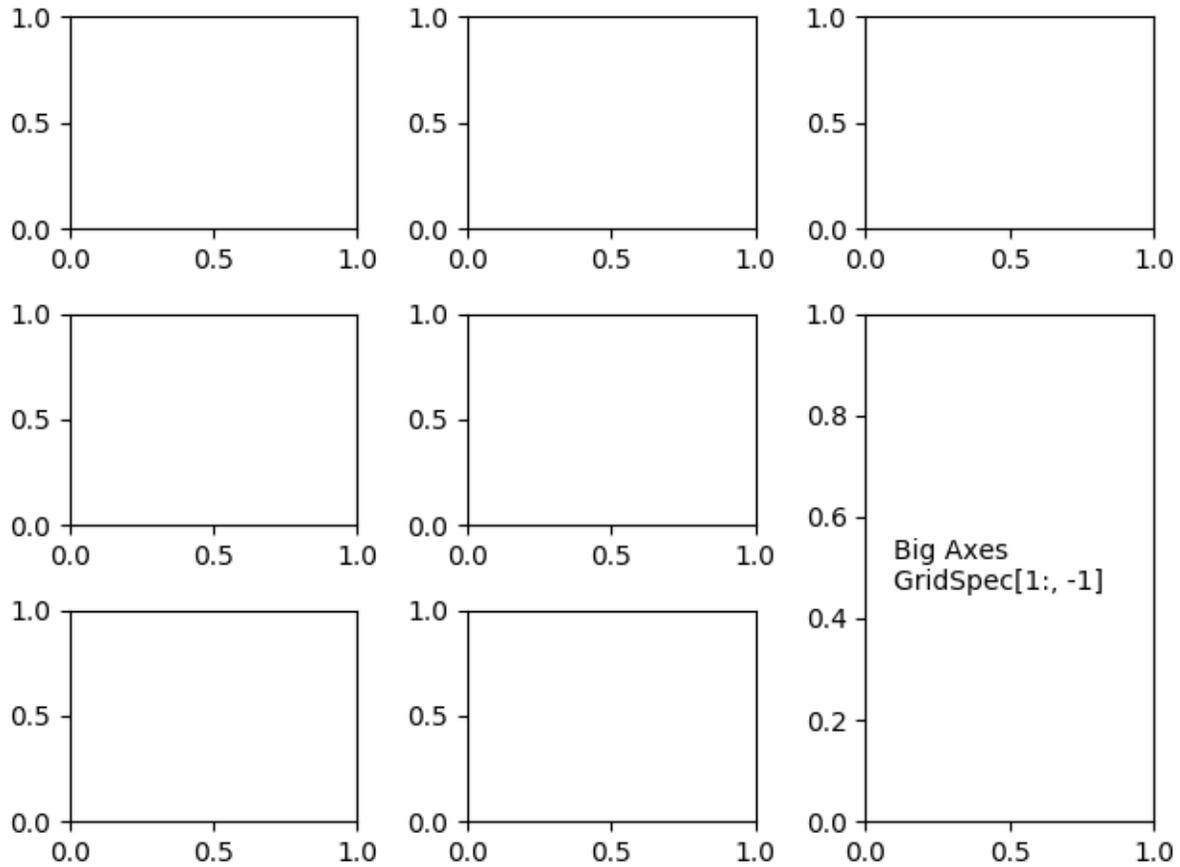
```
gs_kw = dict(width_ratios=widths, height_ratios=heights)
fig6, f6_axes = plt.subplots(ncols=3, nrows=3, constrained_layout=True,
                             gridspec_kw=gs_kw)
for r, row in enumerate(f6_axes):
    for c, ax in enumerate(row):
        label = 'Width: {} \n Height: {}'.format(widths[c], heights[r])
        ax.annotate(label, (0.1, 0.5), xycoords='axes fraction', va='center')
```



The subplots and gridspec methods can be combined since it is sometimes more convenient to make most of the subplots using subplots and then remove some and combine them. Here we create a layout with the bottom two axes in the last column combined.

```
fig7, f7_axs = plt.subplots(ncols=3, rows=3)
gs = f7_axs[1, 2].get_gridspec()
# remove the underlying axes
for ax in f7_axs[1:, -1]:
    ax.remove()
axbig = fig7.add_subplot(gs[1:, -1])
axbig.annotate('Big Axes \nGridSpec[1:, -1]', (0.1, 0.5),
               xycoords='axes fraction', va='center')

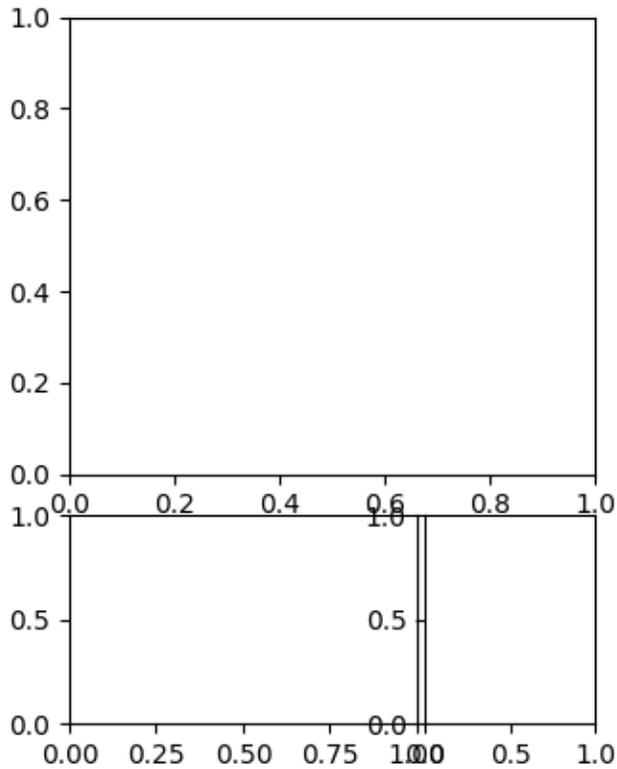
fig7.tight_layout()
```



### Fine Adjustments to a Gridspec Layout

When a `GridSpec` is explicitly used, you can adjust the layout parameters of subplots that are created from the `GridSpec`. Note this option is not compatible with `constrained_layout` or `Figure.tight_layout` which both adjust subplot sizes to fill the figure.

```
fig8 = plt.figure(constrained_layout=False)
gs1 = fig8.add_gridspec(nrows=3, ncols=3, left=0.05, right=0.48, wspace=0.05)
f8_ax1 = fig8.add_subplot(gs1[:-1, :])
f8_ax2 = fig8.add_subplot(gs1[-1, :-1])
f8_ax3 = fig8.add_subplot(gs1[-1, -1])
```

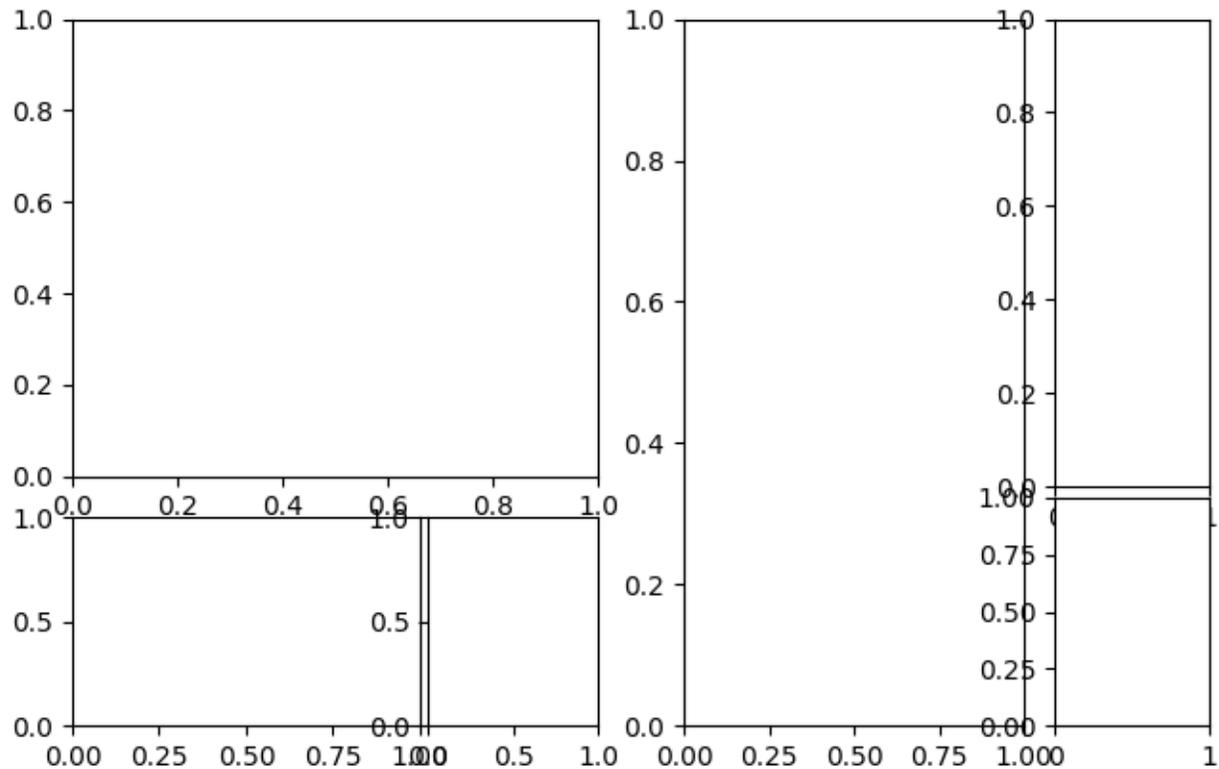


This is similar to `subplots_adjust()`, but it only affects the subplots that are created from the given `GridSpec`.

For example, compare the left and right sides of this figure:

```
fig9 = plt.figure(constrained_layout=False)
gs1 = fig9.add_gridspec(nrows=3, ncols=3, left=0.05, right=0.48,
                        wspace=0.05)
f9_ax1 = fig9.add_subplot(gs1[:-1, :])
f9_ax2 = fig9.add_subplot(gs1[-1, :-1])
f9_ax3 = fig9.add_subplot(gs1[-1, -1])

gs2 = fig9.add_gridspec(nrows=3, ncols=3, left=0.55, right=0.98,
                        hspace=0.05)
f9_ax4 = fig9.add_subplot(gs2[:, :-1])
f9_ax5 = fig9.add_subplot(gs2[:-1, -1])
f9_ax6 = fig9.add_subplot(gs2[-1, -1])
```



### GridSpec using SubplotSpec

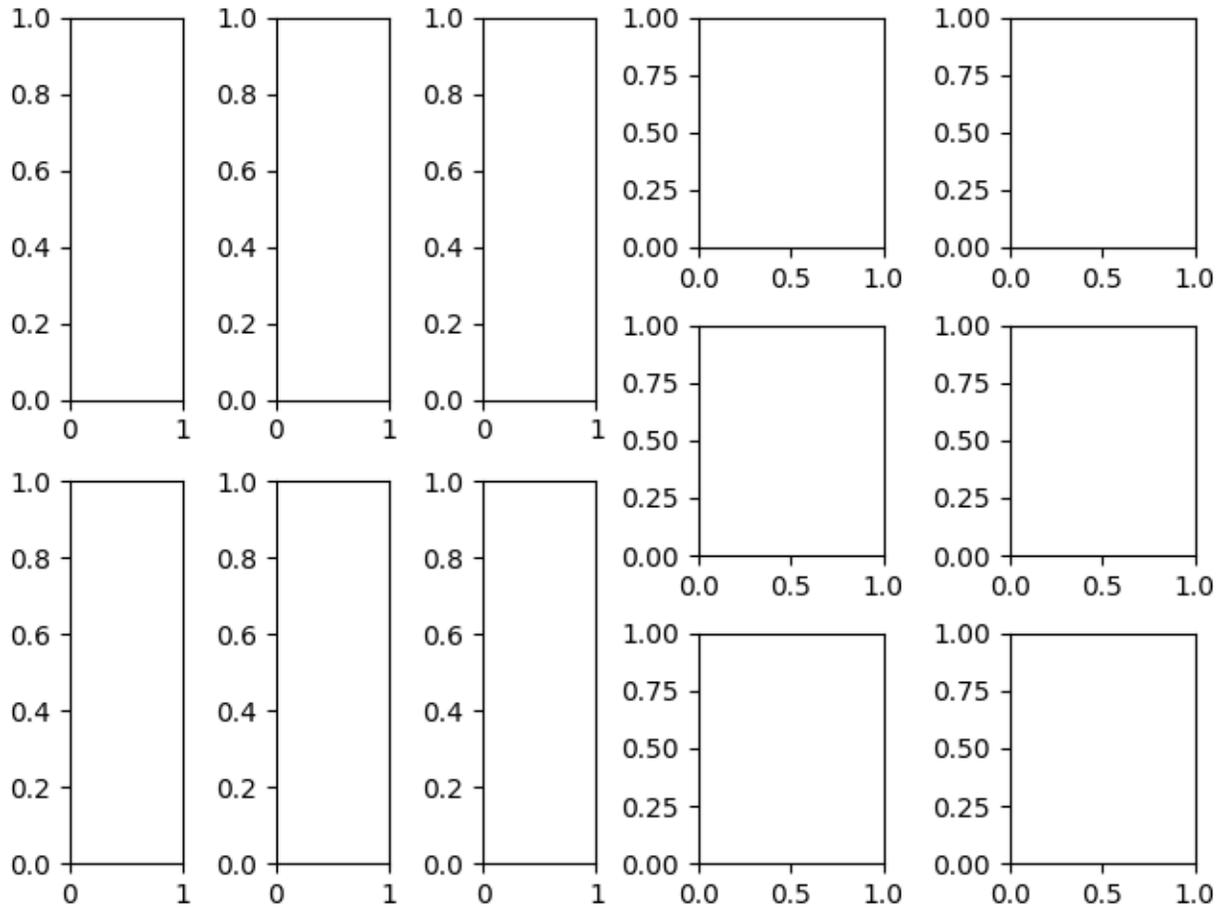
You can create `GridSpec` from the `SubplotSpec`, in which case its layout parameters are set to that of the location of the given `SubplotSpec`.

Note this is also available from the more verbose `gridspec.GridSpecFromSubplotSpec`.

```
fig10 = plt.figure(constrained_layout=True)
gs0 = fig10.add_gridspec(1, 2)

gs00 = gs0[0].subgridspec(2, 3)
gs01 = gs0[1].subgridspec(3, 2)

for a in range(2):
    for b in range(3):
        fig10.add_subplot(gs00[a, b])
        fig10.add_subplot(gs01[b, a])
```



### A Complex Nested GridSpec using SubplotSpec

Here's a more sophisticated example of nested GridSpec where we put a box around each cell of the outer 4x4 grid, by hiding appropriate spines in each of the inner 3x3 grids.

```
import numpy as np
from itertools import product

def squiggle_xy(a, b, c, d, i=np.arange(0.0, 2*np.pi, 0.05)):
    return np.sin(i*a)*np.cos(i*b), np.sin(i*c)*np.cos(i*d)

fig11 = plt.figure(figsize=(8, 8), constrained_layout=False)

# gridspec inside gridspec
outer_grid = fig11.add_gridspec(4, 4, wspace=0.0, hspace=0.0)

for i in range(16):
    inner_grid = outer_grid[i].subgridspec(3, 3, wspace=0.0, hspace=0.0)
    a, b = int(i/4)+1, i % 4+1
    for j, (c, d) in enumerate(product(range(1, 4), repeat=2)):
```

(continues on next page)

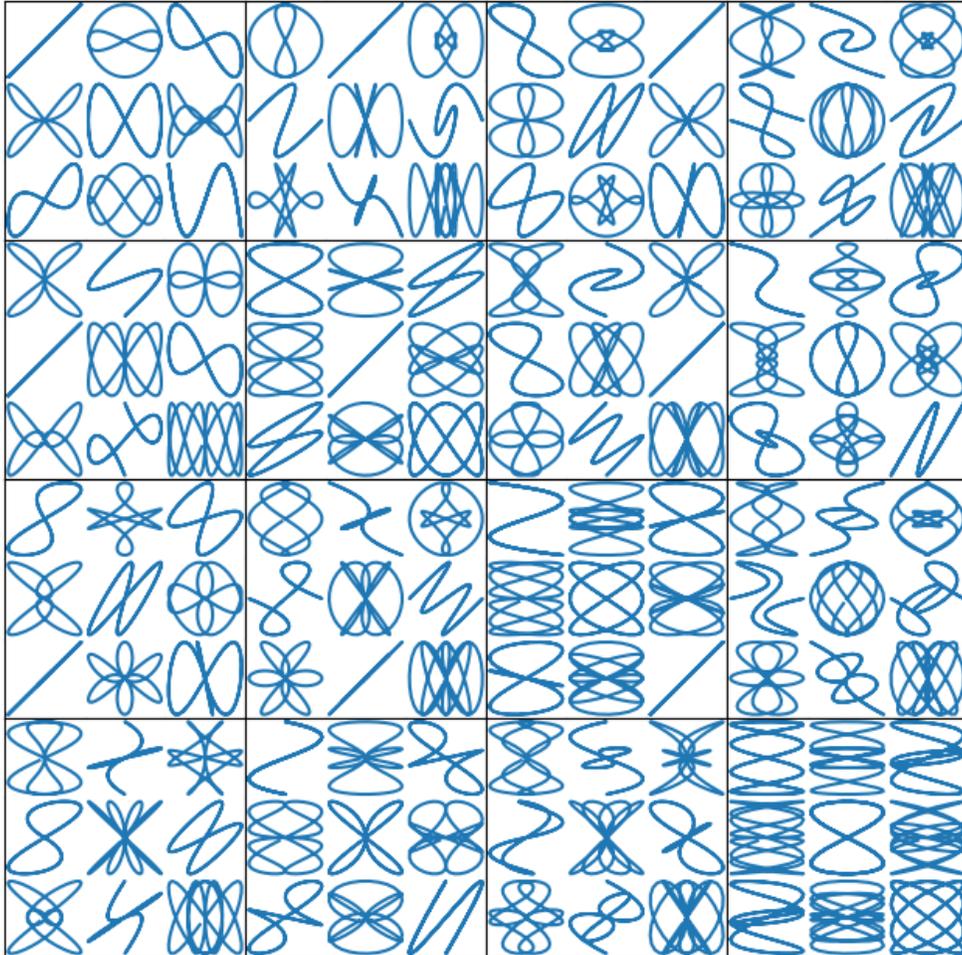
(continued from previous page)

```
ax = fig11.add_subplot(inner_grid[j])
ax.plot(*squiggle_xy(a, b, c, d))
ax.set_xticks([])
ax.set_yticks([])
fig11.add_subplot(ax)

all_axes = fig11.get_axes()

# show only the outside spines
for ax in all_axes:
    for sp in ax.spines.values():
        sp.set_visible(False)
    if ax.is_first_row():
        ax.spines['top'].set_visible(True)
    if ax.is_last_row():
        ax.spines['bottom'].set_visible(True)
    if ax.is_first_col():
        ax.spines['left'].set_visible(True)
    if ax.is_last_col():
        ax.spines['right'].set_visible(True)

plt.show()
```



---

## References

The usage of the following functions and methods is shown in this example:

```
matplotlib.pyplot.subplots
matplotlib.figure.Figure.add_gridspec
matplotlib.figure.Figure.add_subplot
matplotlib.gridspec.GridSpec
matplotlib.gridspec.SubplotSpec.subgridspec
matplotlib.gridspec.GridSpecFromSubplotSpec
```

**Total running time of the script:** ( 0 minutes 4.460 seconds)

---

**Note:** Click [here](#) to download the full example code

---

## 2.2.5 Constrained Layout Guide

How to use constrained-layout to fit plots within your figure cleanly.

*constrained\_layout* automatically adjusts subplots and decorations like legends and colorbars so that they fit in the figure window while still preserving, as best they can, the logical layout requested by the user.

*constrained\_layout* is similar to *tight\_layout*, but uses a constraint solver to determine the size of axes that allows them to fit.

*constrained\_layout* needs to be activated before any axes are added to a figure. Two ways of doing so are

- using the respective argument to *subplots()* or *figure()*, e.g.:

```
plt.subplots(constrained_layout=True)
```

- activate it via *rcParams*, like:

```
plt.rcParams['figure.constrained_layout.use'] = True
```

Those are described in detail throughout the following sections.

**Warning:** Currently Constrained Layout is **experimental**. The behaviour and API are subject to change, or the whole functionality may be removed without a deprecation period. If you *require* your plots to be absolutely reproducible, get the Axes positions after running Constrained Layout and use `ax.set_position()` in your code with `constrained_layout=False`.

### Simple Example

In Matplotlib, the location of axes (including subplots) are specified in normalized figure coordinates. It can happen that your axis labels or titles (or sometimes even ticklabels) go outside the figure area, and are thus clipped.

```
# sphinx_gallery_thumbnail_number = 18

import matplotlib.pyplot as plt
import matplotlib.colors as mcolors
import matplotlib.gridspec as gridspec
import numpy as np

plt.rcParams['savefig.facecolor'] = "0.8"
plt.rcParams['figure.figsize'] = 4.5, 4.
```

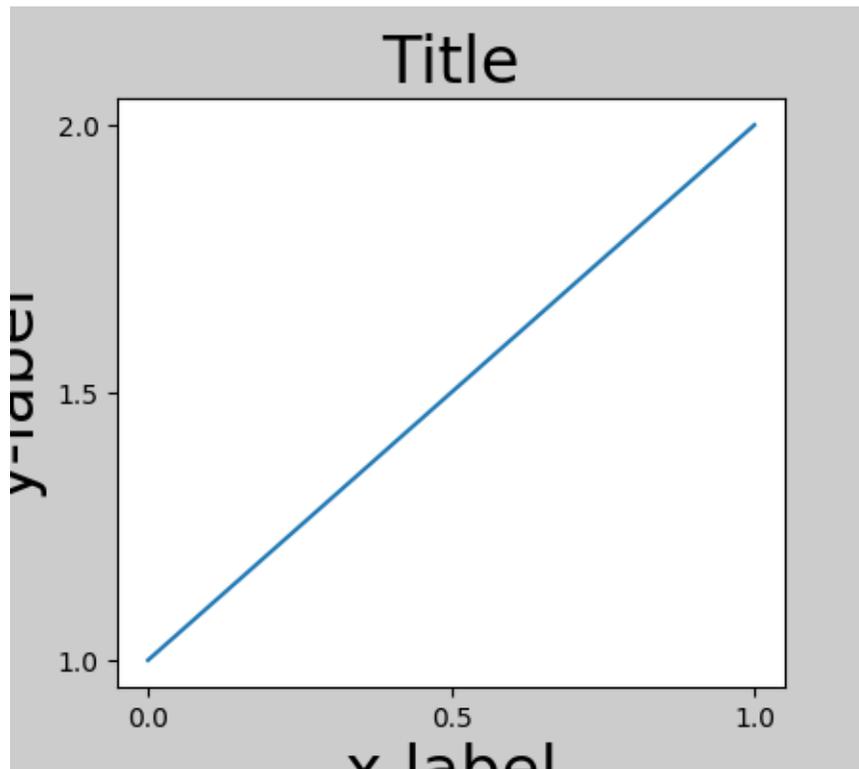
(continues on next page)

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```
def example_plot(ax, fontsize=12, nodec=False):
    ax.plot([1, 2])

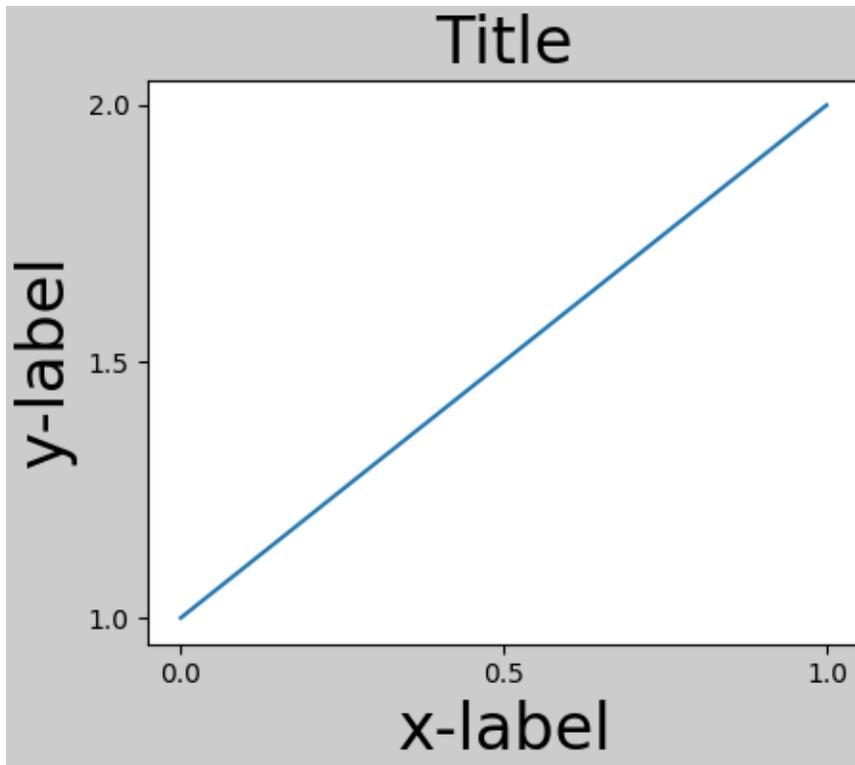
    ax.locator_params(nbins=3)
    if not nodec:
        ax.set_xlabel('x-label', fontsize=fontsize)
        ax.set_ylabel('y-label', fontsize=fontsize)
        ax.set_title('Title', fontsize=fontsize)
    else:
        ax.set_xticklabels('')
        ax.set_yticklabels('')
```

```
fig, ax = plt.subplots(constrained_layout=False)
example_plot(ax, fontsize=24)
```



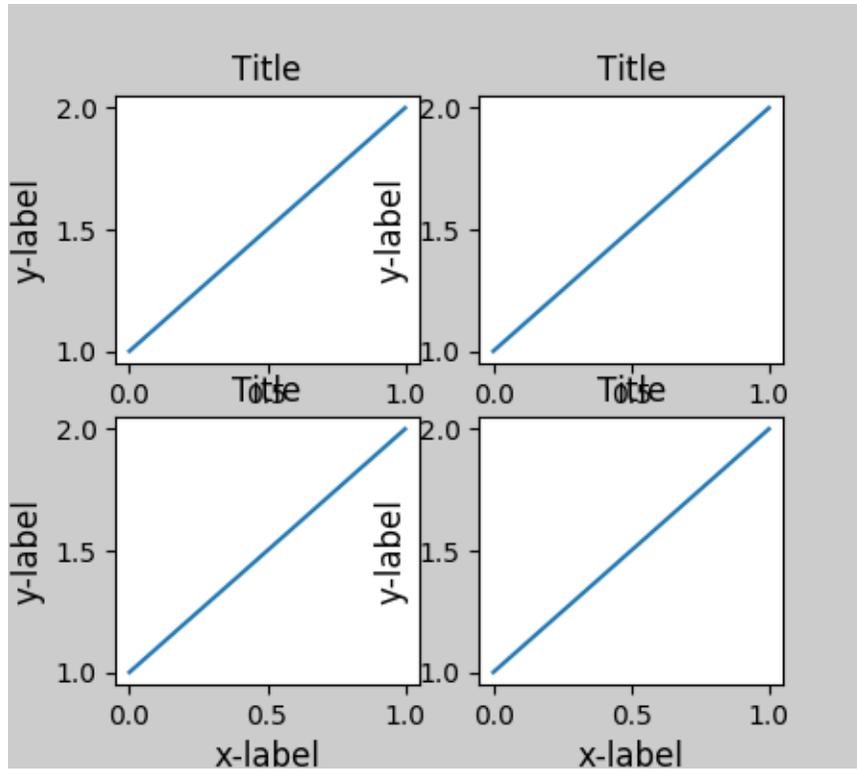
To prevent this, the location of axes needs to be adjusted. For subplots, this can be done by adjusting the subplot params (*Move the edge of an axes to make room for tick labels*). However, specifying your figure with the `constrained_layout=True` kwarg will do the adjusting automatically.

```
fig, ax = plt.subplots(constrained_layout=True)
example_plot(ax, fontsize=24)
```



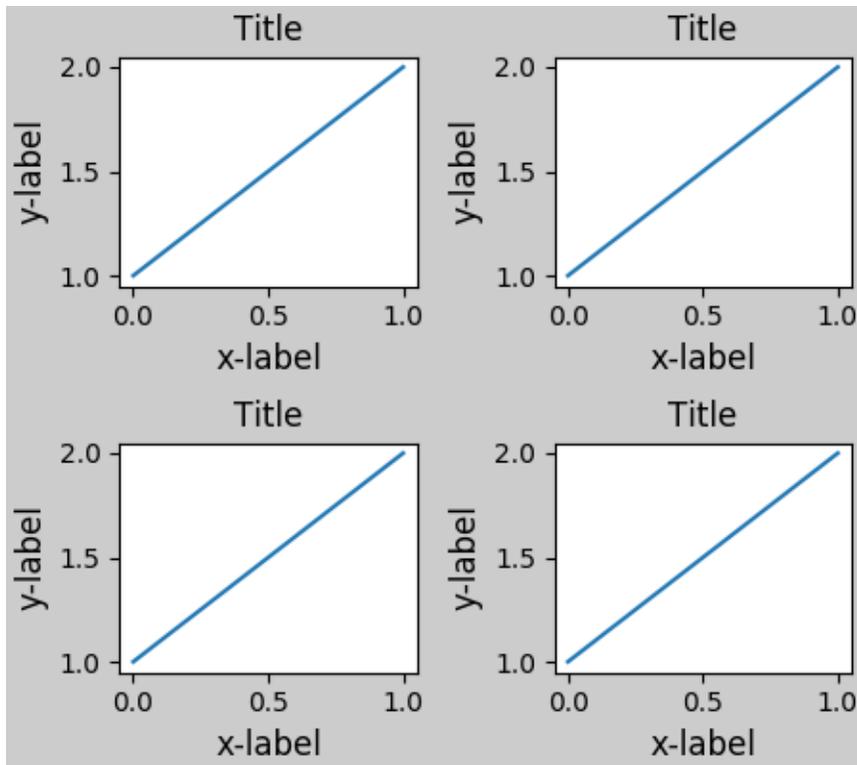
When you have multiple subplots, often you see labels of different axes overlapping each other.

```
fig, axs = plt.subplots(2, 2, constrained_layout=False)
for ax in axs.flat:
    example_plot(ax)
```



Specifying `constrained_layout=True` in the call to `plt.subplots` causes the layout to be properly constrained.

```
fig, axs = plt.subplots(2, 2, constrained_layout=True)
for ax in axs.flat:
    example_plot(ax)
```



### Colorbars

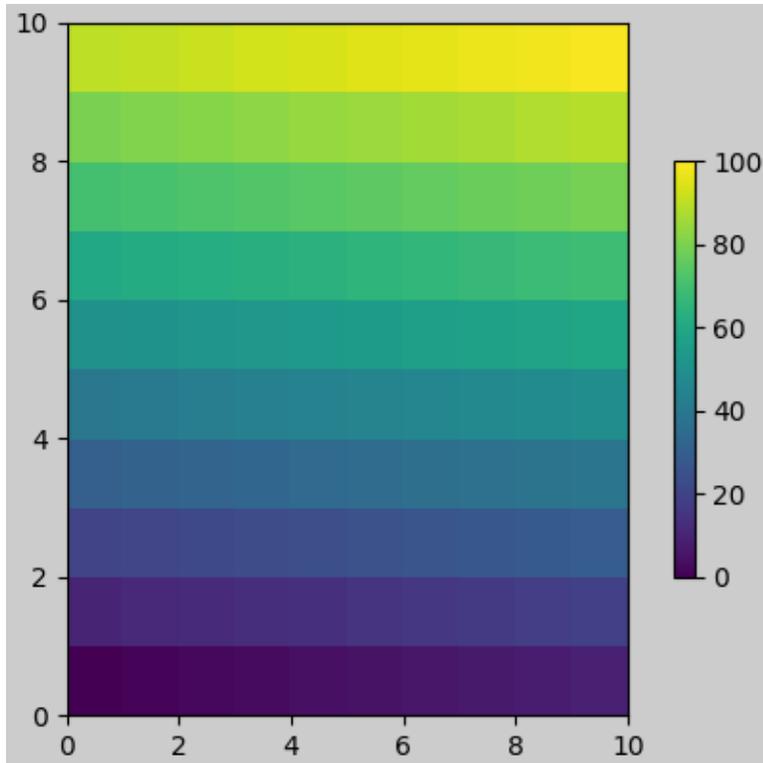
If you create a colorbar with the `colorbar()` command you need to make room for it. `constrained_layout` does this automatically. Note that if you specify `use_gridspec=True` it will be ignored because this option is made for improving the layout via `tight_layout`.

---

**Note:** For the `pcolormesh` kwargs (`pc_kwargs`) we use a dictionary. Below we will assign one colorbar to a number of axes each containing a *ScalarMappable*; specifying the norm and colormap ensures the colorbar is accurate for all the axes.

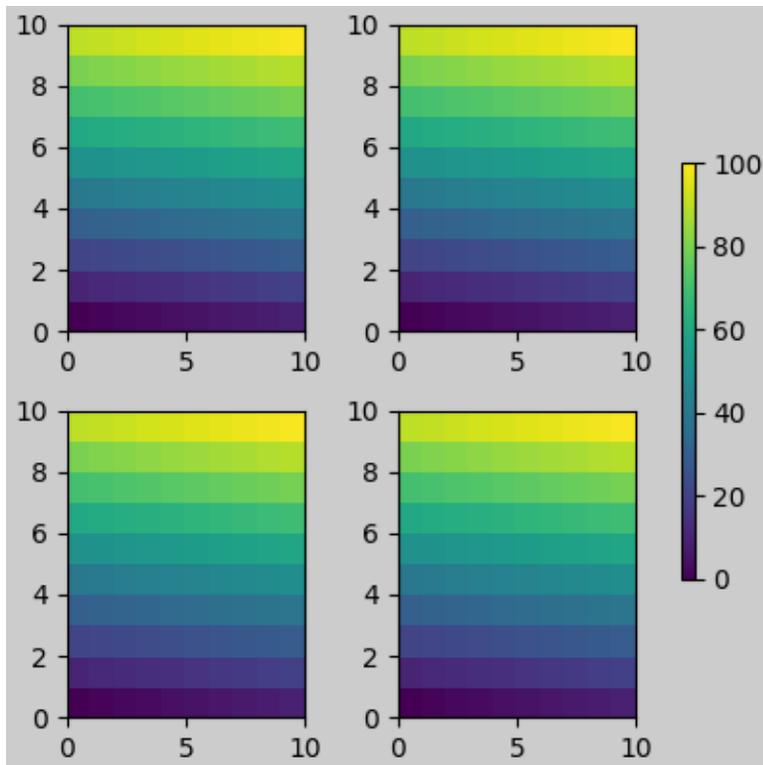
---

```
arr = np.arange(100).reshape((10, 10))
norm = mcolors.Normalize(vmin=0., vmax=100.)
# see note above: this makes all pcolormesh calls consistent:
pc_kwargs = {'rasterized': True, 'cmap': 'viridis', 'norm': norm}
fig, ax = plt.subplots(figsize=(4, 4), constrained_layout=True)
im = ax.pcolormesh(arr, **pc_kwargs)
fig.colorbar(im, ax=ax, shrink=0.6)
```



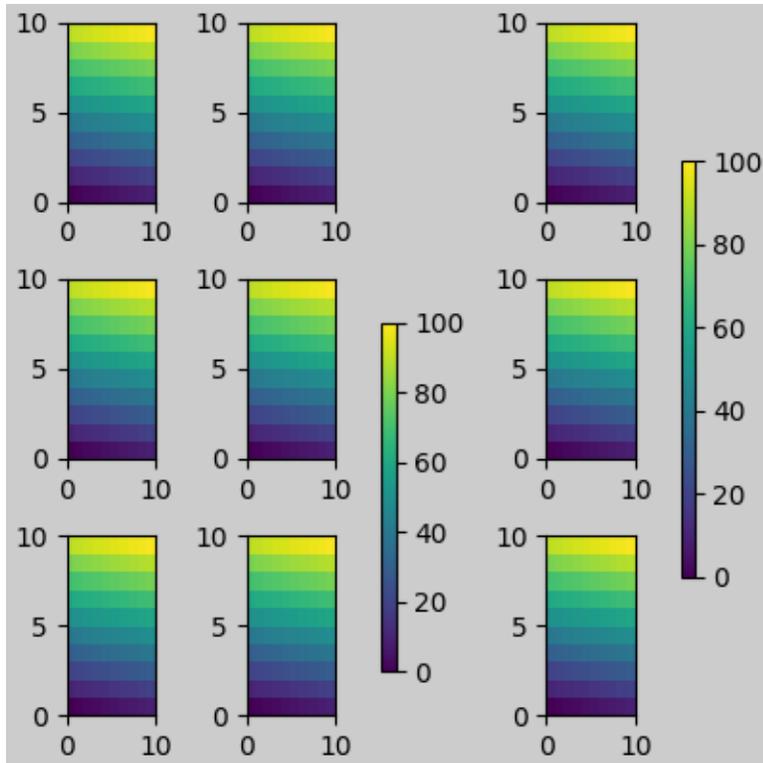
If you specify a list of axes (or other iterable container) to the `ax` argument of `colorbar`, `constrained_layout` will take space from the specified axes.

```
fig, axs = plt.subplots(2, 2, figsize=(4, 4), constrained_layout=True)
for ax in axs.flat:
    im = ax.pcolormesh(arr, **pc_kwargs)
fig.colorbar(im, ax=axs, shrink=0.6)
```



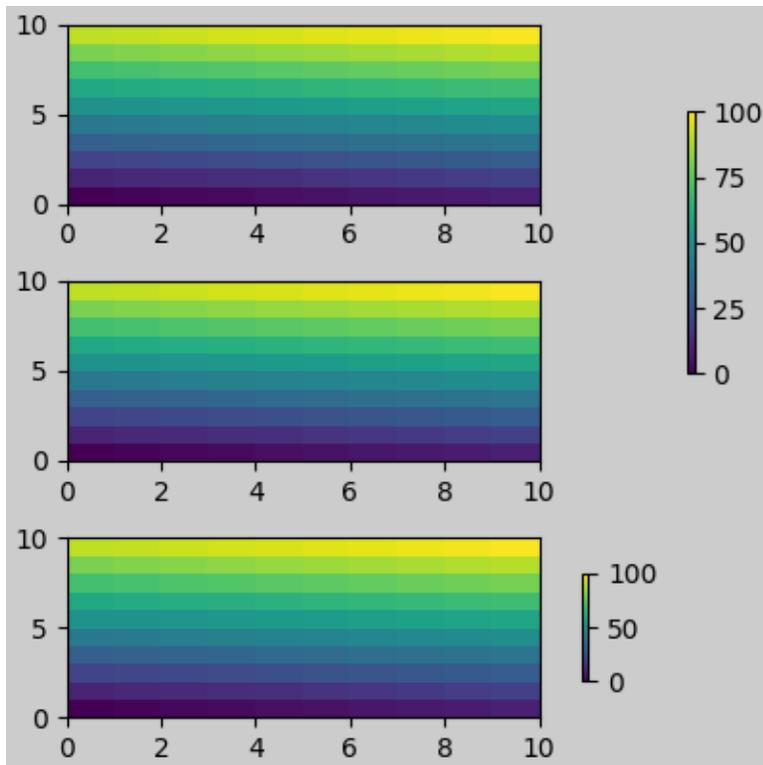
If you specify a list of axes from inside a grid of axes, the colorbar will steal space appropriately, and leave a gap, but all subplots will still be the same size.

```
fig, axs = plt.subplots(3, 3, figsize=(4, 4), constrained_layout=True)
for ax in axs.flat:
    im = ax.pcolormesh(arr, **pc_kwargs)
fig.colorbar(im, ax=axs[1:, ][:, 1], shrink=0.8)
fig.colorbar(im, ax=axs[:, -1], shrink=0.6)
```



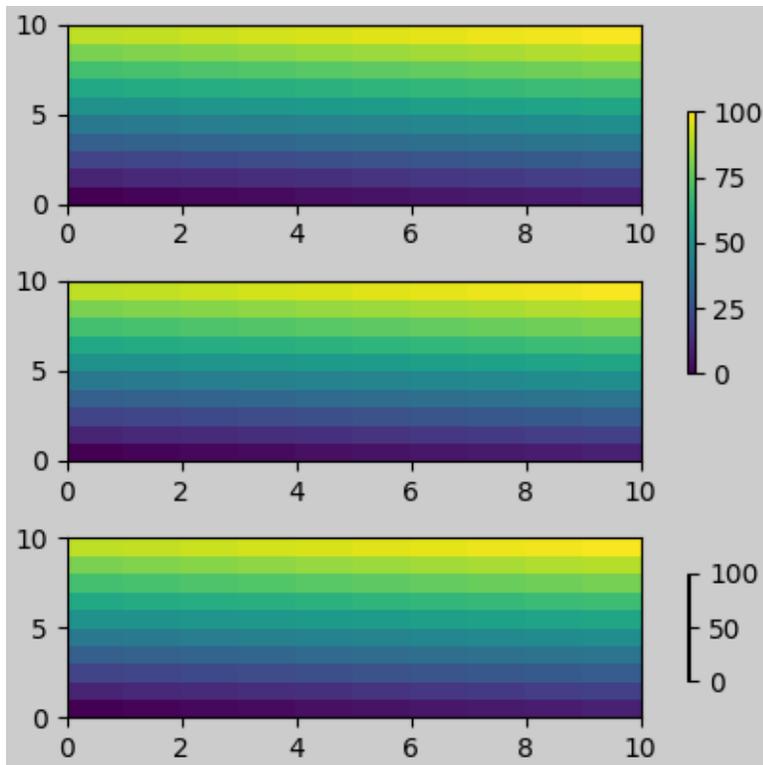
Note that there is a bit of a subtlety when specifying a single axes as the parent. In the following, it might be desirable and expected for the colorbars to line up, but they don't because the colorbar paired with the bottom axes is tied to the subplotspec of the axes, and hence shrinks when the gridspec-level colorbar is added.

```
fig, axs = plt.subplots(3, 1, figsize=(4, 4), constrained_layout=True)
for ax in axs[:2]:
    im = ax.pcolormesh(arr, **pc_kwargs)
fig.colorbar(im, ax=axs[:2], shrink=0.6)
im = axs[2].pcolormesh(arr, **pc_kwargs)
fig.colorbar(im, ax=axs[2], shrink=0.6)
```



The API to make a single-axis behave like a list of axes is to specify it as a list (or other iterable container), as below:

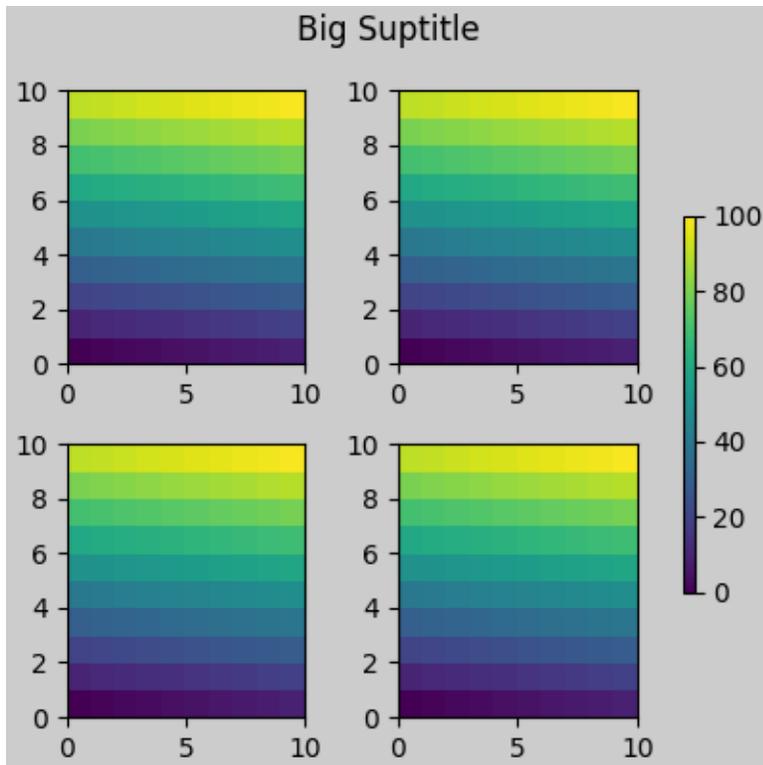
```
fig, axs = plt.subplots(3, 1, figsize=(4, 4), constrained_layout=True)
for ax in axs[:2]:
    im = ax.pcolormesh(arr, **pc_kwargs)
fig.colorbar(im, ax=axs[:2], shrink=0.6)
im = axs[2].pcolormesh(arr, **pc_kwargs)
fig.colorbar(im, ax=[axs[2]], shrink=0.6)
```



## Suptitle

`constrained_layout` can also make room for *suptitle*.

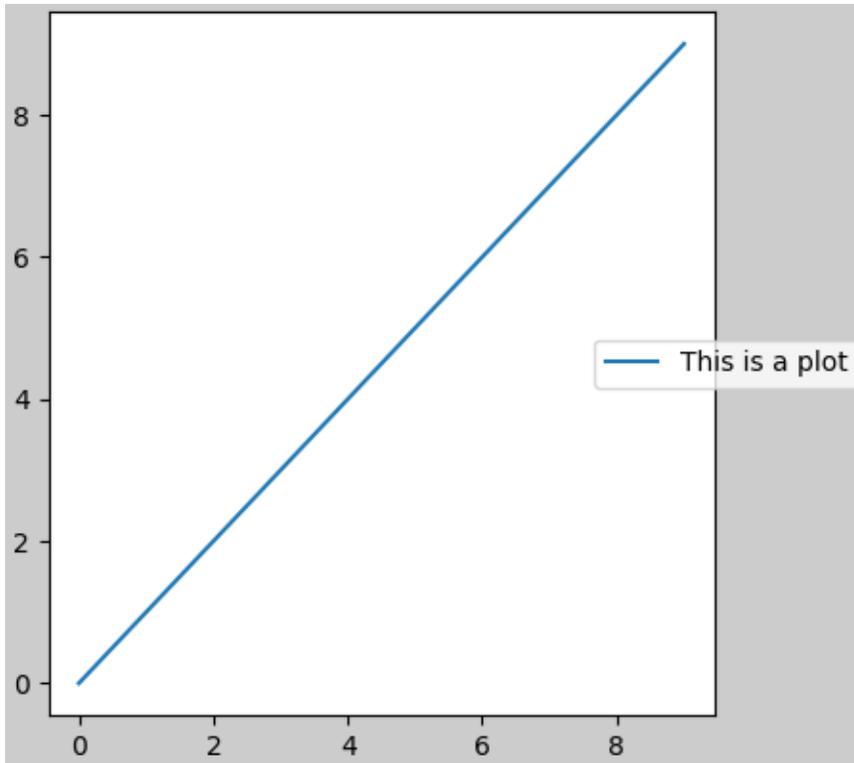
```
fig, axs = plt.subplots(2, 2, figsize=(4, 4), constrained_layout=True)
for ax in axs.flat:
    im = ax.pcolormesh(arr, **pc_kwargs)
fig.colorbar(im, ax=axs, shrink=0.6)
fig.suptitle('Big Suptitle')
```



## Legends

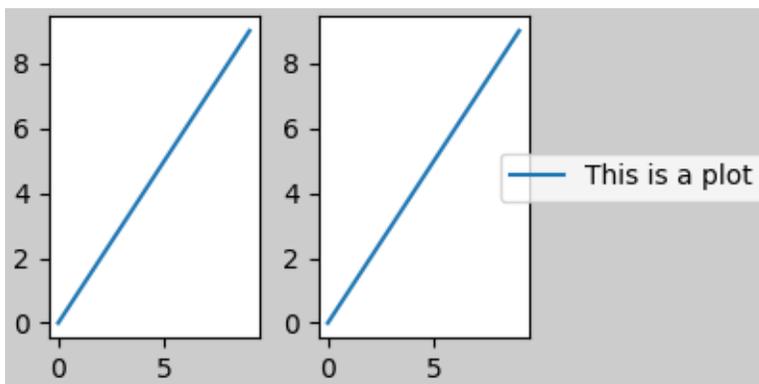
Legends can be placed outside of their parent axis. Constrained-layout is designed to handle this for `Axes.legend()`. However, constrained-layout does *not* handle legends being created via `Figure.legend()` (yet).

```
fig, ax = plt.subplots(constrained_layout=True)
ax.plot(np.arange(10), label='This is a plot')
ax.legend(loc='center left', bbox_to_anchor=(0.8, 0.5))
```



However, this will steal space from a subplot layout:

```
fig, axs = plt.subplots(1, 2, figsize=(4, 2), constrained_layout=True)
axs[0].plot(np.arange(10))
axs[1].plot(np.arange(10), label='This is a plot')
axs[1].legend(loc='center left', bbox_to_anchor=(0.8, 0.5))
```



In order for a legend or other artist to *not* steal space from the subplot layout, we can `leg.set_in_layout(False)`. Of course this can mean the legend ends up cropped, but can be useful if the plot is subsequently called with `fig.savefig('outname.png', bbox_inches='tight')`. Note, however, that the legend's `get_in_layout` status will have to be toggled again to make the saved file work, and we must manually trigger a draw if we want `constrained_layout` to adjust the size of the axes before printing.

```
fig, axs = plt.subplots(1, 2, figsize=(4, 2), constrained_layout=True)
```

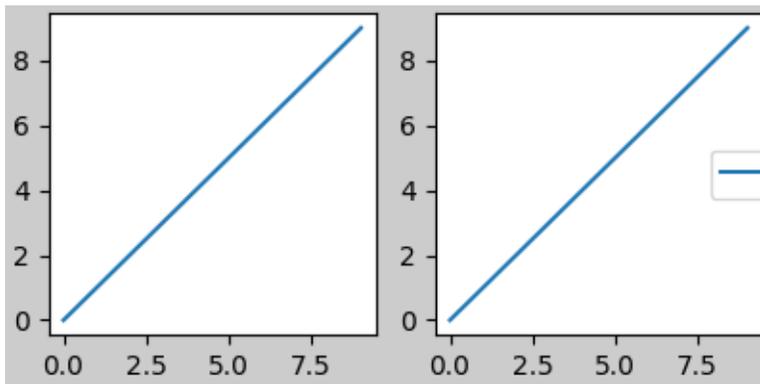
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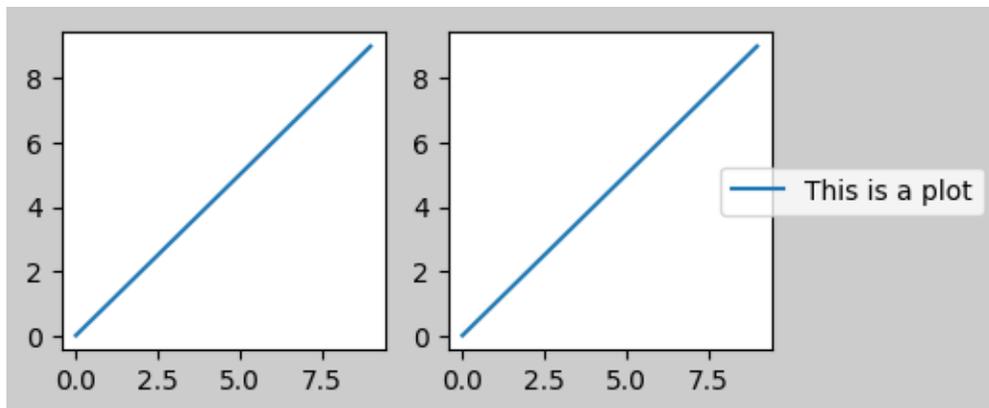
```

axs[0].plot(np.arange(10))
axs[1].plot(np.arange(10), label='This is a plot')
leg = axs[1].legend(loc='center left', bbox_to_anchor=(0.8, 0.5))
leg.set_in_layout(False)
# trigger a draw so that constrained_layout is executed once
# before we turn it off when printing...
fig.canvas.draw()
# we want the legend included in the bbox_inches='tight' calcs.
leg.set_in_layout(True)
# we don't want the layout to change at this point.
fig.set_constrained_layout(False)
fig.savefig('CL01.png', bbox_inches='tight', dpi=100)

```



The saved file looks like:

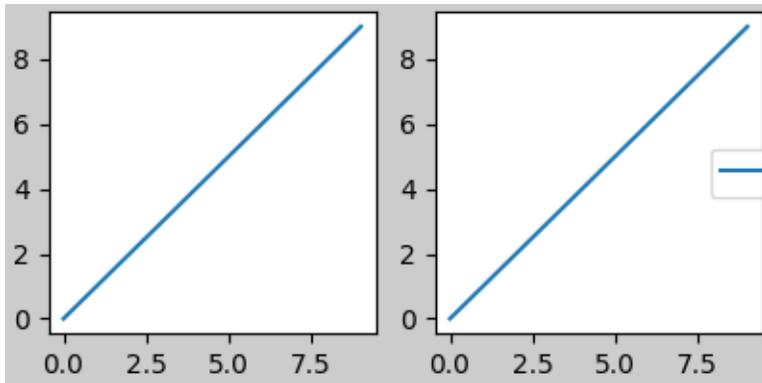


A better way to get around this awkwardness is to simply use the legend method provided by *Figure.legend*:

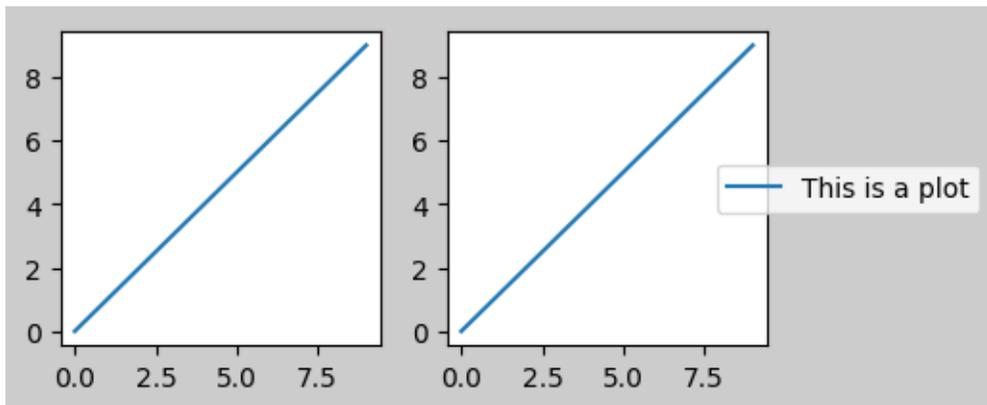
```

fig, axs = plt.subplots(1, 2, figsize=(4, 2), constrained_layout=True)
axs[0].plot(np.arange(10))
lines = axs[1].plot(np.arange(10), label='This is a plot')
labels = [l.get_label() for l in lines]
leg = fig.legend(lines, labels, loc='center left',
                 bbox_to_anchor=(0.8, 0.5), bbox_transform=axs[1].transAxes)
fig.savefig('CL02.png', bbox_inches='tight', dpi=100)

```



The saved file looks like:

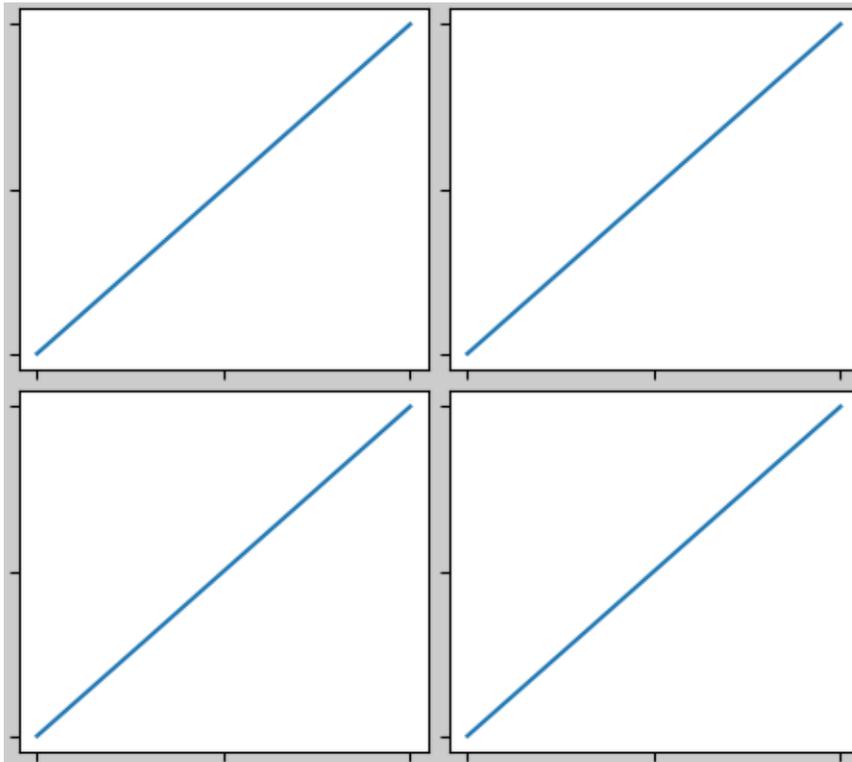
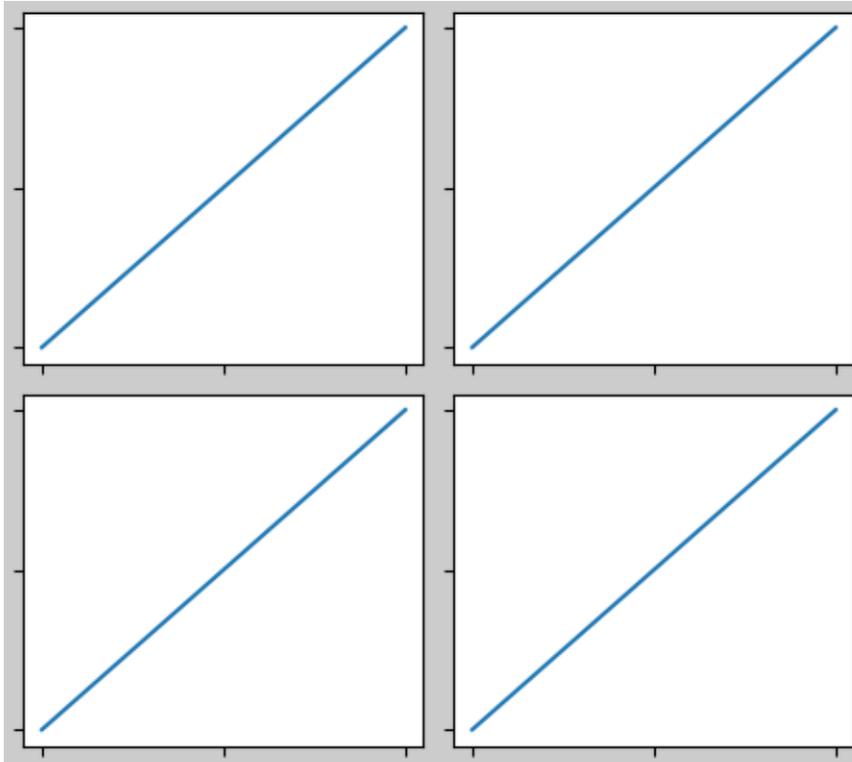


### Padding and Spacing

For `constrained_layout`, we have implemented a padding around the edge of each axes. This padding sets the distance from the edge of the plot, and the minimum distance between adjacent plots. It is specified in inches by the keyword arguments `w_pad` and `h_pad` to the function `set_constrained_layout_pads`:

```
fig, axs = plt.subplots(2, 2, constrained_layout=True)
for ax in axs.flat:
    example_plot(ax, nodec=True)
    ax.set_xticklabels('')
    ax.set_yticklabels('')
fig.set_constrained_layout_pads(w_pad=4./72., h_pad=4./72.,
                                hspace=0., wspace=0.)

fig, axs = plt.subplots(2, 2, constrained_layout=True)
for ax in axs.flat:
    example_plot(ax, nodec=True)
    ax.set_xticklabels('')
    ax.set_yticklabels('')
fig.set_constrained_layout_pads(w_pad=2./72., h_pad=2./72.,
                                hspace=0., wspace=0.)
```

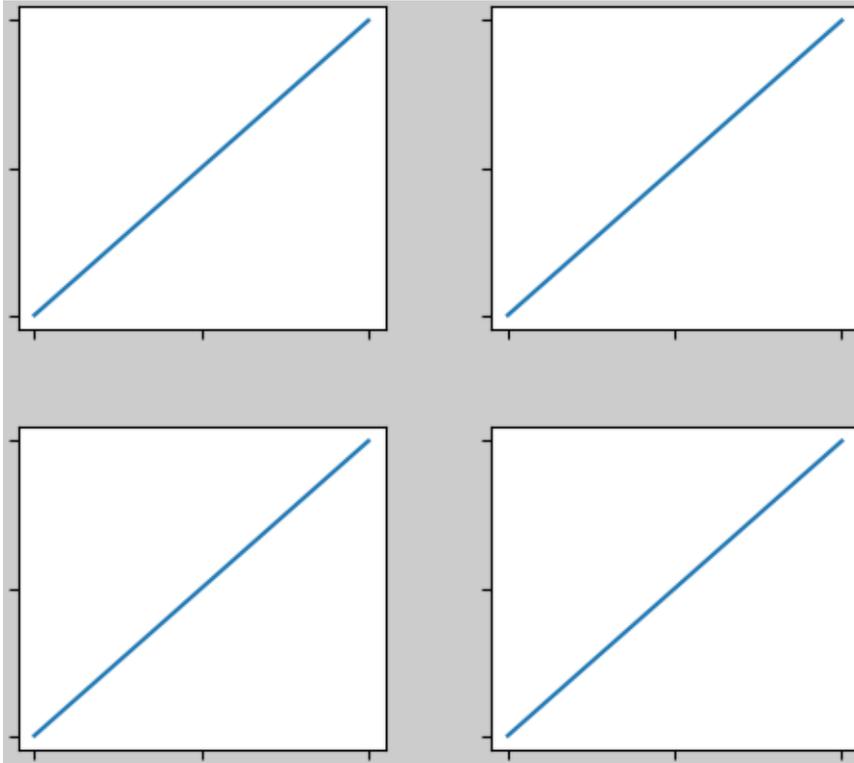


Spacing between subplots is set by `wspace` and `hspace`. They are specified as a fraction of the size of the subplot group as a whole. If the size of the figure is changed, then these spaces change in proportion. Note in the below how the space at the edges doesn't change from the above, but the space between subplots does.

```

fig, axs = plt.subplots(2, 2, constrained_layout=True)
for ax in axs.flat:
    example_plot(ax, nodec=True)
    ax.set_xticklabels('')
    ax.set_yticklabels('')
fig.set_constrained_layout_pads(w_pad=2./72., h_pad=2./72.,
                                hspace=0.2, wspace=0.2)

```



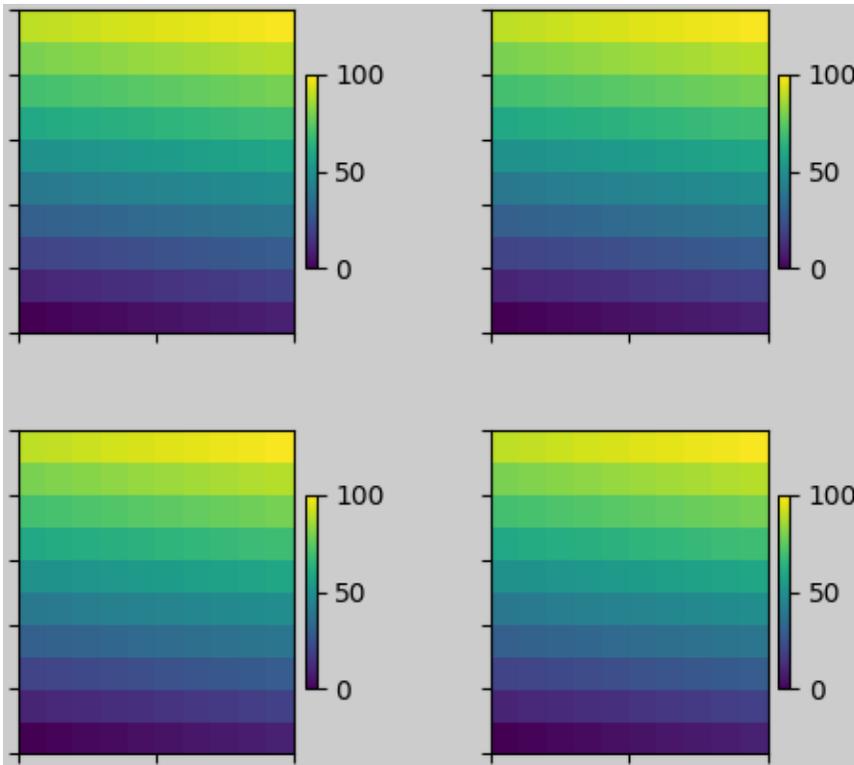
### Spacing with colorbars

Colorbars will be placed `wspace` and `hspace` apart from other subplots. The padding between the colorbar and the axis it is attached to will never be less than `w_pad` (for a vertical colorbar) or `h_pad` (for a horizontal colorbar). Note the use of the `pad` kwarg here in the `colorbar` call. It defaults to 0.02 of the size of the axis it is attached to.

```

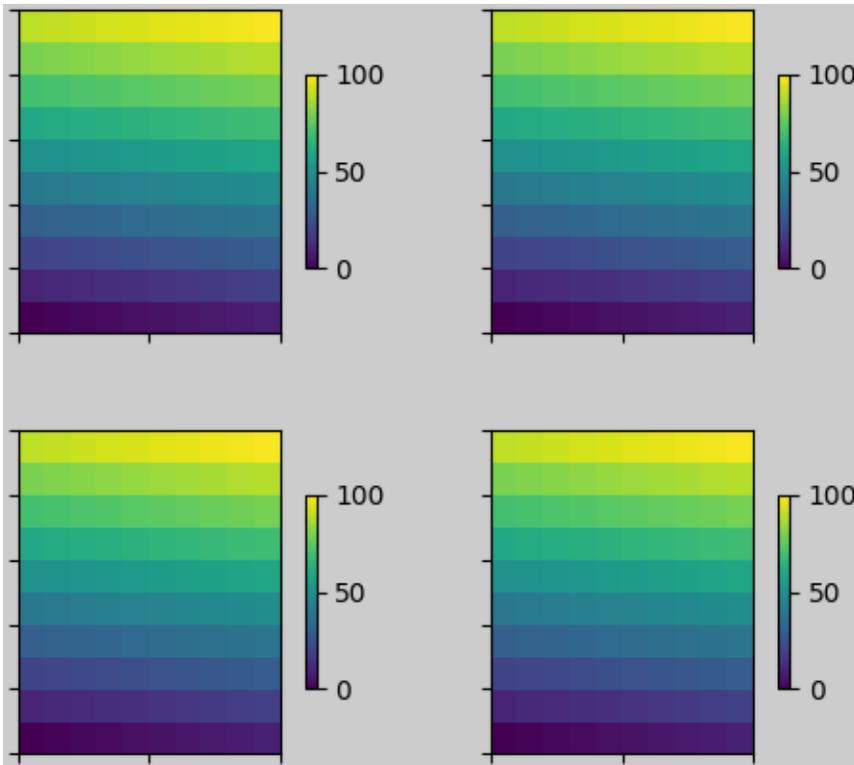
fig, axs = plt.subplots(2, 2, constrained_layout=True)
for ax in axs.flat:
    pc = ax.pcolormesh(arr, **pc_kwargs)
    fig.colorbar(pc, ax=ax, shrink=0.6, pad=0)
    ax.set_xticklabels('')
    ax.set_yticklabels('')
fig.set_constrained_layout_pads(w_pad=2./72., h_pad=2./72.,
                                hspace=0.2, wspace=0.2)

```



In the above example, the colorbar will not ever be closer than 2 pts to the plot, but if we want it a bit further away, we can specify its value for `pad` to be non-zero.

```
fig, axs = plt.subplots(2, 2, constrained_layout=True)
for ax in axs.flat:
    pc = ax.pcolormesh(arr, **pc_kwargs)
    fig.colorbar(im, ax=ax, shrink=0.6, pad=0.05)
    ax.set_xticklabels('')
    ax.set_yticklabels('')
fig.set_constrained_layout_pads(w_pad=2./72., h_pad=2./72.,
                                hspace=0.2, wspace=0.2)
```

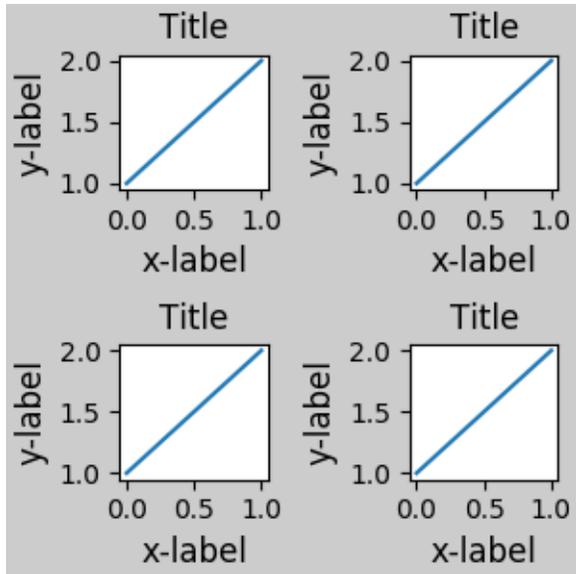


### rcParams

There are five *rcParams* that can be set, either in a script or in the `matplotlibrc` file. They all have the prefix `figure.constrained_layout`:

- `use`: Whether to use `constrained_layout`. Default is `False`
- `w_pad`, `h_pad`: **Padding around axes objects**. Float representing inches. Default is `3./72.` inches (3 pts)
- `wspace`, `hspace`: **Space between subplot groups**. Float representing a fraction of the subplot widths being separated. Default is `0.02`.

```
plt.rcParams['figure.constrained_layout.use'] = True
fig, axs = plt.subplots(2, 2, figsize=(3, 3))
for ax in axs.flat:
    example_plot(ax)
```



### Use with GridSpec

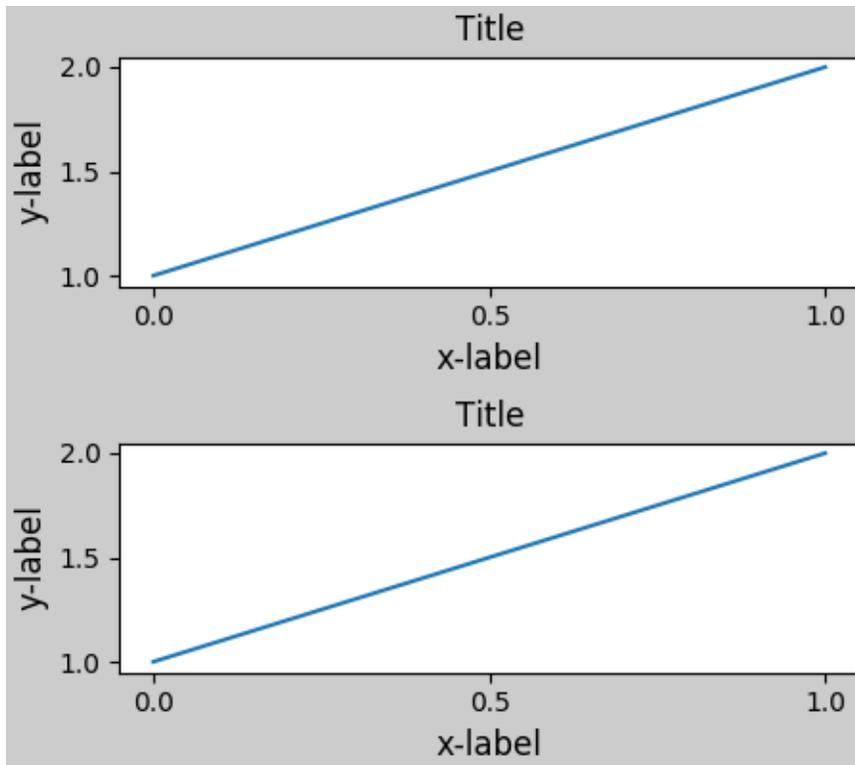
`constrained_layout` is meant to be used with `subplots()` or `GridSpec()` and `add_subplot()`.

Note that in what follows `constrained_layout=True`

```
fig = plt.figure()

gs1 = gridspec.GridSpec(2, 1, figure=fig)
ax1 = fig.add_subplot(gs1[0])
ax2 = fig.add_subplot(gs1[1])

example_plot(ax1)
example_plot(ax2)
```



More complicated gridspec layouts are possible. Note here we use the convenience functions `add_gridspec` and `subgridspec`.

```
fig = plt.figure()

gs0 = fig.add_gridspec(1, 2)

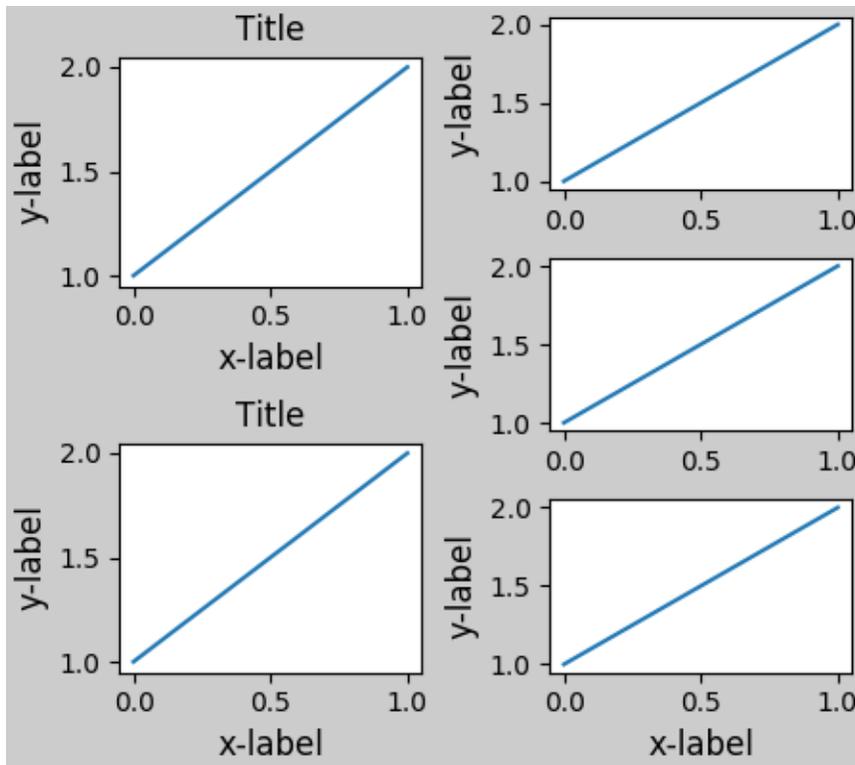
gs1 = gs0[0].subgridspec(2, 1)
ax1 = fig.add_subplot(gs1[0])
ax2 = fig.add_subplot(gs1[1])

example_plot(ax1)
example_plot(ax2)

gs2 = gs0[1].subgridspec(3, 1)

for ss in gs2:
    ax = fig.add_subplot(ss)
    example_plot(ax)
    ax.set_title("")
    ax.set_xlabel("")

ax.set_xlabel("x-label", fontsize=12)
```



Note that in the above the left and columns don't have the same vertical extent. If we want the top and bottom of the two grids to line up then they need to be in the same gridspec:

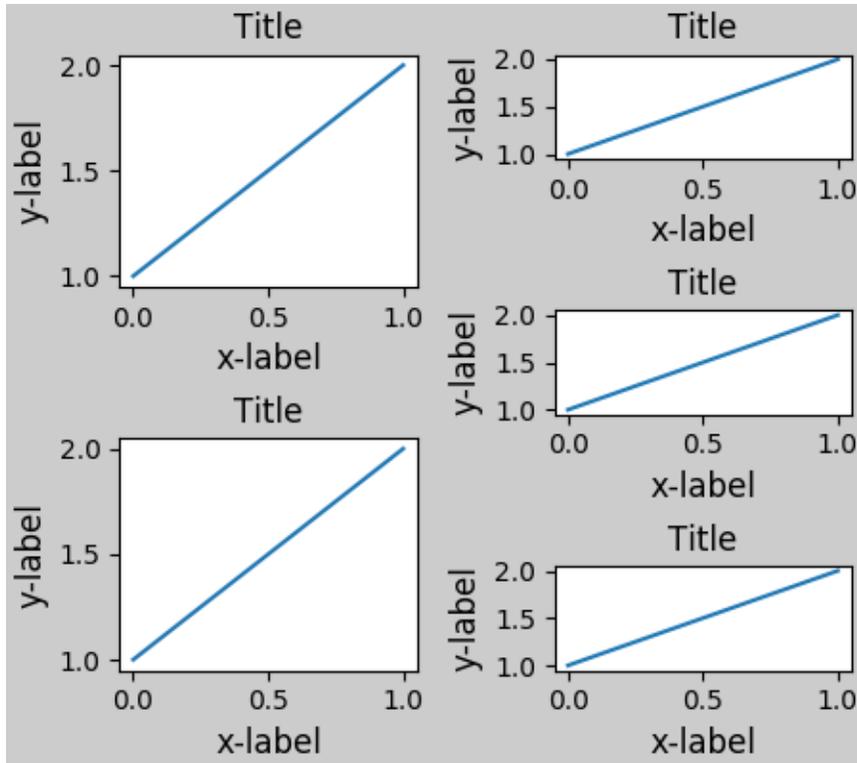
```
fig = plt.figure()

gs0 = fig.add_gridspec(6, 2)

ax1 = fig.add_subplot(gs0[:3, 0])
ax2 = fig.add_subplot(gs0[3:, 0])

example_plot(ax1)
example_plot(ax2)

ax = fig.add_subplot(gs0[0:2, 1])
example_plot(ax)
ax = fig.add_subplot(gs0[2:4, 1])
example_plot(ax)
ax = fig.add_subplot(gs0[4:, 1])
example_plot(ax)
```



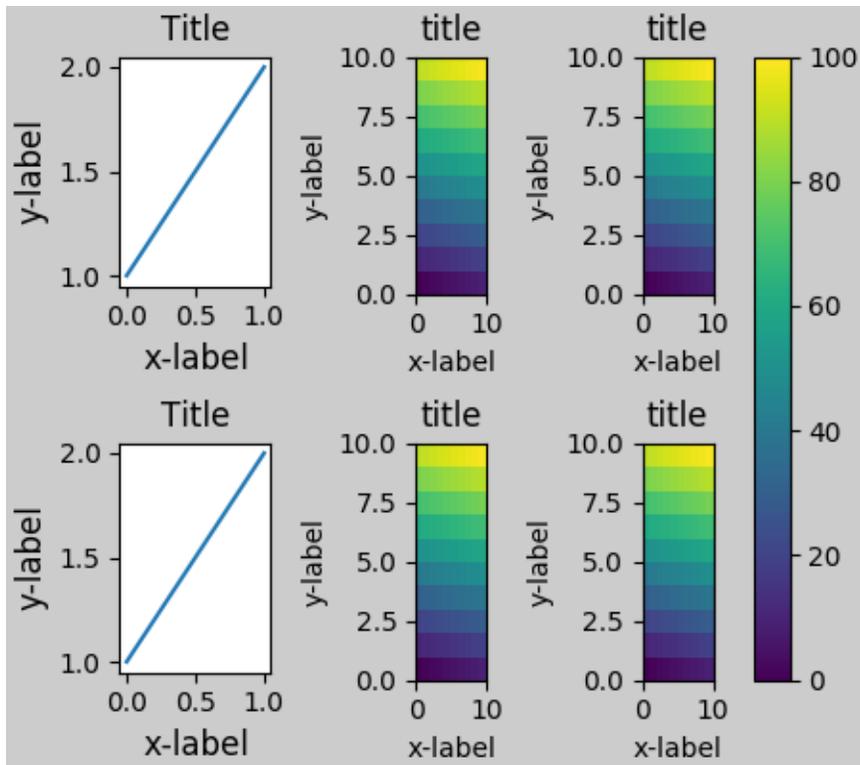
This example uses two gridspecs to have the colorbar only pertain to one set of pcors. Note how the left column is wider than the two right-hand columns because of this. Of course, if you wanted the subplots to be the same size you only needed one gridspec.

```
def docomplicated(suptitle=None):
    fig = plt.figure()
    gs0 = fig.add_gridspec(1, 2, figure=fig, width_ratios=[1., 2.])
    gsl = gs0[0].subgridspec(2, 1)
    gsr = gs0[1].subgridspec(2, 2)

    for gs in gsl:
        ax = fig.add_subplot(gs)
        example_plot(ax)
    axs = []
    for gs in gsr:
        ax = fig.add_subplot(gs)
        pcm = ax.pcolormesh(arr, **pc_kwargs)
        ax.set_xlabel('x-label')
        ax.set_ylabel('y-label')
        ax.set_title('title')

        axs += [ax]
    fig.colorbar(pcm, ax=axs)
    if suptitle is not None:
        fig.suptitle(suptitle)

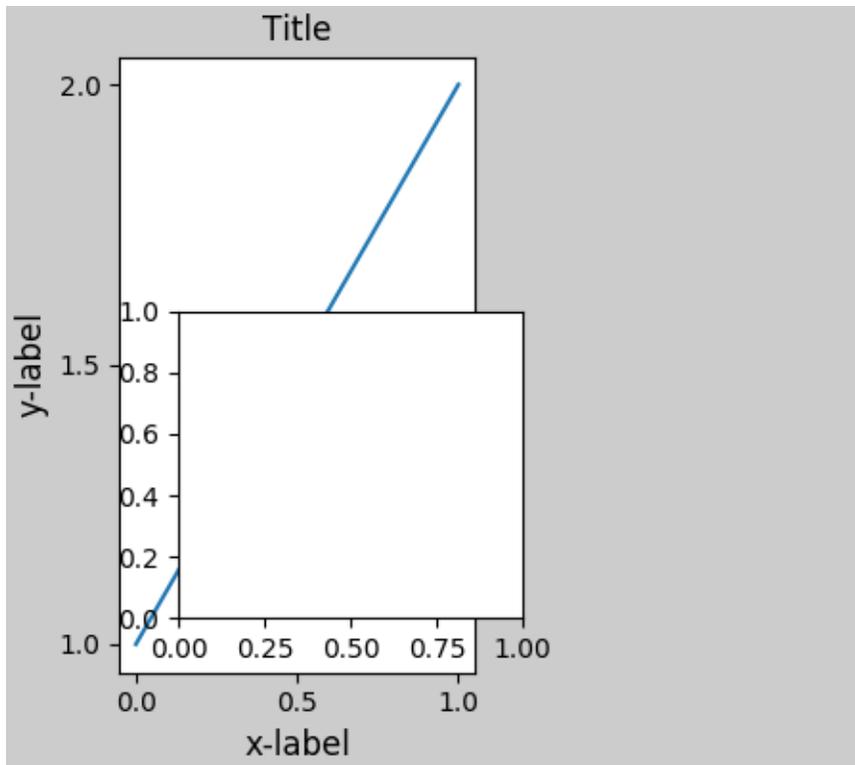
docomplicated()
```



### Manually setting axes positions

There can be good reasons to manually set an axes position. A manual call to `set_position` will set the axes so `constrained_layout` has no effect on it anymore. (Note that `constrained_layout` still leaves the space for the axes that is moved).

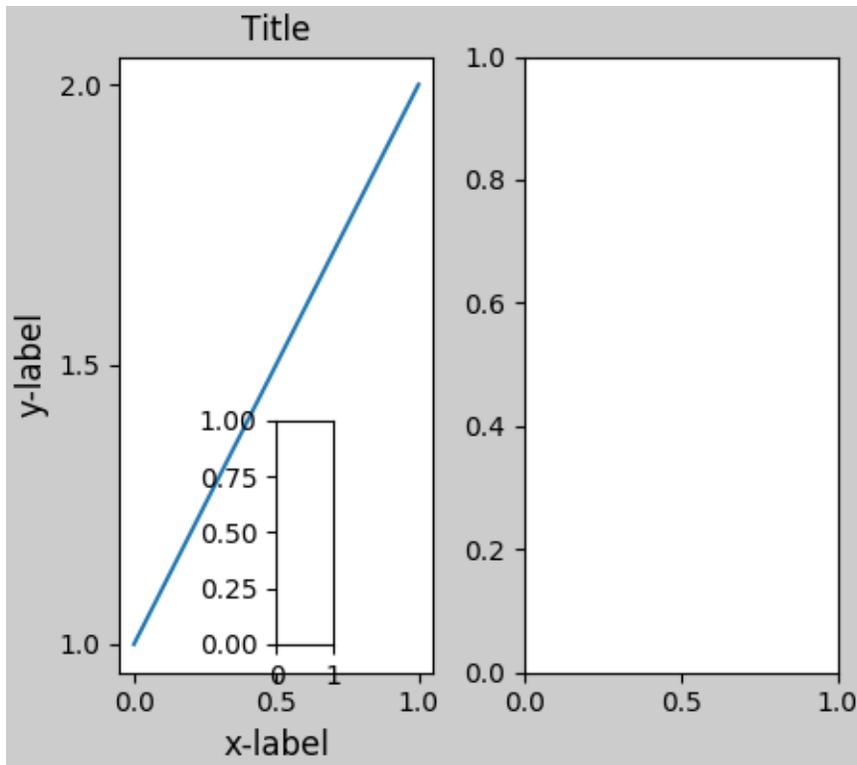
```
fig, axs = plt.subplots(1, 2)
example_plot(axs[0], fontsize=12)
axs[1].set_position([0.2, 0.2, 0.4, 0.4])
```



If you want an inset axes in data-space, you need to manually execute the layout using `fig.execute_constrained_layout()` call. The inset figure will then be properly positioned. However, it will not be properly positioned if the size of the figure is subsequently changed. Similarly, if the figure is printed to another backend, there may be slight changes of location due to small differences in how the backends render fonts.

```
from matplotlib.transforms import Bbox

fig, axs = plt.subplots(1, 2)
example_plot(axs[0], fontsize=12)
fig.execute_constrained_layout()
# put into data-space:
bb_data_ax2 = Bbox.from_bounds(0.5, 1., 0.2, 0.4)
disp_coords = axs[0].transData.transform(bb_data_ax2)
fig_coords_ax2 = fig.transFigure.inverted().transform(disp_coords)
bb_ax2 = Bbox(fig_coords_ax2)
ax2 = fig.add_axes(bb_ax2)
```



### Manually turning off `constrained_layout`

`constrained_layout` usually adjusts the axes positions on each draw of the figure. If you want to get the spacing provided by `constrained_layout` but not have it update, then do the initial draw and then call `fig.set_constrained_layout(False)`. This is potentially useful for animations where the tick labels may change length.

Note that `constrained_layout` is turned off for ZOOM and PAN GUI events for the backends that use the toolbar. This prevents the axes from changing position during zooming and panning.

### Limitations

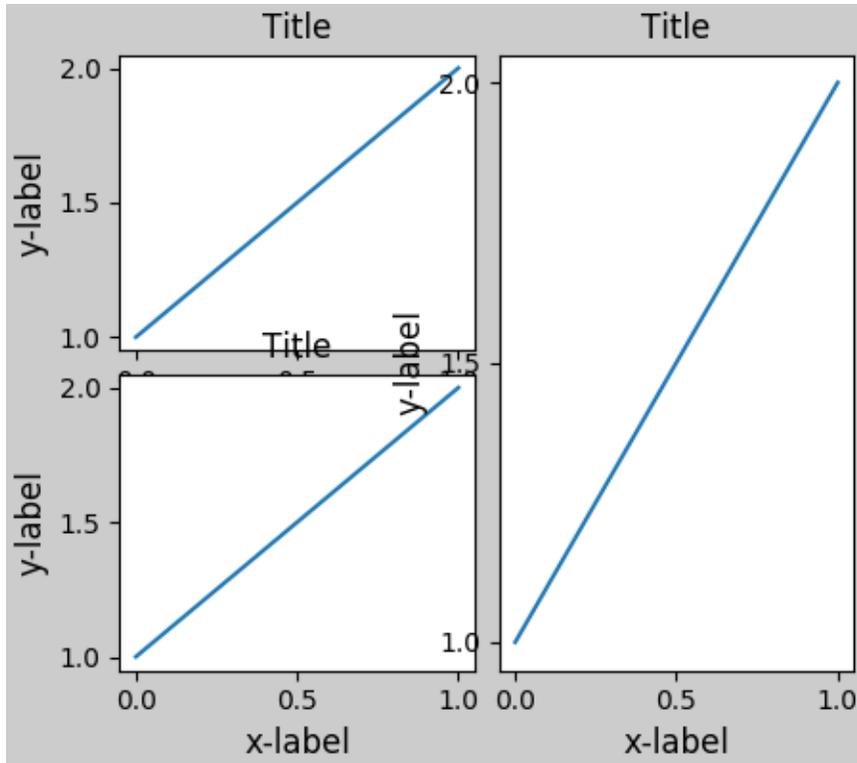
#### Incompatible functions

`constrained_layout` will not work on subplots created via the `subplot` command. The reason is that each of these commands creates a separate `GridSpec` instance and `constrained_layout` uses (nested) gridspecs to carry out the layout. So the following fails to yield a nice layout:

```
fig = plt.figure()

ax1 = plt.subplot(221)
ax2 = plt.subplot(223)
ax3 = plt.subplot(122)

example_plot(ax1)
example_plot(ax2)
example_plot(ax3)
```

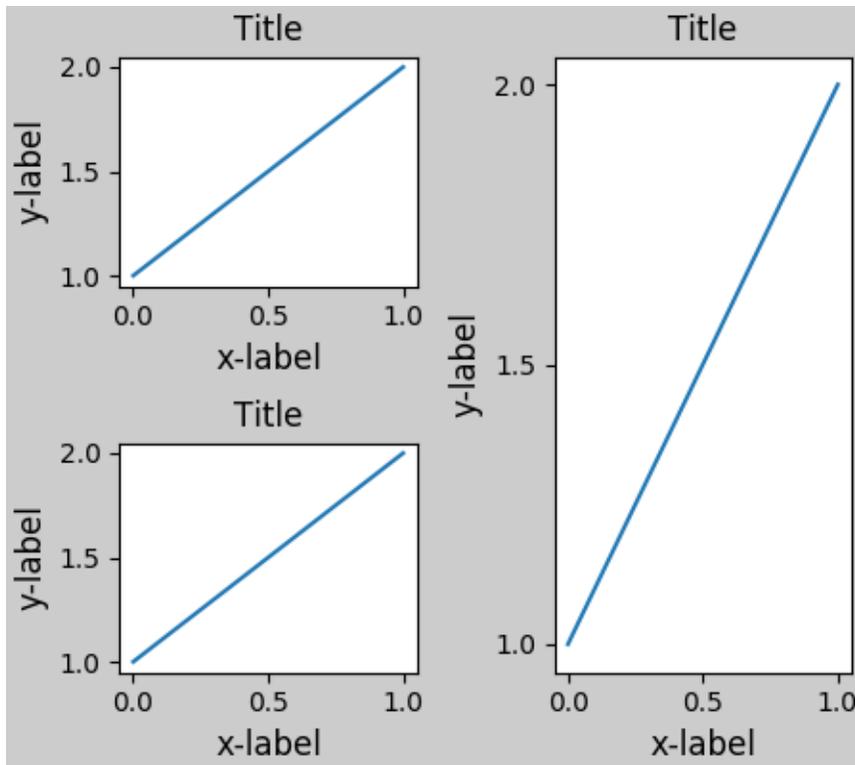


Of course that layout is possible using a gridspec:

```
fig = plt.figure()
gs = fig.add_gridspec(2, 2)

ax1 = fig.add_subplot(gs[0, 0])
ax2 = fig.add_subplot(gs[1, 0])
ax3 = fig.add_subplot(gs[:, 1])

example_plot(ax1)
example_plot(ax2)
example_plot(ax3)
```

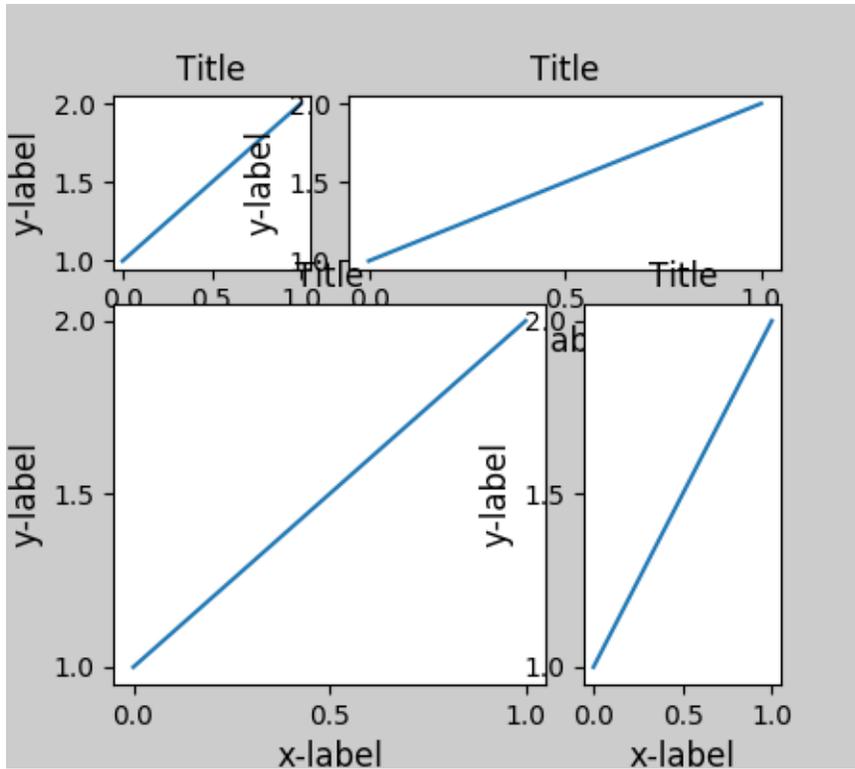


Similarly, `subplot2grid()` doesn't work for the same reason: each call creates a different parent gridspec.

```
fig = plt.figure()

ax1 = plt.subplot2grid((3, 3), (0, 0))
ax2 = plt.subplot2grid((3, 3), (0, 1), colspan=2)
ax3 = plt.subplot2grid((3, 3), (1, 0), colspan=2, rowspan=2)
ax4 = plt.subplot2grid((3, 3), (1, 2), rowspan=2)

example_plot(ax1)
example_plot(ax2)
example_plot(ax3)
example_plot(ax4)
```

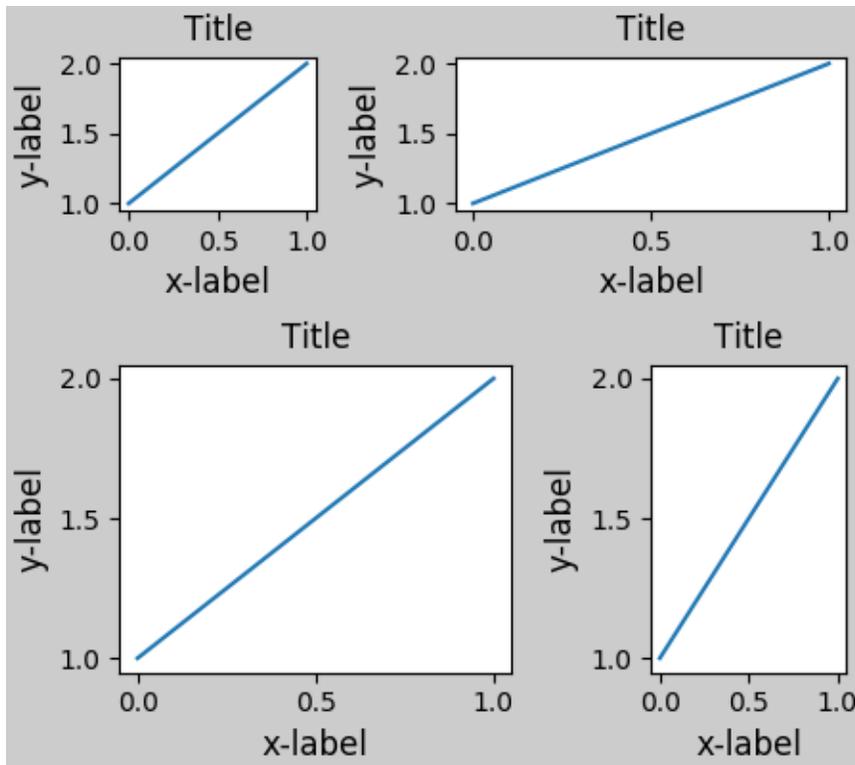


The way to make this plot compatible with `constrained_layout` is again to use `gridspec` directly

```
fig = plt.figure()
gs = fig.add_gridspec(3, 3)

ax1 = fig.add_subplot(gs[0, 0])
ax2 = fig.add_subplot(gs[0, 1:])
ax3 = fig.add_subplot(gs[1:, 0:2])
ax4 = fig.add_subplot(gs[1:, -1])

example_plot(ax1)
example_plot(ax2)
example_plot(ax3)
example_plot(ax4)
```



### Other Caveats

- `constrained_layout` only considers ticklabels, axis labels, titles, and legends. Thus, other artists may be clipped and also may overlap.
- It assumes that the extra space needed for ticklabels, axis labels, and titles is independent of original location of axes. This is often true, but there are rare cases where it is not.
- There are small differences in how the backends handle rendering fonts, so the results will not be pixel-identical.

### Debugging

Constrained-layout can fail in somewhat unexpected ways. Because it uses a constraint solver the solver can find solutions that are mathematically correct, but that aren't at all what the user wants. The usual failure mode is for all sizes to collapse to their smallest allowable value. If this happens, it is for one of two reasons:

1. There was not enough room for the elements you were requesting to draw.
2. There is a bug - in which case open an issue at <https://github.com/matplotlib/matplotlib/issues>.

If there is a bug, please report with a self-contained example that does not require outside data or dependencies (other than numpy).

## Notes on the algorithm

The algorithm for the constraint is relatively straightforward, but has some complexity due to the complex ways we can layout a figure.

## Figure layout

Figures are laid out in a hierarchy:

1. Figure: `fig = plt.figure()`
  - a. Gridspec: `gs0 = gridspec.GridSpec(1, 2, figure=fig)`
    - i. Subplotspec: `ss = gs[0, 0]`
      1. Axes: `ax0 = fig.add_subplot(ss)`
    - ii. Subplotspec: `ss = gs[0, 1]`
      1. Gridspec: `gsR = gridspec.GridSpecFromSubplotSpec(2, 1, ss)`
        - Subplotspec: `ss = gsR[0, 0]`
          - Axes: `axR0 = fig.add_subplot(ss)`
        - Subplotspec: `ss = gsR[1, 0]`
          - Axes: `axR1 = fig.add_subplot(ss)`

Each item has a `layoutbox` associated with it. The nesting of gridspecs created with `GridSpecFromSubplotSpec` can be arbitrarily deep.

Each `Axes` has *two* `layoutboxes`. The first one, `ax._layoutbox` represents the outside of the `Axes` and all its decorations (i.e. ticklabels, axis labels, etc.). The second `layoutbox` corresponds to the `Axes`' `ax.position`, which sets where in the figure the spines are placed.

Why so many stacked containers? Ideally, all that would be needed are the `Axes` layout boxes. For the `Gridspec` case, a container is needed if the `Gridspec` is nested via `GridSpecFromSubplotSpec`. At the top level, it is desirable for symmetry, but it also makes room for *supertitle*.

For the `Subplotspec/Axes` case, `Axes` often have colorbars or other annotations that need to be packaged inside the `Subplotspec`, hence the need for the outer layer.

## Simple case: one Axes

For a single `Axes` the layout is straight forward. The `Figure` and outer `Gridspec` `layoutboxes` coincide. The `Subplotspec` and `Axes` boxes also coincide because the `Axes` has no colorbar. Note the difference between the red `pos` box and the green `ax` box is set by the size of the decorations around the `Axes`.

In the code, this is accomplished by the entries in `do_constrained_layout()` like:

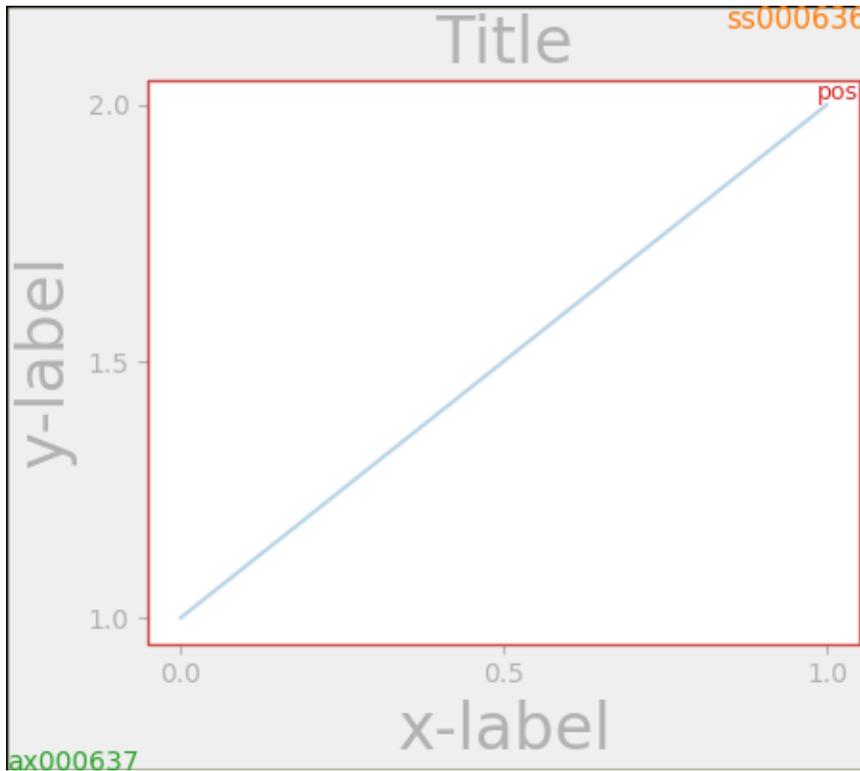
```
ax._poslayoutbox.edit_left_margin_min(-bbox.x0 + pos.x0 + w_padt)
```

```

from matplotlib.layoutbox import plot_children

fig, ax = plt.subplots(constrained_layout=True)
example_plot(ax, fontsize=24)
plot_children(fig, fig._layoutbox, printit=False)

```



### Simple case: two Axes

For this case, the Axes layoutboxes and the Subplotspec boxes still co-incide. However, because the decorations in the right-hand plot are so much smaller than the left-hand, so the right-hand layoutboxes are smaller.

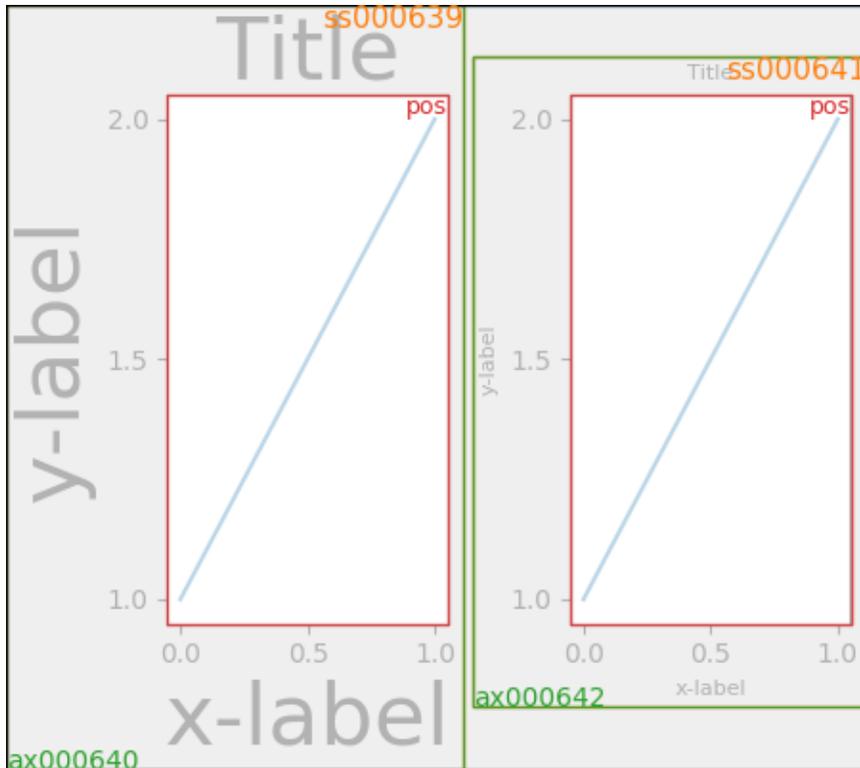
The Subplotspec boxes are laid out in the code in the subroutine `arrange_subplotspecs()`, which simply checks the subplotspecs in the code against one another and stacks them appropriately.

The two `pos` axes are lined up. Because they have the same minimum row, they are lined up at the top. Because they have the same maximum row they are lined up at the bottom. In the code this is accomplished via the calls to `layoutbox.align`. If there was more than one row, then the same horizontal alignment would occur between the rows.

The two `pos` axes are given the same width because the subplotspecs occupy the same number of columns. This is accomplished in the code where `dcols0` is compared to `dcolsC`. If they are equal, then their widths are constrained to be equal.

While it is a bit subtle in this case, note that the division between the Subplotspecs is *not* centered, but has been moved to the right to make space for the larger labels on the left-hand plot.

```
fig, ax = plt.subplots(1, 2, constrained_layout=True)
example_plot(ax[0], fontsize=32)
example_plot(ax[1], fontsize=8)
plot_children(fig, fig._layoutbox, printit=False)
```



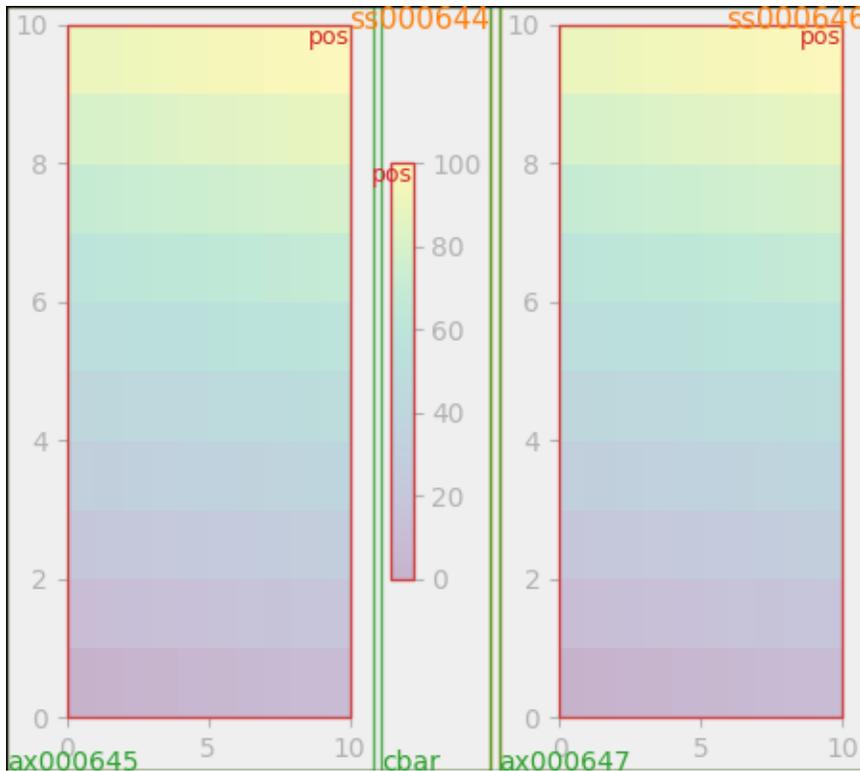
### Two Axes and colorbar

Adding a colorbar makes it clear why the Subplotspec layoutboxes must be different from the axes layoutboxes. Here we see the left-hand subplotspec has more room to accommodate the *colorbar*, and that there are two green ax boxes inside the *ss* box.

Note that the width of the *pos* boxes is still the same because of the constraint on their widths because their subplotspecs occupy the same number of columns (one in this example).

The colorbar layout logic is contained in *make\_axes* which calls `_constrained_layout.layoutcolorbarsingle()` for cbars attached to a single axes, and `_constrained_layout.layoutcolorbargridspec()` if the colorbar is associated with a gridspec.

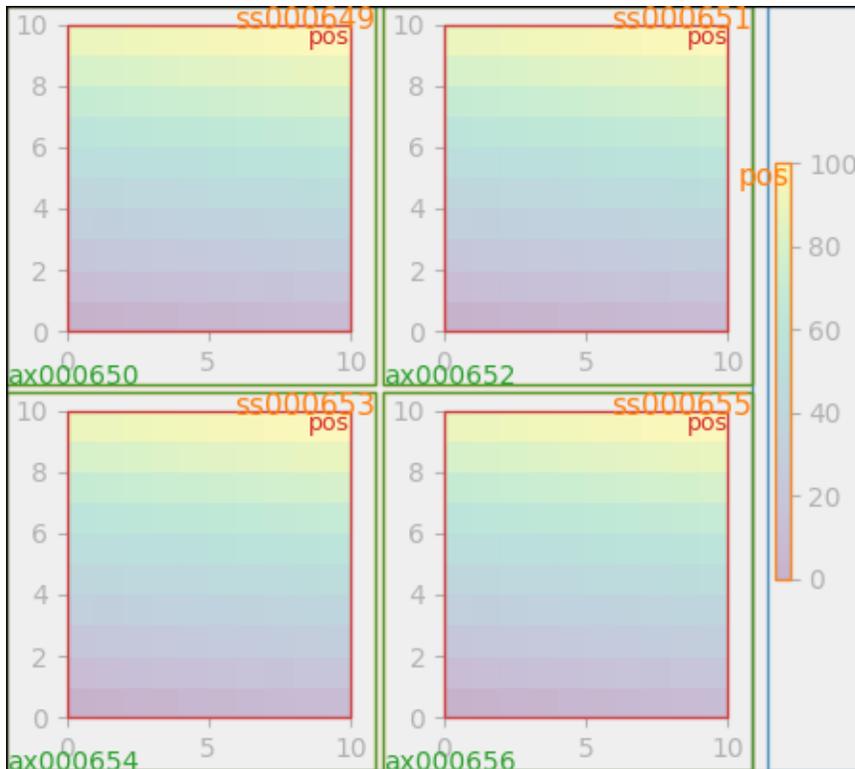
```
fig, ax = plt.subplots(1, 2, constrained_layout=True)
im = ax[0].pcolormesh(arr, **pc_kwargs)
fig.colorbar(im, ax=ax[0], shrink=0.6)
im = ax[1].pcolormesh(arr, **pc_kwargs)
plot_children(fig, fig._layoutbox, printit=False)
```



### Colorbar associated with a Gridspec

This example shows the Subplotspec layoutboxes being made smaller by a colorbar layoutbox. The size of the colorbar layoutbox is set to be shrink smaller than the vertical extent of the pos layoutboxes in the gridspec, and it is made to be centered between those two points.

```
fig, axs = plt.subplots(2, 2, constrained_layout=True)
for ax in axs.flat:
    im = ax.pcolormesh(arr, **pc_kwargs)
fig.colorbar(im, ax=axs, shrink=0.6)
plot_children(fig, fig._layoutbox, printit=False)
```



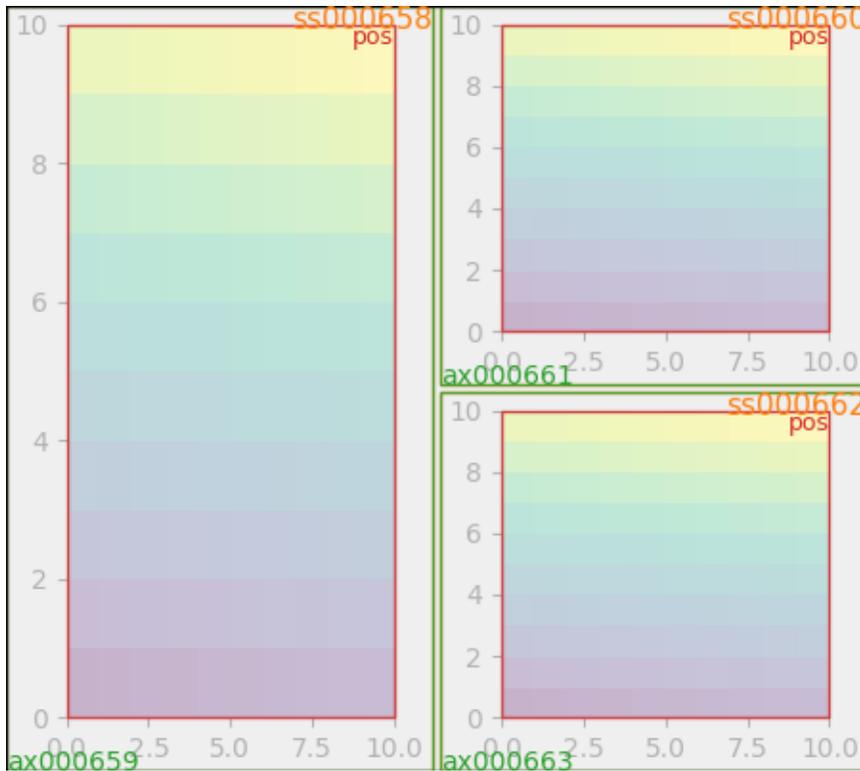
### Uneven sized Axes

There are two ways to make axes have an uneven size in a Gridspec layout, either by specifying them to cross Gridspecs rows or columns, or by specifying width and height ratios.

The first method is used here. The constraint that makes the heights be correct is in the code where `drowsC < drows0` which in this case would be 1 is less than 2. So we constrain the height of the 1-row Axes to be less than half the height of the 2-row Axes.

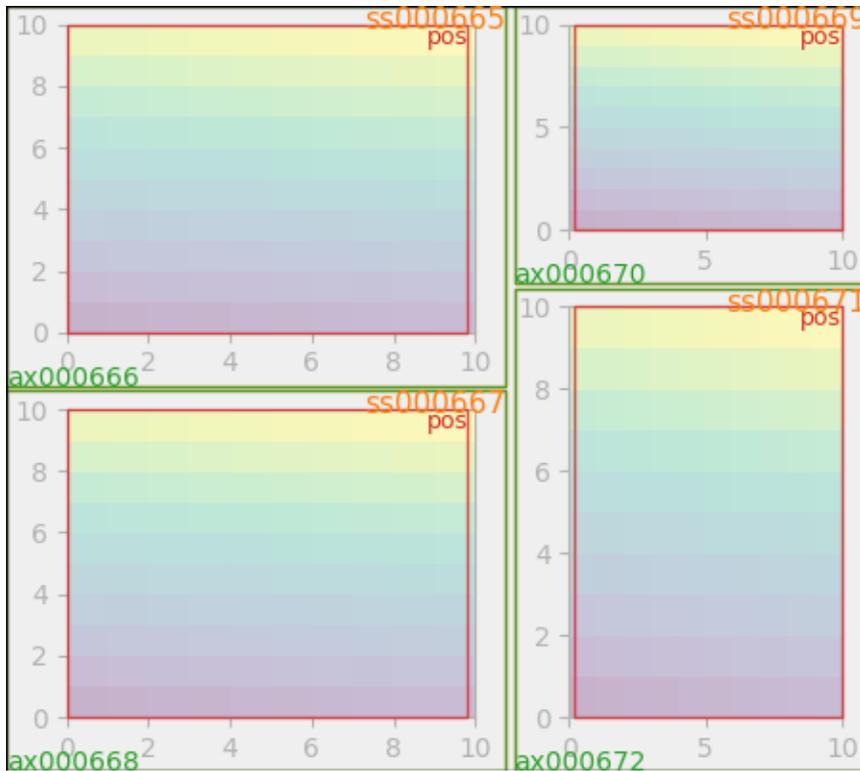
**Note:** This algorithm can be wrong if the decorations attached to the smaller axes are very large, so there is an unaccounted-for edge case.

```
fig = plt.figure(constrained_layout=True)
gs = gridspec.GridSpec(2, 2, figure=fig)
ax = fig.add_subplot(gs[:, 0])
im = ax.pcolormesh(arr, **pc_kwargs)
ax = fig.add_subplot(gs[0, 1])
im = ax.pcolormesh(arr, **pc_kwargs)
ax = fig.add_subplot(gs[1, 1])
im = ax.pcolormesh(arr, **pc_kwargs)
plot_children(fig, fig._layoutbox, printit=False)
```



Height and width ratios are accommodated with the same part of the code with the smaller axes always constrained to be less in size than the larger.

```
fig = plt.figure(constrained_layout=True)
gs = gridspec.GridSpec(3, 2, figure=fig,
    height_ratios=[1., 0.5, 1.5],
    width_ratios=[1.2, 0.8])
ax = fig.add_subplot(gs[:2, 0])
im = ax.pcolormesh(arr, **pc_kwargs)
ax = fig.add_subplot(gs[2, 0])
im = ax.pcolormesh(arr, **pc_kwargs)
ax = fig.add_subplot(gs[0, 1])
im = ax.pcolormesh(arr, **pc_kwargs)
ax = fig.add_subplot(gs[1:, 1])
im = ax.pcolormesh(arr, **pc_kwargs)
plot_children(fig, fig._layoutbox, printit=False)
```

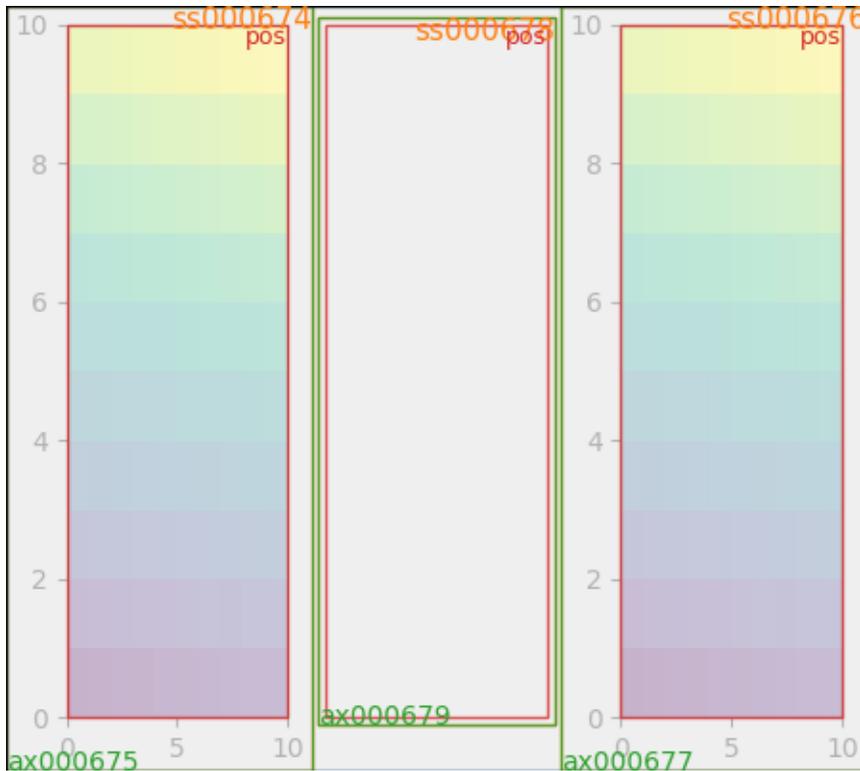


### Empty gridspec slots

The final piece of the code that has not been explained is what happens if there is an empty gridspec opening. In that case a fake invisible axes is added and we proceed as before. The empty gridspec has no decorations, but the axes position in made the same size as the occupied Axes positions.

This is done at the start of `_constrained_layout.do_constrained_layout()` (`hassubplotspec`).

```
fig = plt.figure(constrained_layout=True)
gs = gridspec.GridSpec(1, 3, figure=fig)
ax = fig.add_subplot(gs[0])
im = ax.pcolormesh(arr, **pc_kwargs)
ax = fig.add_subplot(gs[-1])
im = ax.pcolormesh(arr, **pc_kwargs)
plot_children(fig, fig._layoutbox, printit=False)
plt.show()
```



#### Other notes

The layout is called only once. This is OK if the original layout was pretty close (which it should be in most cases). However, if the layout changes a lot from the default layout then the decorators can change size. In particular the x and ytick labels can change. If this happens, then we should probably call the whole routine twice.

**Total running time of the script:** ( 0 minutes 7.359 seconds)

---

**Note:** Click [here](#) to download the full example code

---

## 2.2.6 Tight Layout guide

How to use tight-layout to fit plots within your figure cleanly.

*tight\_layout* automatically adjusts subplot params so that the subplot(s) fits in to the figure area. This is an experimental feature and may not work for some cases. It only checks the extents of ticklabels, axis labels, and titles.

An alternative to *tight\_layout* is *constrained\_layout*.

### Simple Example

In matplotlib, the location of axes (including subplots) are specified in normalized figure coordinates. It can happen that your axis labels or titles (or sometimes even ticklabels) go outside

the figure area, and are thus clipped.

```
# sphinx_gallery_thumbnail_number = 7

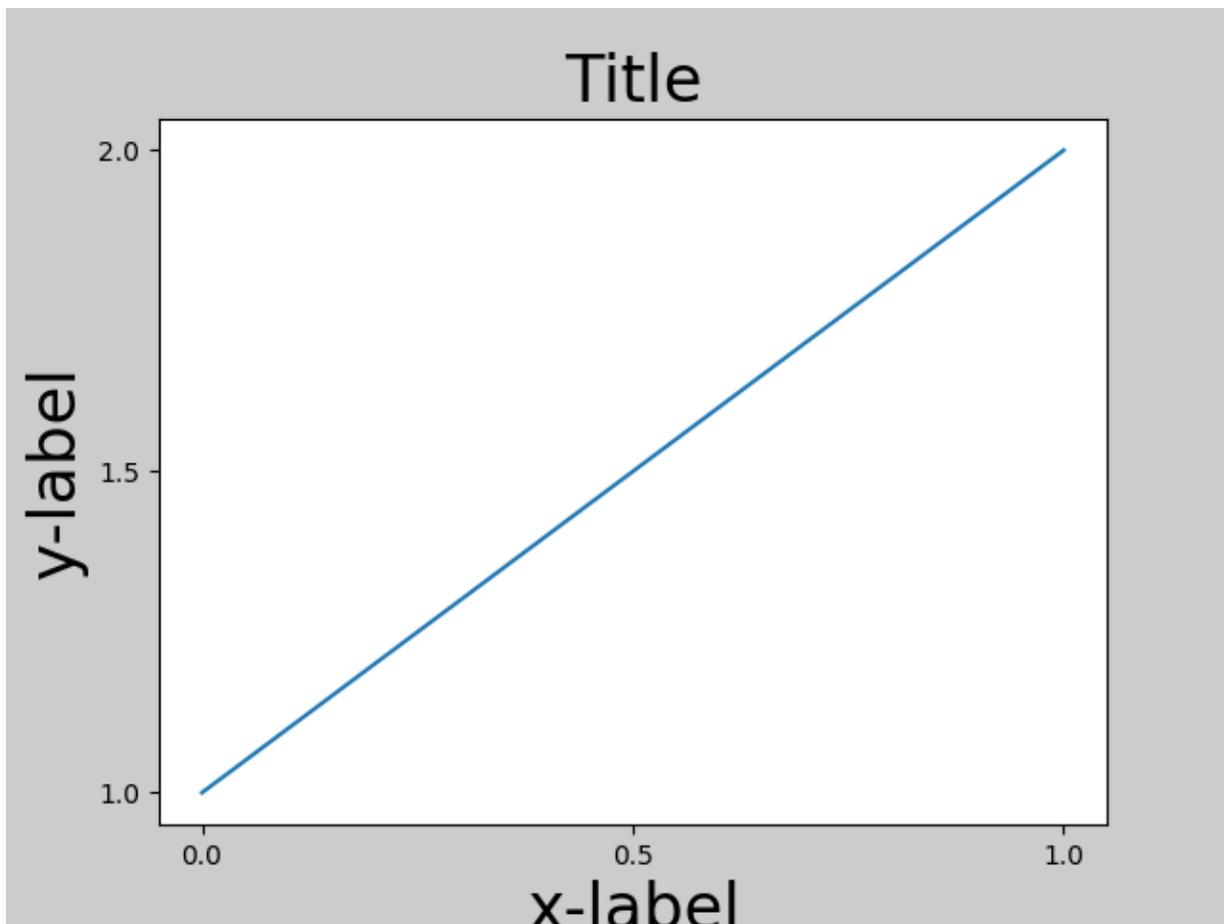
import matplotlib.pyplot as plt
import numpy as np

plt.rcParams['savefig.facecolor'] = "0.8"

def example_plot(ax, fontsize=12):
    ax.plot([1, 2])

    ax.locator_params(nbins=3)
    ax.set_xlabel('x-label', fontsize=fontsize)
    ax.set_ylabel('y-label', fontsize=fontsize)
    ax.set_title('Title', fontsize=fontsize)

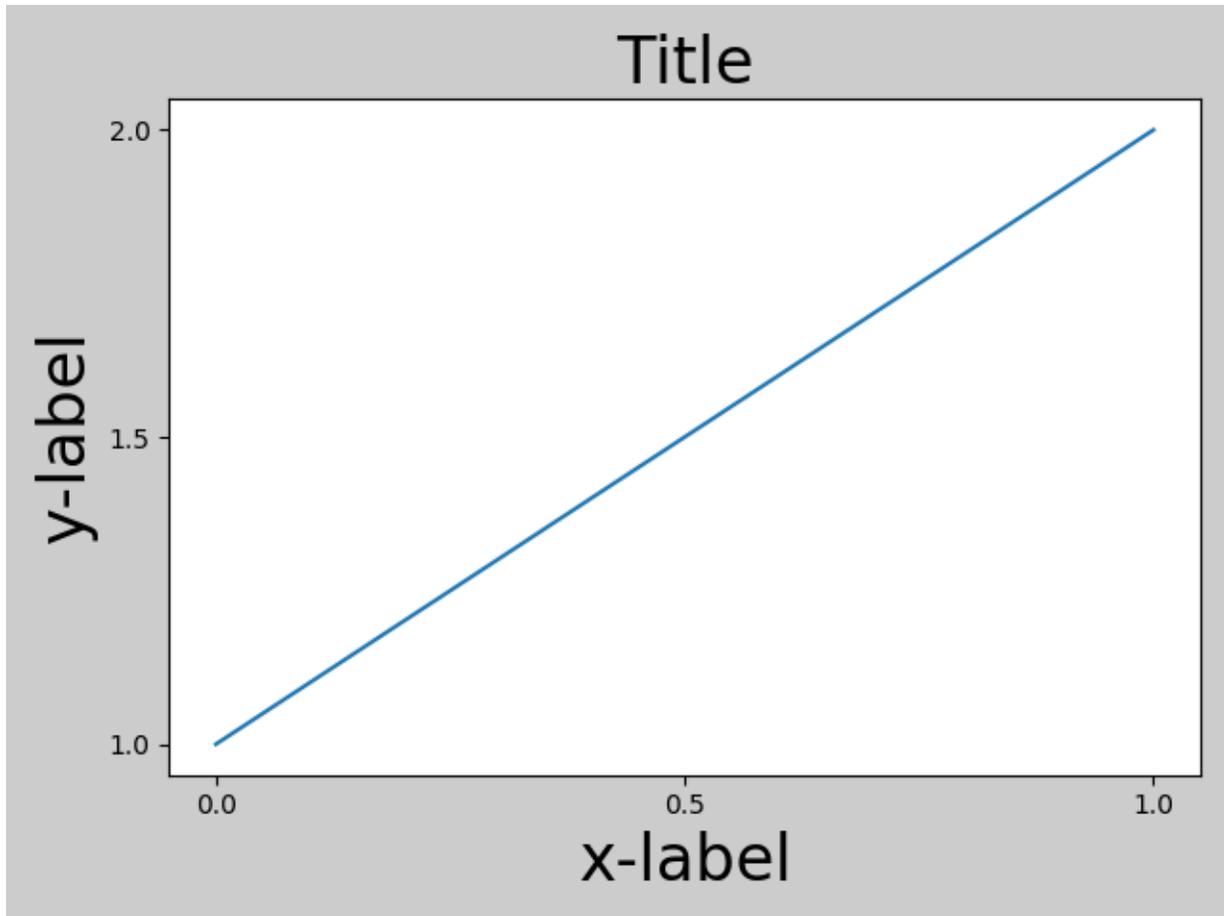
plt.close('all')
fig, ax = plt.subplots()
example_plot(ax, fontsize=24)
```



To prevent this, the location of axes needs to be adjusted. For subplots, this can be done by adjusting the subplot params (*Move the edge of an axes to make room for tick labels*). Matplotlib v1.1 introduces a new command `tight_layout()` that does this automatically for

you.

```
fig, ax = plt.subplots()
example_plot(ax, fontsize=24)
plt.tight_layout()
```

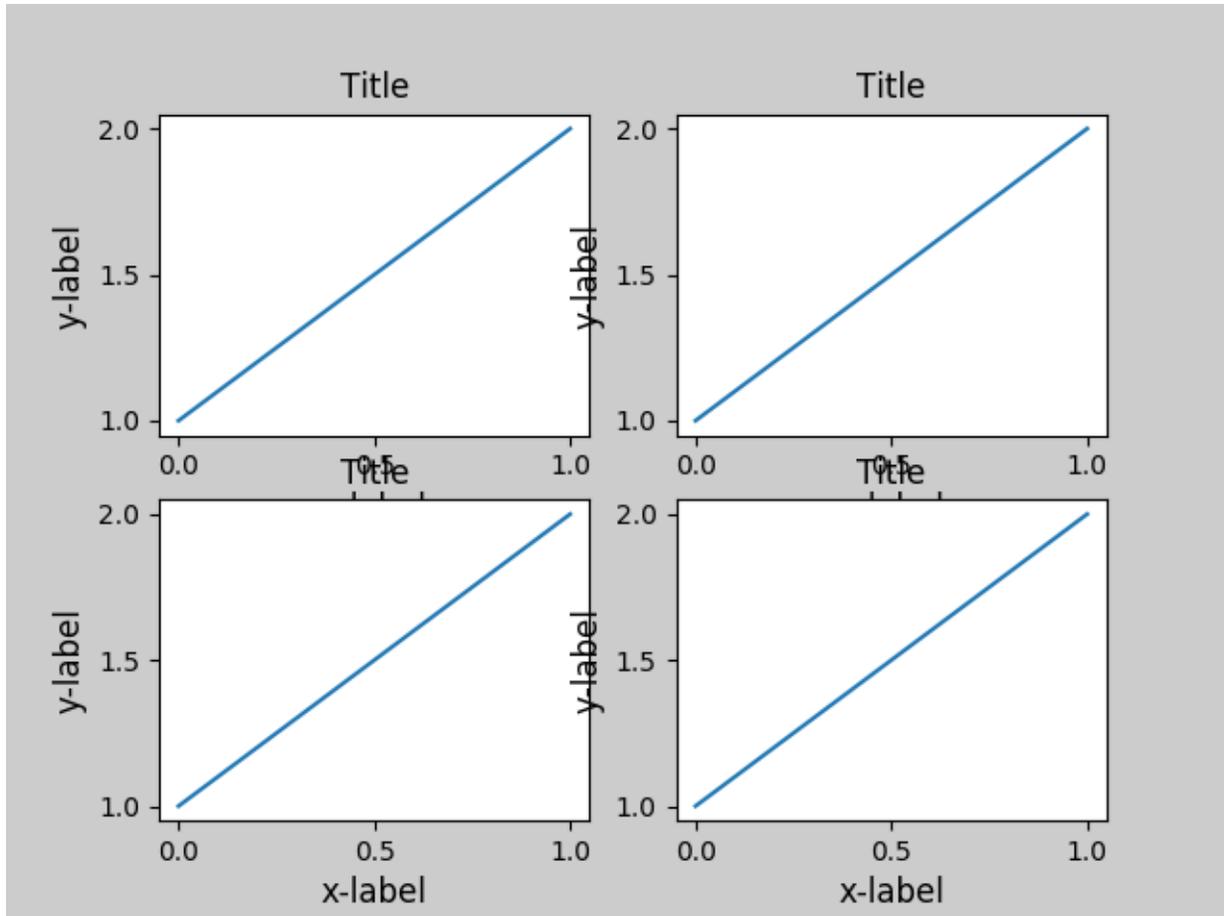


Note that `matplotlib.pyplot.tight_layout()` will only adjust the subplot params when it is called. In order to perform this adjustment each time the figure is redrawn, you can call `fig.set_tight_layout(True)`, or, equivalently, set the `figure.autolayout` rcParam to `True`.

When you have multiple subplots, often you see labels of different axes overlapping each other.

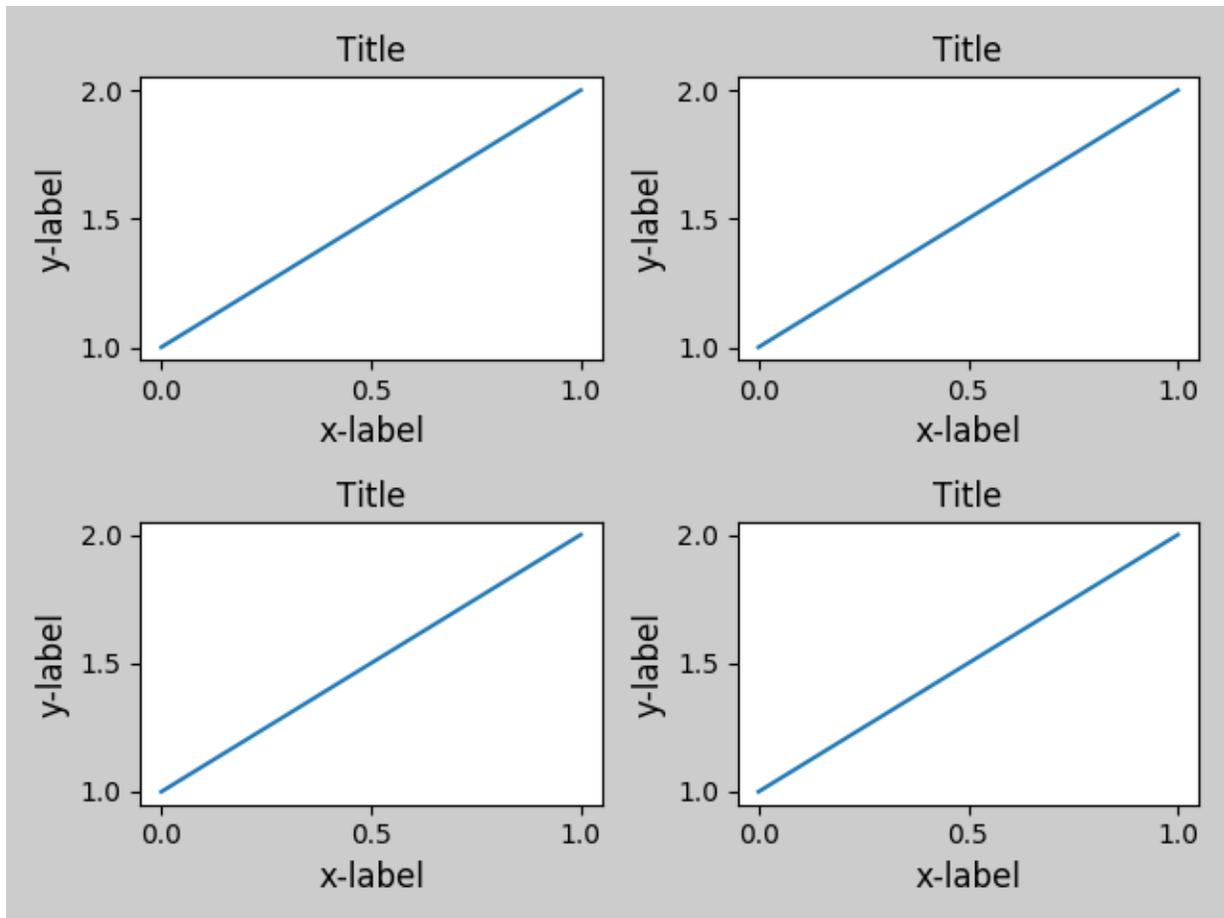
```
plt.close('all')

fig, ((ax1, ax2), (ax3, ax4)) = plt.subplots(nrows=2, ncols=2)
example_plot(ax1)
example_plot(ax2)
example_plot(ax3)
example_plot(ax4)
```



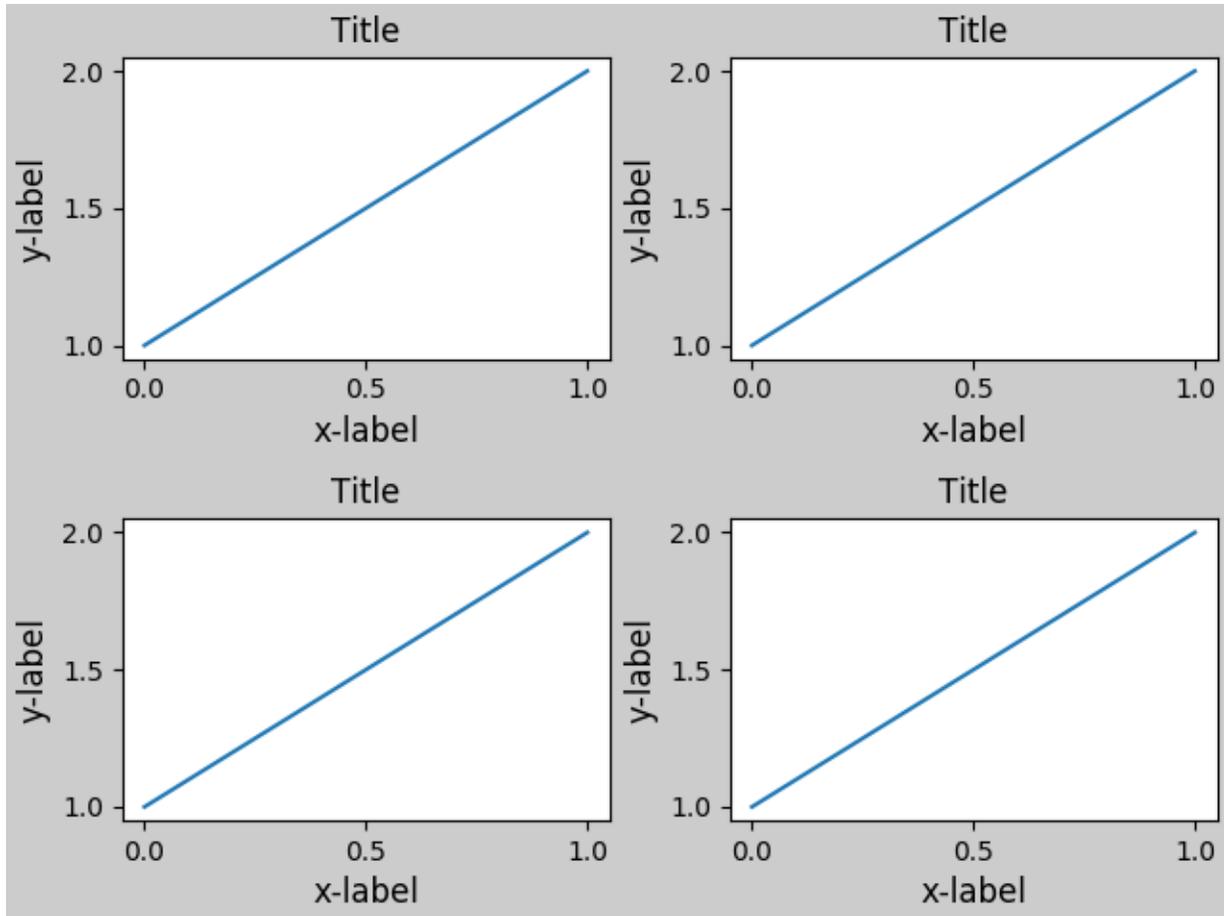
`tight_layout()` will also adjust spacing between subplots to minimize the overlaps.

```
fig, ((ax1, ax2), (ax3, ax4)) = plt.subplots(nrows=2, ncols=2)
example_plot(ax1)
example_plot(ax2)
example_plot(ax3)
example_plot(ax4)
plt.tight_layout()
```



`tight_layout()` can take keyword arguments of `pad`, `w_pad` and `h_pad`. These control the extra padding around the figure border and between subplots. The pads are specified in fraction of fontsize.

```
fig, ((ax1, ax2), (ax3, ax4)) = plt.subplots(nrows=2, ncols=2)
example_plot(ax1)
example_plot(ax2)
example_plot(ax3)
example_plot(ax4)
plt.tight_layout(pad=0.4, w_pad=0.5, h_pad=1.0)
```



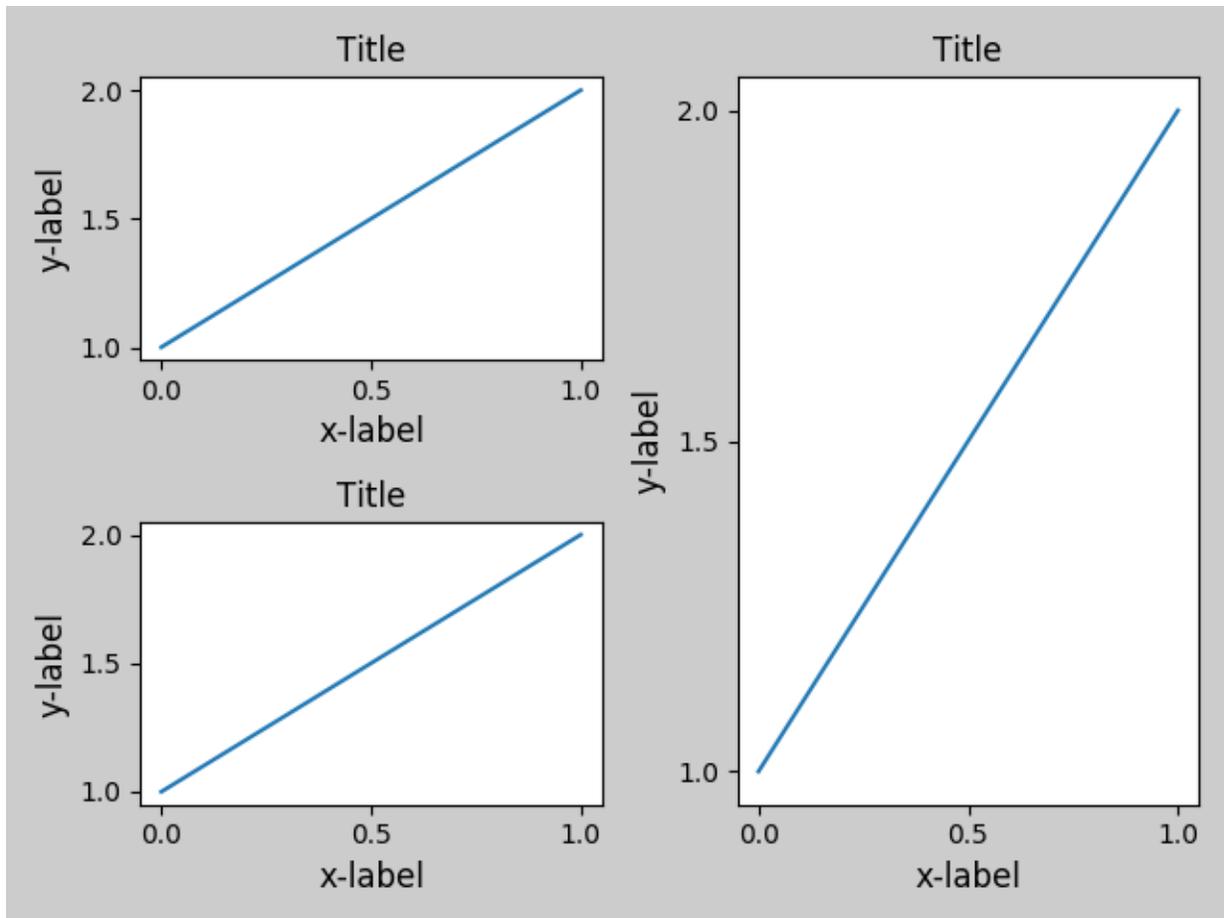
`tight_layout()` will work even if the sizes of subplots are different as far as their grid specification is compatible. In the example below, `ax1` and `ax2` are subplots of a 2x2 grid, while `ax3` is of a 1x2 grid.

```
plt.close('all')
fig = plt.figure()

ax1 = plt.subplot(221)
ax2 = plt.subplot(223)
ax3 = plt.subplot(122)

example_plot(ax1)
example_plot(ax2)
example_plot(ax3)

plt.tight_layout()
```



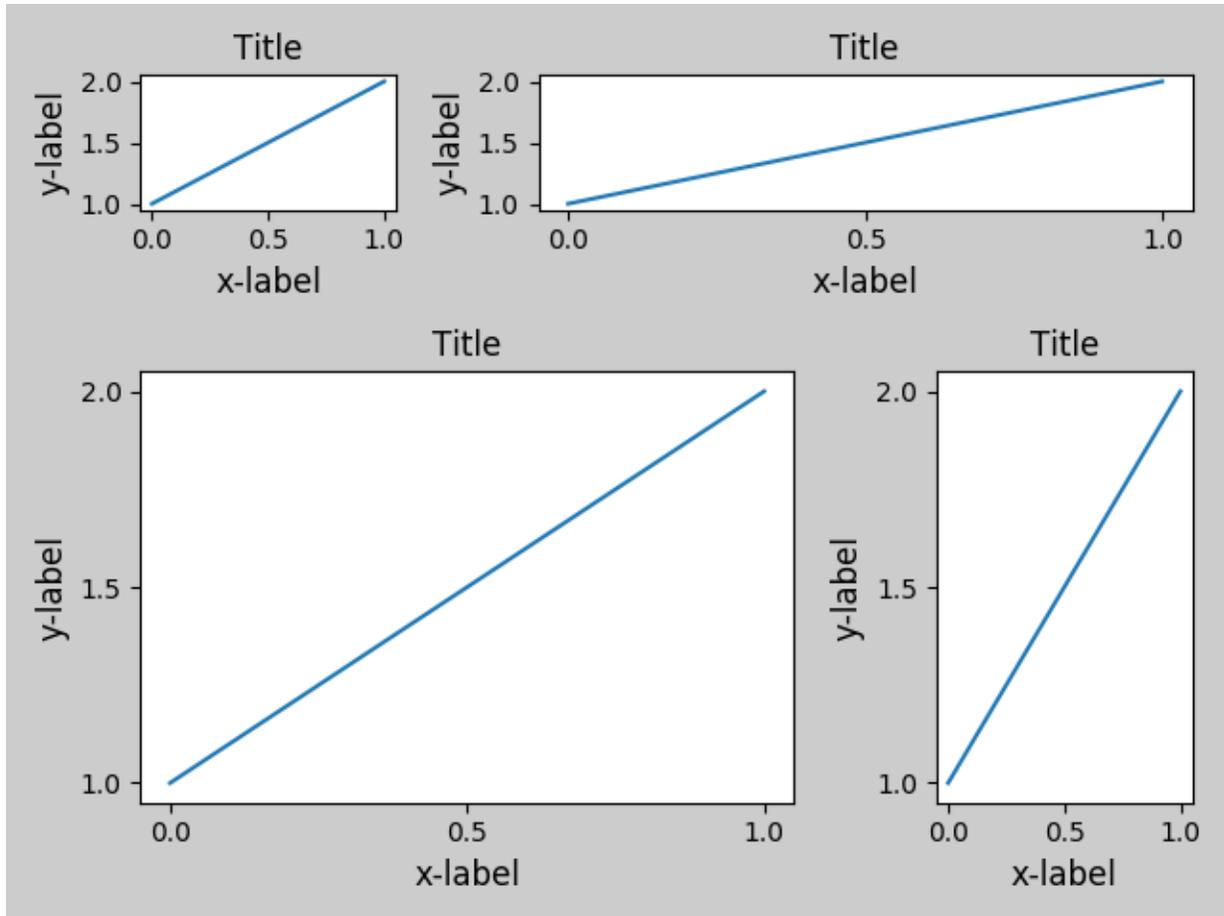
It works with subplots created with `subplot2grid()`. In general, subplots created from the gridspec (*Customizing Figure Layouts Using GridSpec and Other Functions*) will work.

```
plt.close('all')
fig = plt.figure()

ax1 = plt.subplot2grid((3, 3), (0, 0))
ax2 = plt.subplot2grid((3, 3), (0, 1), colspan=2)
ax3 = plt.subplot2grid((3, 3), (1, 0), colspan=2, rowspan=2)
ax4 = plt.subplot2grid((3, 3), (1, 2), rowspan=2)

example_plot(ax1)
example_plot(ax2)
example_plot(ax3)
example_plot(ax4)

plt.tight_layout()
```



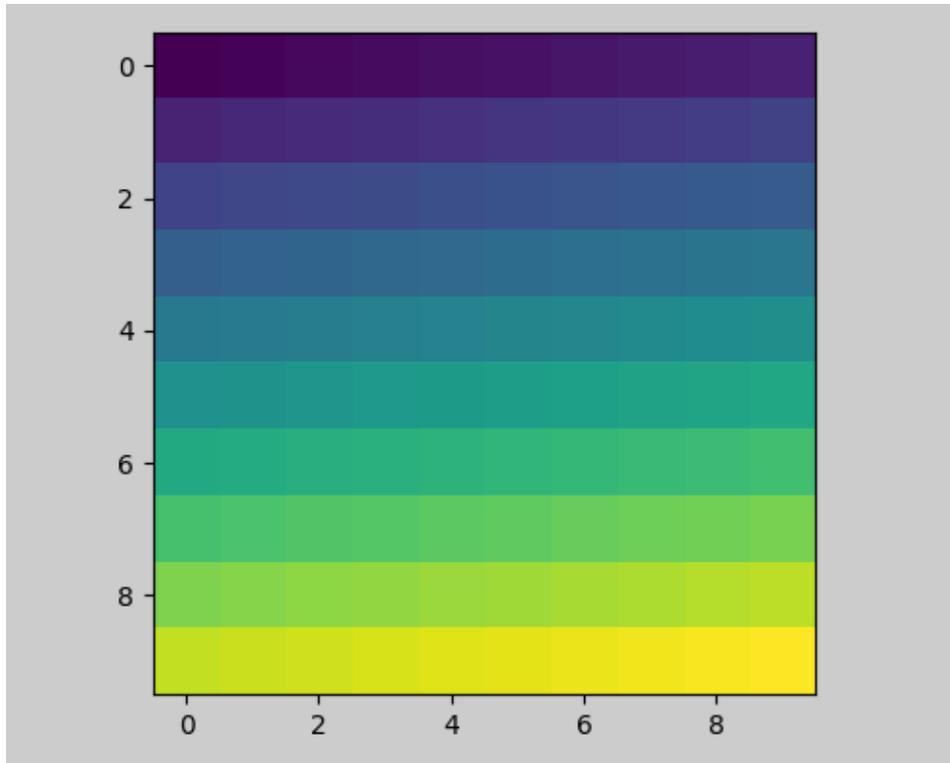
Although not thoroughly tested, it seems to work for subplots with `aspect != "auto"` (e.g., axes with images).

```
arr = np.arange(100).reshape((10, 10))

plt.close('all')
fig = plt.figure(figsize=(5, 4))

ax = plt.subplot(111)
im = ax.imshow(arr, interpolation="none")

plt.tight_layout()
```



### Caveats

- `tight_layout()` only considers ticklabels, axis labels, and titles. Thus, other artists may be clipped and also may overlap.
- It assumes that the extra space needed for ticklabels, axis labels, and titles is independent of original location of axes. This is often true, but there are rare cases where it is not.
- `pad=0` clips some of the texts by a few pixels. This may be a bug or a limitation of the current algorithm and it is not clear why it happens. Meanwhile, use of `pad` at least larger than 0.3 is recommended.

### Use with GridSpec

GridSpec has its own `tight_layout()` method (the pyplot api `tight_layout()` also works).

```
import matplotlib.gridspec as gridspec

plt.close('all')
fig = plt.figure()

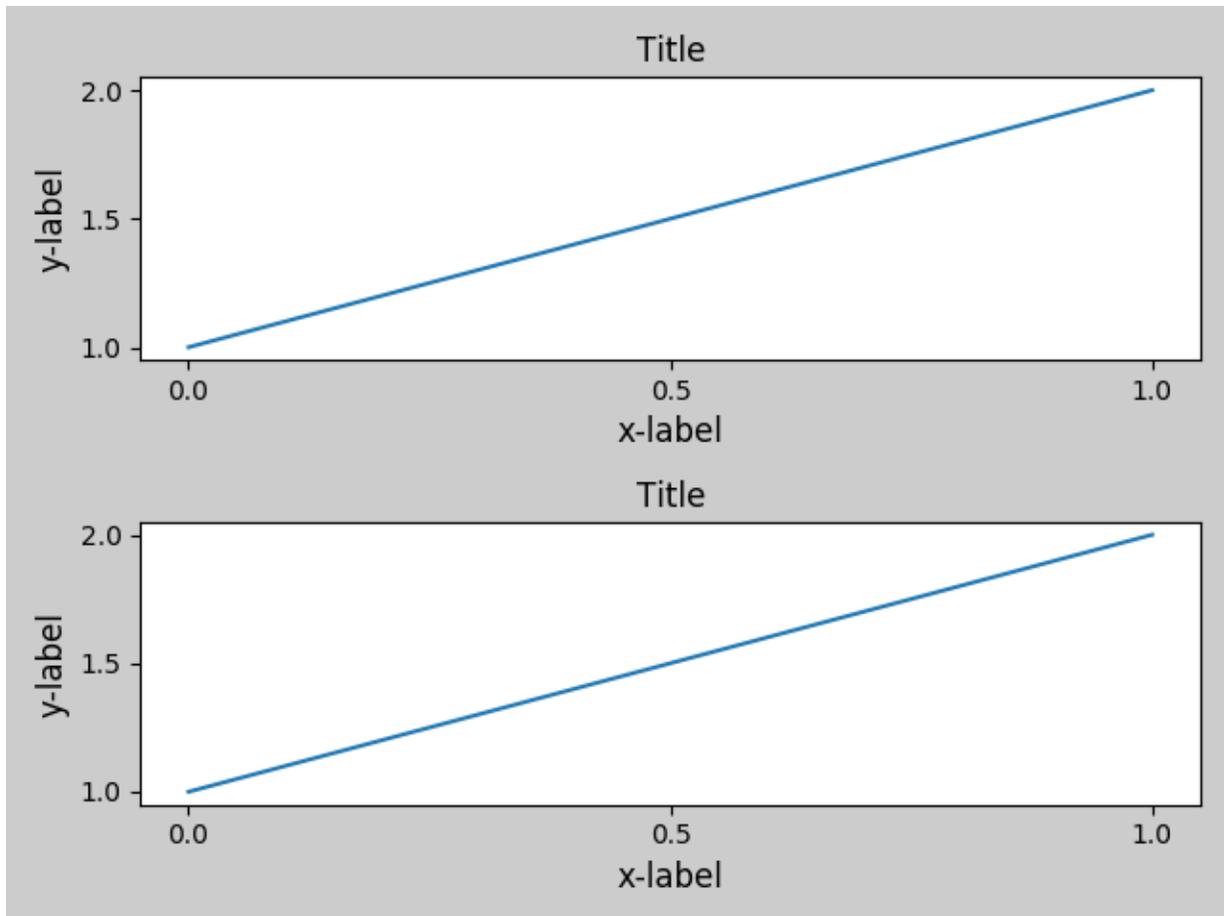
gs1 = gridspec.GridSpec(2, 1)
ax1 = fig.add_subplot(gs1[0])
ax2 = fig.add_subplot(gs1[1])

example_plot(ax1)
```

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```
example_plot(ax2)
gs1.tight_layout(fig)
```



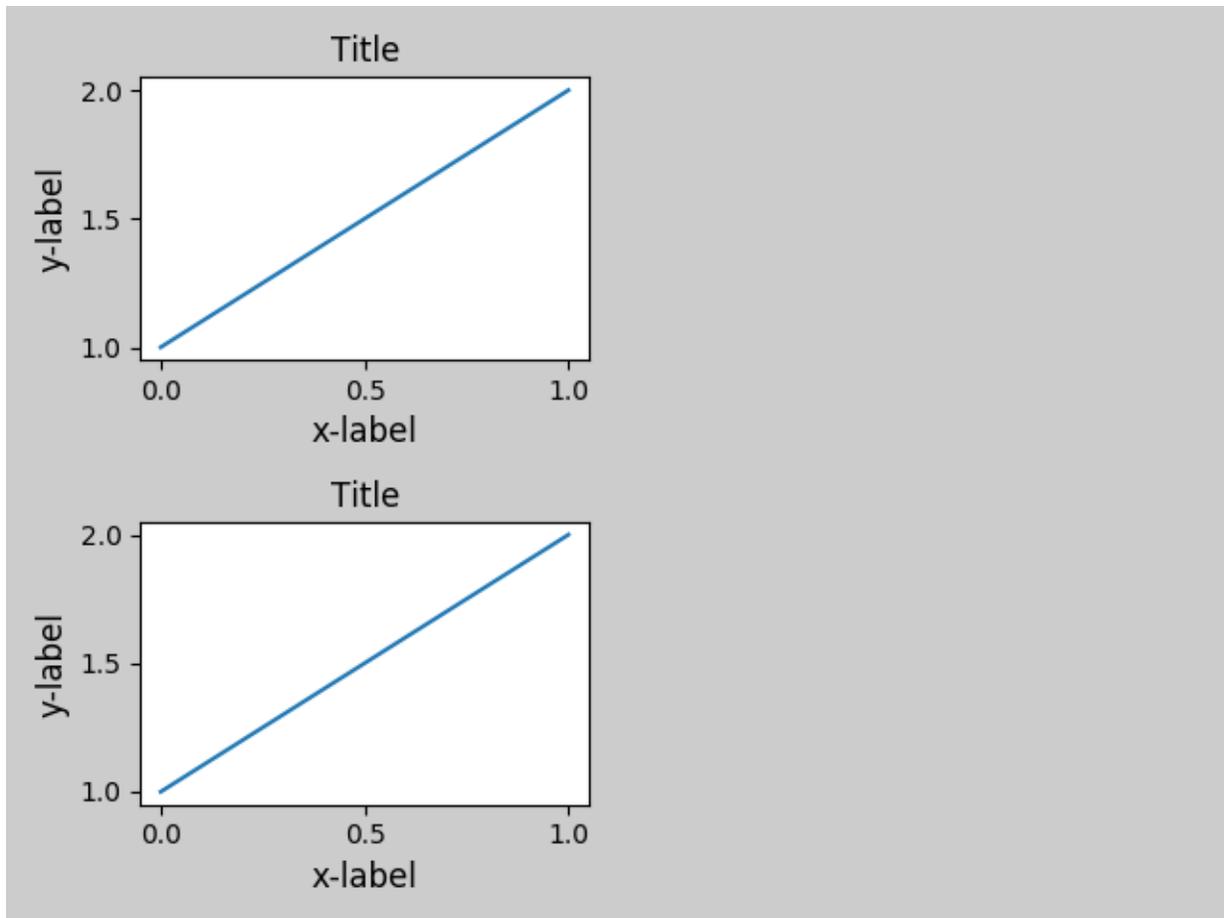
You may provide an optional *rect* parameter, which specifies the bounding box that the subplots will be fit inside. The coordinates must be in normalized figure coordinates and the default is (0, 0, 1, 1).

```
fig = plt.figure()

gs1 = gridspec.GridSpec(2, 1)
ax1 = fig.add_subplot(gs1[0])
ax2 = fig.add_subplot(gs1[1])

example_plot(ax1)
example_plot(ax2)

gs1.tight_layout(fig, rect=[0, 0, 0.5, 1])
```



For example, this can be used for a figure with multiple gridspecs.

```
fig = plt.figure()

gs1 = gridspec.GridSpec(2, 1)
ax1 = fig.add_subplot(gs1[0])
ax2 = fig.add_subplot(gs1[1])

example_plot(ax1)
example_plot(ax2)

gs1.tight_layout(fig, rect=[0, 0, 0.5, 1])

gs2 = gridspec.GridSpec(3, 1)

for ss in gs2:
    ax = fig.add_subplot(ss)
    example_plot(ax)
    ax.set_title("")
    ax.set_xlabel("")

ax.set_xlabel("x-label", fontsize=12)

gs2.tight_layout(fig, rect=[0.5, 0, 1, 1], h_pad=0.5)
```

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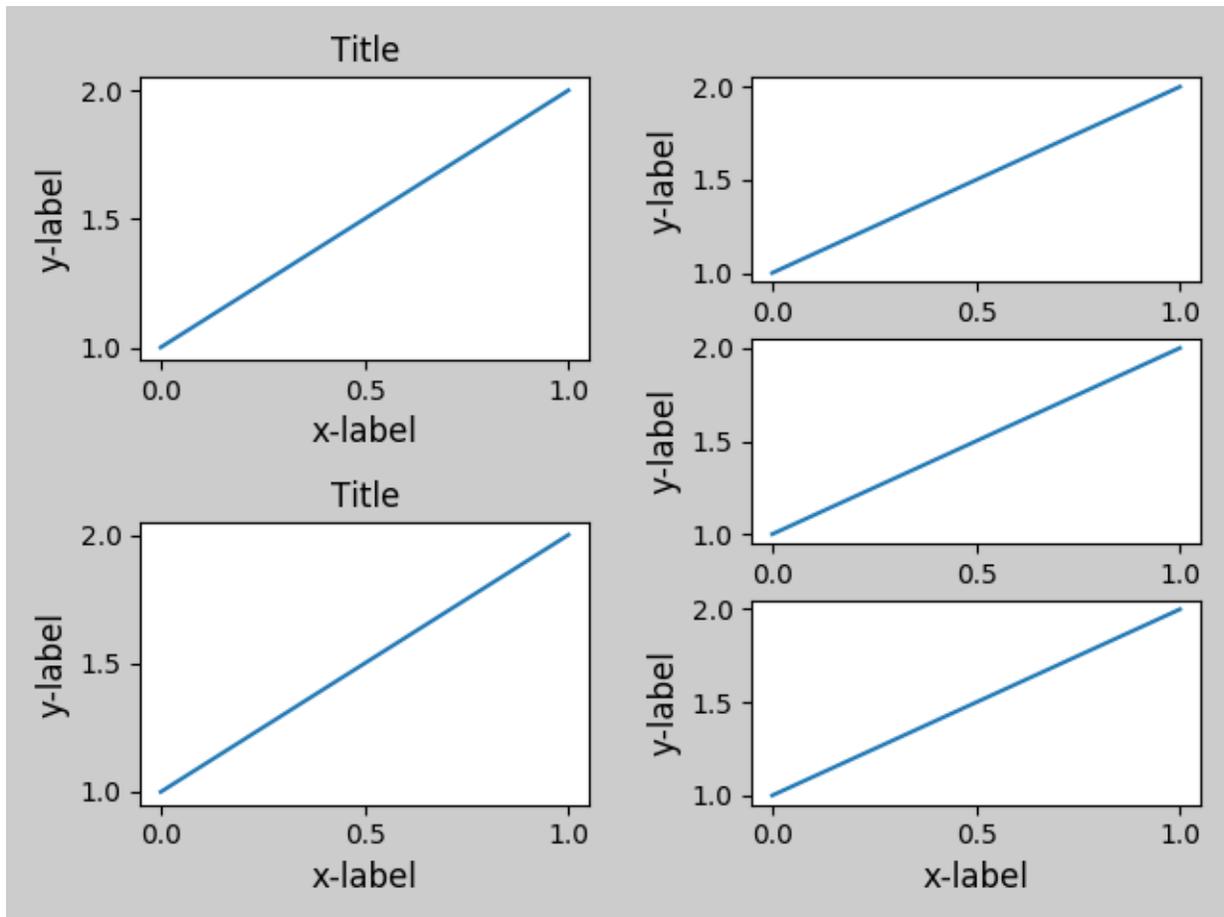
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```

# We may try to match the top and bottom of two grids ::
top = min(gs1.top, gs2.top)
bottom = max(gs1.bottom, gs2.bottom)

gs1.update(top=top, bottom=bottom)
gs2.update(top=top, bottom=bottom)
plt.show()

```



While this should be mostly good enough, adjusting top and bottom may require adjustment of hspace also. To update hspace & vspace, we call `tight_layout()` again with updated rect argument. Note that the rect argument specifies the area including the ticklabels, etc. Thus, we will increase the bottom (which is 0 for the normal case) by the difference between the *bottom* from above and the bottom of each gridspec. Same thing for the top.

```

fig = plt.gcf()

gs1 = gridspec.GridSpec(2, 1)
ax1 = fig.add_subplot(gs1[0])
ax2 = fig.add_subplot(gs1[1])

example_plot(ax1)

```

(continues on next page)

```
example_plot(ax2)

gs1.tight_layout(fig, rect=[0, 0, 0.5, 1])

gs2 = gridspec.GridSpec(3, 1)

for ss in gs2:
    ax = fig.add_subplot(ss)
    example_plot(ax)
    ax.set_title("")
    ax.set_xlabel("")

ax.set_xlabel("x-label", fontsize=12)

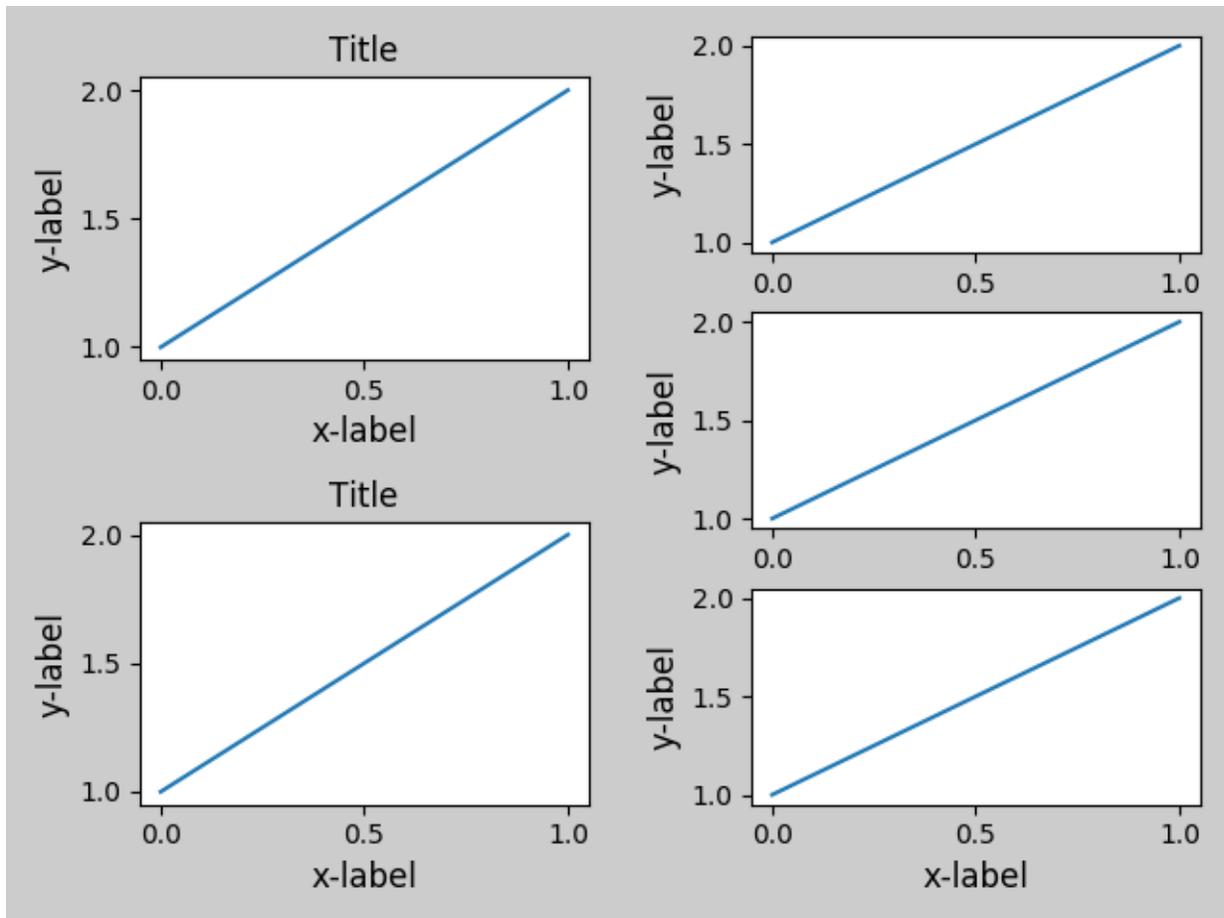
gs2.tight_layout(fig, rect=[0.5, 0, 1, 1], h_pad=0.5)

top = min(gs1.top, gs2.top)
bottom = max(gs1.bottom, gs2.bottom)

gs1.update(top=top, bottom=bottom)
gs2.update(top=top, bottom=bottom)

top = min(gs1.top, gs2.top)
bottom = max(gs1.bottom, gs2.bottom)

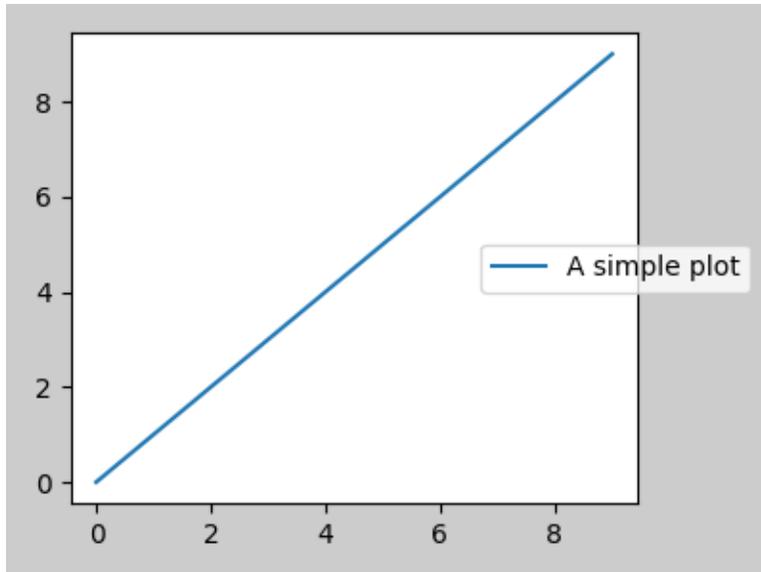
gs1.tight_layout(fig, rect=[None, 0 + (bottom-gs1.bottom),
                           0.5, 1 - (gs1.top-top)])
gs2.tight_layout(fig, rect=[0.5, 0 + (bottom-gs2.bottom),
                           None, 1 - (gs2.top-top)],
                  h_pad=0.5)
```



### Legends and Annotations

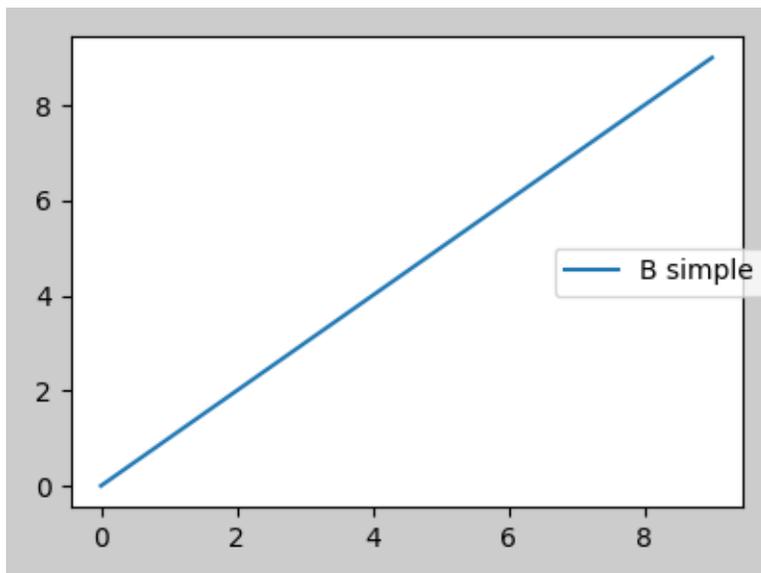
Pre Matplotlib 2.2, legends and annotations were excluded from the bounding box calculations that decide the layout. Subsequently these artists were added to the calculation, but sometimes it is undesirable to include them. For instance in this case it might be good to have the axes shrink a bit to make room for the legend:

```
fig, ax = plt.subplots(figsize=(4, 3))
lines = ax.plot(range(10), label='A simple plot')
ax.legend(bbox_to_anchor=(0.7, 0.5), loc='center left',)
fig.tight_layout()
plt.show()
```



However, sometimes this is not desired (quite often when using `fig.savefig('outname.png', bbox_inches='tight')`). In order to remove the legend from the bounding box calculation, we simply set its bounding `leg.set_in_layout(False)` and the legend will be ignored.

```
fig, ax = plt.subplots(figsize=(4, 3))
lines = ax.plot(range(10), label='B simple plot')
leg = ax.legend(bbox_to_anchor=(0.7, 0.5), loc='center left',)
leg.set_in_layout(False)
fig.tight_layout()
plt.show()
```



### Use with AxesGrid1

While limited, the `axes_grid1` toolkit is also supported.

```

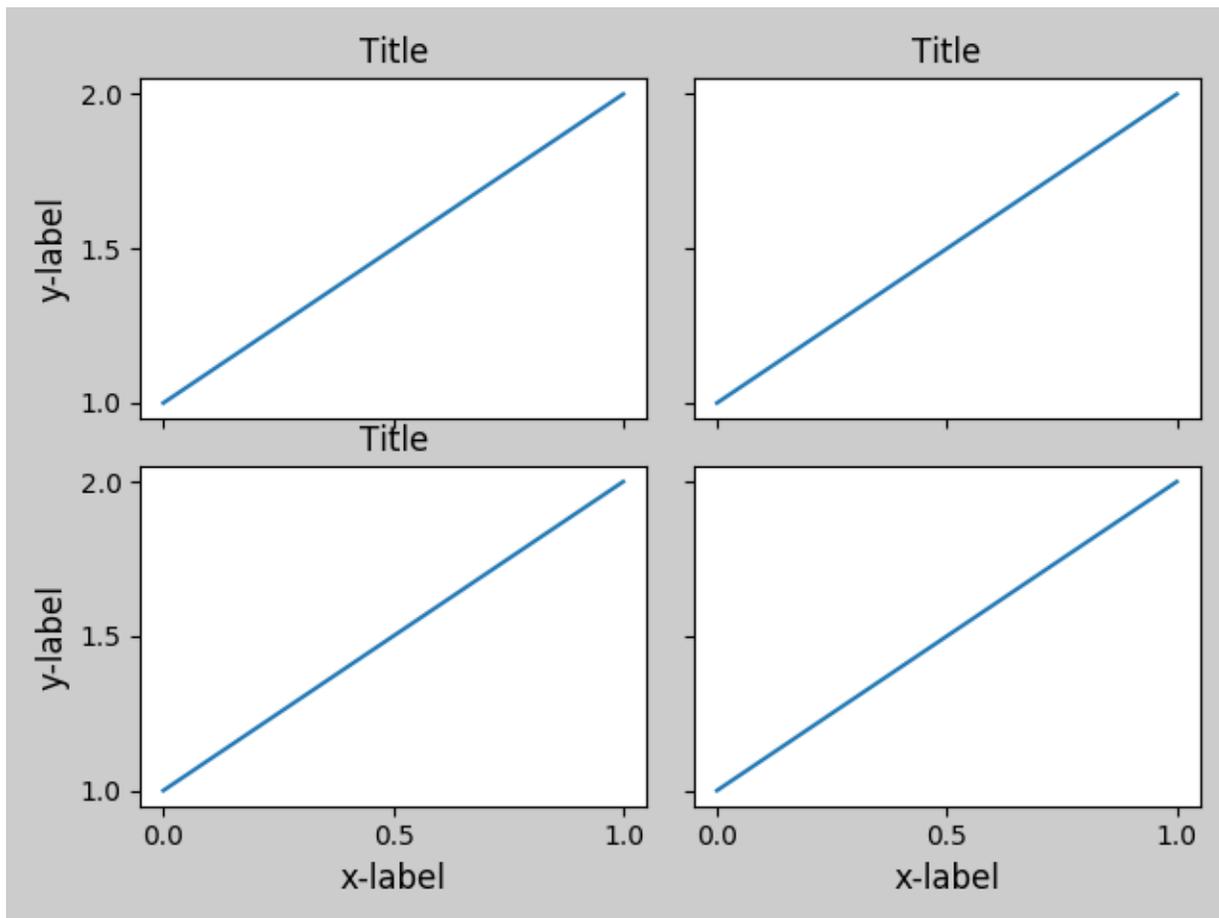
from mpl_toolkits.axes_grid1 import Grid

plt.close('all')
fig = plt.figure()
grid = Grid(fig, rect=111, nrows_ncols=(2, 2),
            axes_pad=0.25, label_mode='L',
            )

for ax in grid:
    example_plot(ax)
ax.title.set_visible(False)

plt.tight_layout()

```



### Colorbar

If you create a colorbar with the `colorbar()` command, the created colorbar is an instance of `Axes`, *not* `Subplot`, so `tight_layout` does not work. With Matplotlib v1.1, you may create a colorbar as a subplot using the `gridspec`.

```

plt.close('all')
arr = np.arange(100).reshape((10, 10))

```

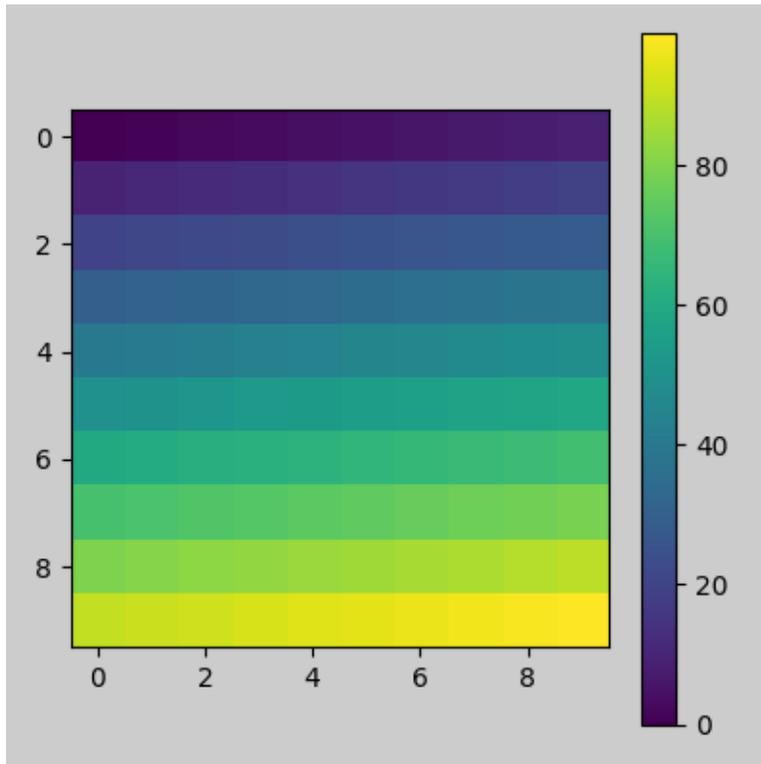
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```
fig = plt.figure(figsize=(4, 4))
im = plt.imshow(arr, interpolation="none")

plt.colorbar(im, use_gridspec=True)

plt.tight_layout()
```



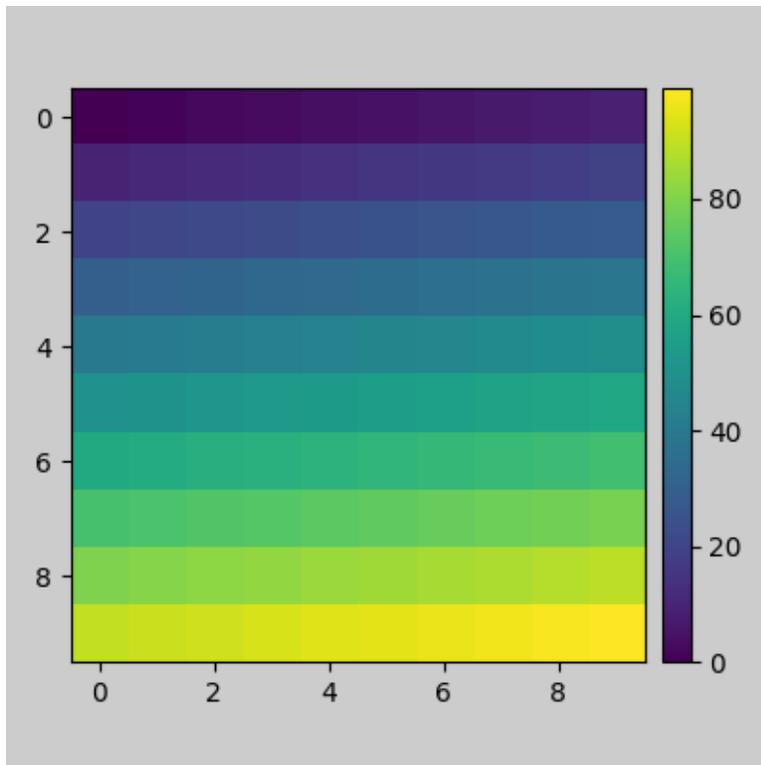
Another option is to use AxesGrid1 toolkit to explicitly create an axes for colorbar.

```
from mpl_toolkits.axes_grid1 import make_axes_locatable

plt.close('all')
arr = np.arange(100).reshape((10, 10))
fig = plt.figure(figsize=(4, 4))
im = plt.imshow(arr, interpolation="none")

divider = make_axes_locatable(plt.gca())
cax = divider.append_axes("right", "5%", pad="3%")
plt.colorbar(im, cax=cax)

plt.tight_layout()
```



**Total running time of the script:** ( 0 minutes 1.919 seconds)

**Note:** Click [here](#) to download the full example code

### 2.2.7 *origin* and *extent* in `imshow`

`imshow()` allows you to render an image (either a 2D array which will be color-mapped (based on *norm* and *cmap*) or and 3D RGB(A) array which will be used as-is) to a rectangular region in dataspace. The orientation of the image in the final rendering is controlled by the *origin* and *extent* kwargs (and attributes on the resulting `AxesImage` instance) and the data limits of the axes.

The *extent* kwarg controls the bounding box in data coordinates that the image will fill specified as (left, right, bottom, top) in **data coordinates**, the *origin* kwarg controls how the image fills that bounding box, and the orientation in the final rendered image is also affected by the axes limits.

**Hint:** Most of the code below is used for adding labels and informative text to the plots. The described effects of *origin* and *extent* can be seen in the plots without the need to follow all code details.

For a quick understanding, you may want to skip the code details below and directly continue with the discussion of the results.

```

import numpy as np
import matplotlib.pyplot as plt
from matplotlib.gridspec import GridSpec

def index_to_coordinate(index, extent, origin):
    """Return the pixel center of an index."""
    left, right, bottom, top = extent

    hshift = 0.5 * np.sign(right - left)
    left, right = left + hshift, right - hshift
    vshift = 0.5 * np.sign(top - bottom)
    bottom, top = bottom + vshift, top - vshift

    if origin == 'upper':
        bottom, top = top, bottom

    return {
        "[0, 0]": (left, bottom),
        "[M', 0]": (left, top),
        "[0, N']": (right, bottom),
        "[M', N']": (right, top),
    }[index]

def get_index_label_pos(index, extent, origin, inverted_xindex):
    """
    Return the desired position and horizontal alignment of an index label.
    """
    if extent is None:
        extent = lookup_extent(origin)
    left, right, bottom, top = extent
    x, y = index_to_coordinate(index, extent, origin)

    is_x0 = index[-2:] == "0"
    halign = 'left' if is_x0 ^ inverted_xindex else 'right'
    hshift = 0.5 * np.sign(left - right)
    x += hshift * (1 if is_x0 else -1)
    return x, y, halign

def get_color(index, data, cmap):
    """Return the data color of an index."""
    val = {
        "[0, 0]": data[0, 0],
        "[0, N']": data[0, -1],
        "[M', 0]": data[-1, 0],
        "[M', N']": data[-1, -1],
    }[index]
    return cmap(val / data.max())

```

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```

def lookup_extent(origin):
    """Return extent for label positioning when not given explicitly."""
    if origin == 'lower':
        return (-0.5, 6.5, -0.5, 5.5)
    else:
        return (-0.5, 6.5, 5.5, -0.5)

def set_extent_None_text(ax):
    ax.text(3, 2.5, 'equals\nextent=None', size='large',
           ha='center', va='center', color='w')

def plot_imshow_with_labels(ax, data, extent, origin, xlim, ylim):
    """Actually run ``imshow()`` and add extent and index labels."""
    im = ax.imshow(data, origin=origin, extent=extent)

    # extent labels (left, right, bottom, top)
    left, right, bottom, top = im.get_extent()
    if xlim is None or top > bottom:
        upper_string, lower_string = 'top', 'bottom'
    else:
        upper_string, lower_string = 'bottom', 'top'
    if ylim is None or left < right:
        port_string, starboard_string = 'left', 'right'
        inverted_xindex = False
    else:
        port_string, starboard_string = 'right', 'left'
        inverted_xindex = True
    bbox_kwargs = {'fc': 'w', 'alpha': .75, 'boxstyle': "round4"}
    ann_kwargs = {'xycoords': 'axes fraction',
                  'textcoords': 'offset points',
                  'bbox': bbox_kwargs}
    ax.annotate(upper_string, xy=(.5, 1), xytext=(0, -1),
                ha='center', va='top', **ann_kwargs)
    ax.annotate(lower_string, xy=(.5, 0), xytext=(0, 1),
                ha='center', va='bottom', **ann_kwargs)
    ax.annotate(port_string, xy=(0, .5), xytext=(1, 0),
                ha='left', va='center', rotation=90,
                **ann_kwargs)
    ax.annotate(starboard_string, xy=(1, .5), xytext=(-1, 0),
                ha='right', va='center', rotation=-90,
                **ann_kwargs)
    ax.set_title('origin: {origin}'.format(origin=origin))

    # index labels
    for index in ["[0, 0]", "[0, N]", "[M, 0]", "[M, N]"]:
        tx, ty, halign = get_index_label_pos(index, extent, origin,
                                             inverted_xindex)
        facecolor = get_color(index, data, im.get_cmap())
        ax.text(tx, ty, index, color='white', ha=halign, va='center',
               bbox={'boxstyle': 'square', 'facecolor': facecolor})

```

(continues on next page)

```

if xlim:
    ax.set_xlim(*xlim)
if ylim:
    ax.set_ylim(*ylim)

def generate_imshow_demo_grid(extents, xlim=None, ylim=None):
    N = len(extents)
    fig = plt.figure(tight_layout=True)
    fig.set_size_inches(6, N * (11.25) / 5)
    gs = GridSpec(N, 5, figure=fig)

    columns = {'label': [fig.add_subplot(gs[j, 0]) for j in range(N)],
              'upper': [fig.add_subplot(gs[j, 1:3]) for j in range(N)],
              'lower': [fig.add_subplot(gs[j, 3:5]) for j in range(N)]}
    x, y = np.ogrid[0:6, 0:7]
    data = x + y

    for origin in ['upper', 'lower']:
        for ax, extent in zip(columns[origin], extents):
            plot_imshow_with_labels(ax, data, extent, origin, xlim, ylim)

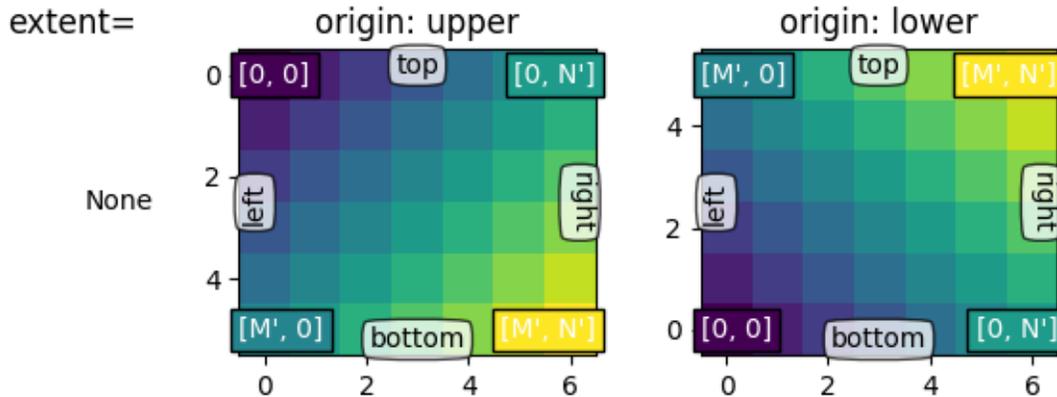
    for ax, extent in zip(columns['label'], extents):
        text_kwargs = {'ha': 'right',
                      'va': 'center',
                      'xycoords': 'axes fraction',
                      'xy': (1, .5)}
        if extent is None:
            ax.annotate('None', **text_kwargs)
            ax.set_title('extent=')
        else:
            left, right, bottom, top = extent
            text = ('left: {left:0.1f}\nright: {right:0.1f}\n' +
                  'bottom: {bottom:0.1f}\ntop: {top:0.1f}\n').format(
                left=left, right=right, bottom=bottom, top=top)
            ax.annotate(text, **text_kwargs)
        ax.axis('off')
    return columns

```

### Default extent

First, let's have a look at the default extent=None

```
generate_imshow_demo_grid(extents=[None])
```



Generally, for an array of shape  $(M, N)$ , the first index runs along the vertical, the second index runs along the horizontal. The pixel centers are at integer positions ranging from 0 to  $N' = N - 1$  horizontally and from 0 to  $M' = M - 1$  vertically. *origin* determines how the data is filled in the bounding box.

For *origin*='lower':

- $[0, 0]$  is at (left, bottom)
- $[M', 0]$  is at (left, top)
- $[0, N']$  is at (right, bottom)
- $[M', N']$  is at (right, top)

*origin*='upper' reverses the vertical axes direction and filling:

- $[0, 0]$  is at (left, top)
- $[M', 0]$  is at (left, bottom)
- $[0, N']$  is at (right, top)
- $[M', N']$  is at (right, bottom)

In summary, the position of the  $[0, 0]$  index as well as the extent are influenced by *origin*:

origin	$[0, 0]$ position	extent
upper	top left	$(-0.5, \text{numcols}-0.5, \text{numrows}-0.5, -0.5)$
lower	bottom left	$(-0.5, \text{numcols}-0.5, -0.5, \text{numrows}-0.5)$

The default value of *origin* is set by `rcParams["image.origin"]` which defaults to 'upper' to match the matrix indexing conventions in math and computer graphics image indexing conventions.

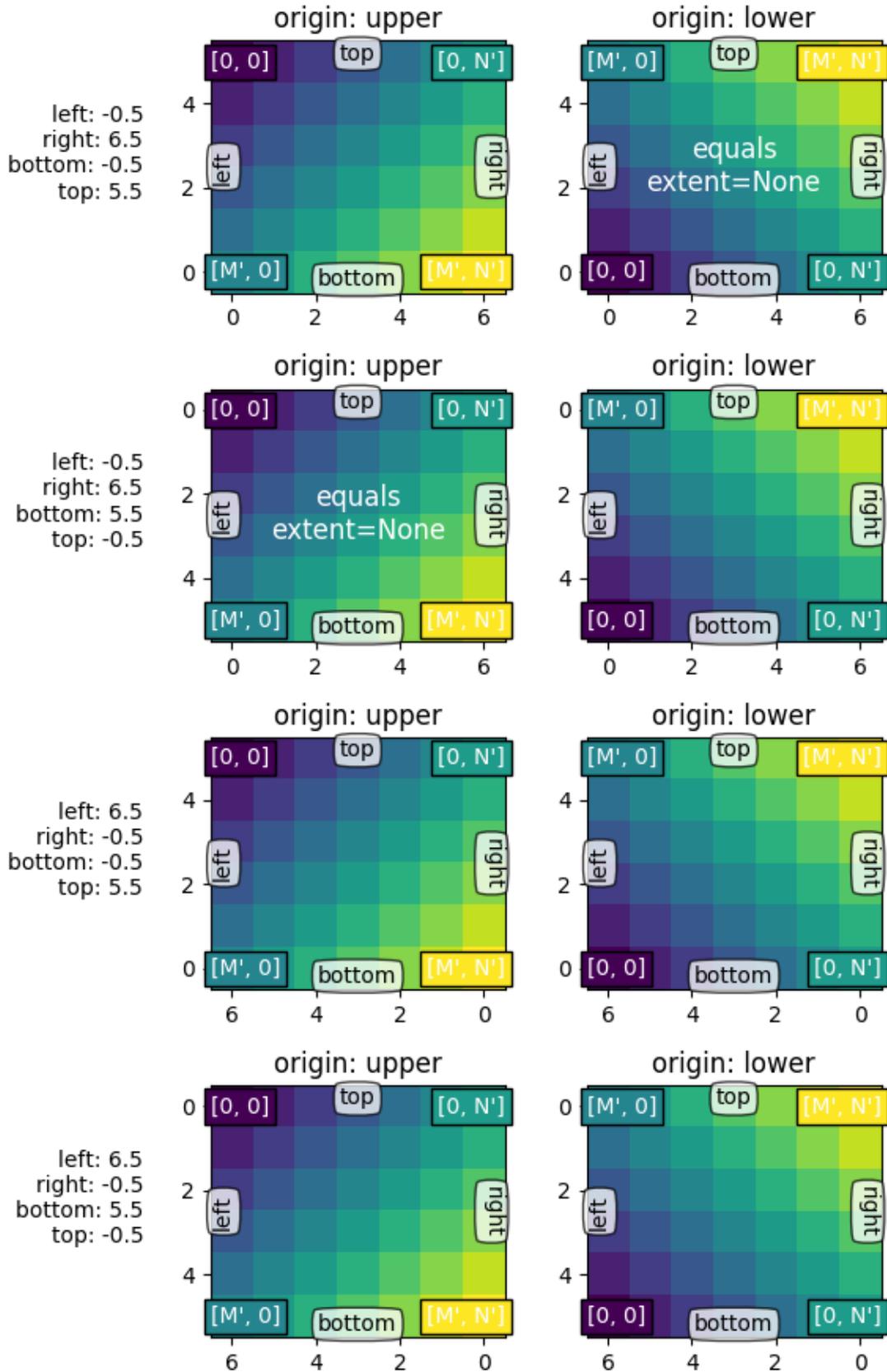
### Explicit extent

By setting *extent* we define the coordinates of the image area. The underlying image data is interpolated/resampled to fill that area.

If the axes is set to autoscale, then the view limits of the axes are set to match the *extent* which ensures that the coordinate set by (left, bottom) is at the bottom left of the axes! However, this may invert the axis so they do not increase in the 'natural' direction.

```
extents = [(-0.5, 6.5, -0.5, 5.5),
           (-0.5, 6.5, 5.5, -0.5),
           (6.5, -0.5, -0.5, 5.5),
           (6.5, -0.5, 5.5, -0.5)]

columns = generate_imshow_demo_grid(extents)
set_extent_None_text(columns['upper'][1])
set_extent_None_text(columns['lower'][0])
```



### Explicit extent and axes limits

If we fix the axes limits by explicitly setting `set_xlim / set_ylim`, we force a certain size and orientation of the axes. This can decouple the 'left-right' and 'top-bottom' sense of the image from the orientation on the screen.

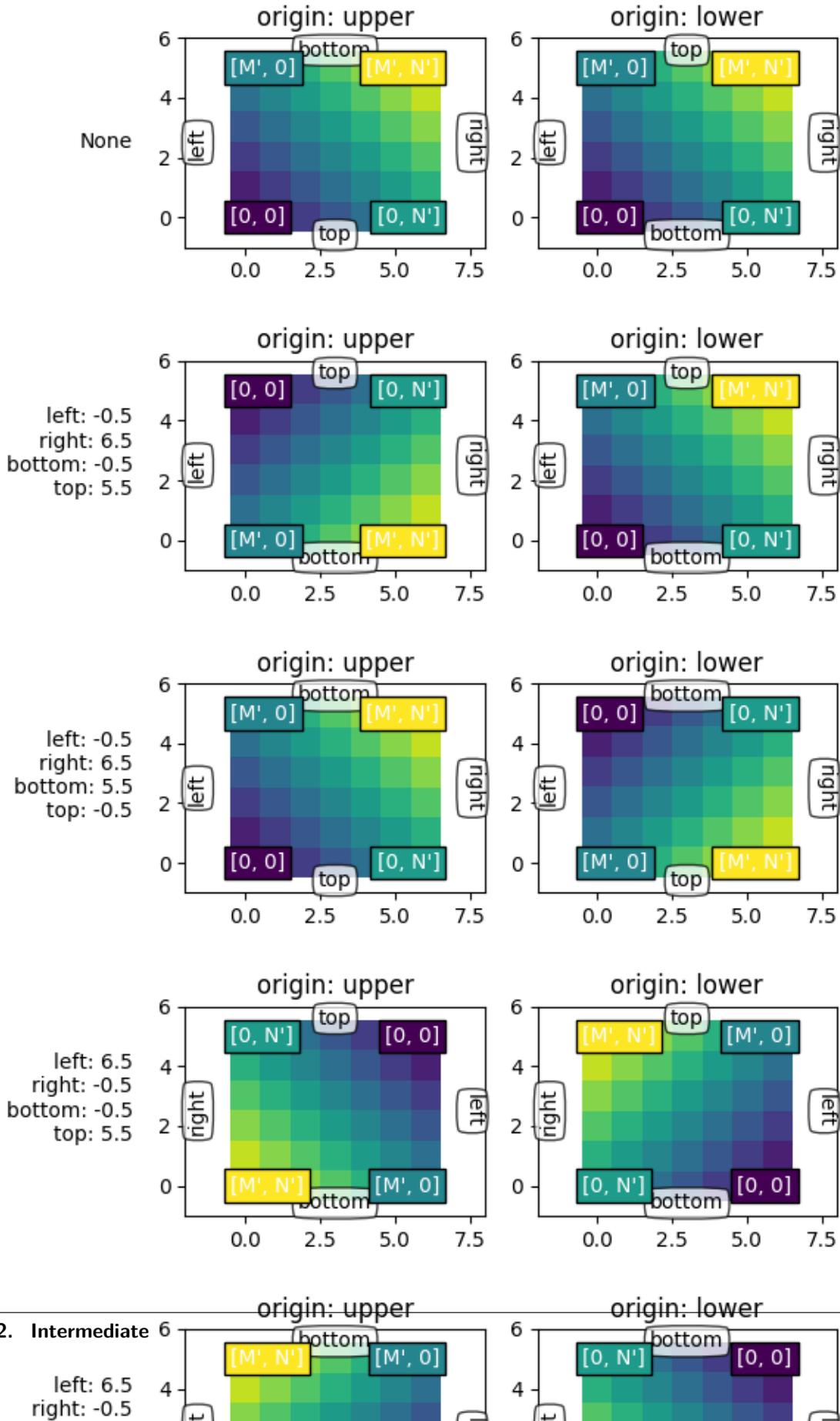
In the example below we have chosen the limits slightly larger than the extent (note the white areas within the Axes).

While we keep the extents as in the examples before, the coordinate (0, 0) is now explicitly put at the bottom left and values increase to up and to the right (from the viewer point of view). We can see that:

- The coordinate (left, bottom) anchors the image which then fills the box going towards the (right, top) point in data space.
- The first column is always closest to the 'left'.
- *origin* controls if the first row is closest to 'top' or 'bottom'.
- The image may be inverted along either direction.
- The 'left-right' and 'top-bottom' sense of the image may be uncoupled from the orientation on the screen.

```
generate_imshow_demo_grid(extents=[None] + extents,  
                           xlim=(-2, 8), ylim=(-1, 6))
```

extent=



**Total running time of the script:** ( 0 minutes 1.086 seconds)

## 2.3 Advanced

These tutorials cover advanced topics for experienced Matplotlib users and developers.

---

**Note:** Click *here* to download the full example code

---

### 2.3.1 Path Tutorial

Defining paths in your Matplotlib visualization.

The object underlying all of the `matplotlib.patch` objects is the *Path*, which supports the standard set of `moveto`, `lineto`, `curveto` commands to draw simple and compound outlines consisting of line segments and splines. The *Path* is instantiated with a (N,2) array of (x,y) vertices, and a N-length array of path codes. For example to draw the unit rectangle from (0,0) to (1,1), we could use this code

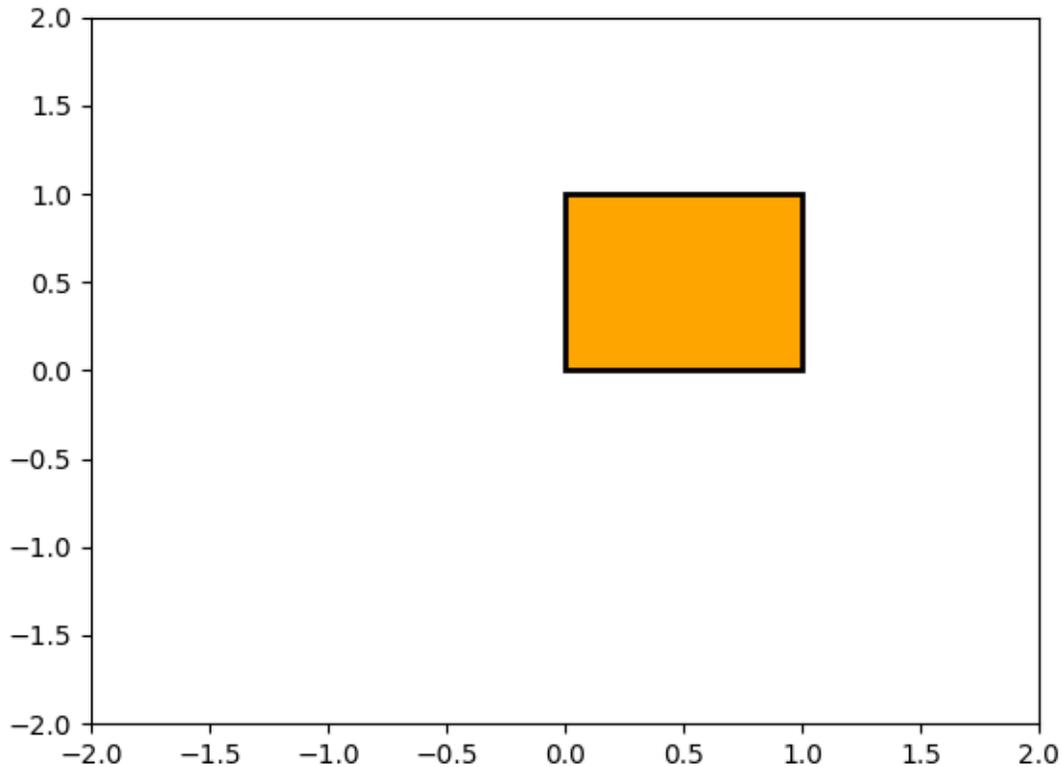
```
import matplotlib.pyplot as plt
from matplotlib.path import Path
import matplotlib.patches as patches

verts = [
    (0., 0.), # left, bottom
    (0., 1.), # left, top
    (1., 1.), # right, top
    (1., 0.), # right, bottom
    (0., 0.), # ignored
]

codes = [
    Path.MOVETO,
    Path.LINETO,
    Path.LINETO,
    Path.LINETO,
    Path.CLOSEPOLY,
]

path = Path(verts, codes)

fig, ax = plt.subplots()
patch = patches.PathPatch(path, facecolor='orange', lw=2)
ax.add_patch(patch)
ax.set_xlim(-2, 2)
ax.set_ylim(-2, 2)
plt.show()
```



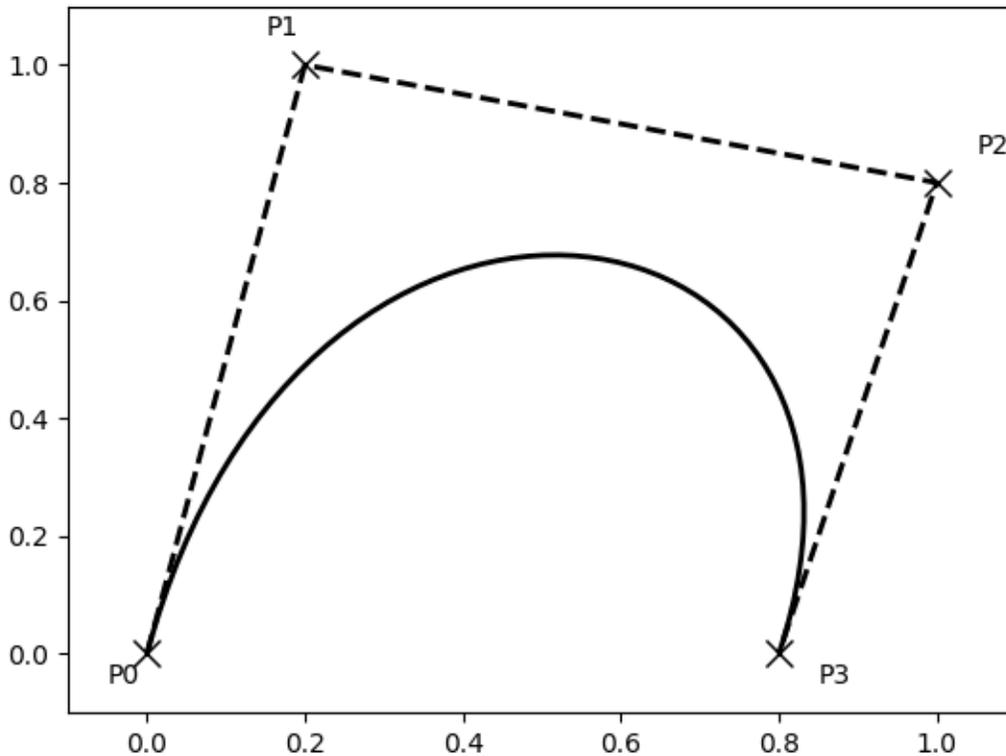
The following path codes are recognized

Code	Vertices	Description
STOP	1 (ignored)	A marker for the end of the entire path (currently not required and ignored)
MOVETO	1	Pick up the pen and move to the given vertex.
LINETO	1	Draw a line from the current position to the given vertex.
CURVE3	2 (1 control point, 1 endpoint)	Draw a quadratic Bézier curve from the current position, with the given control point, to the given end point.
CURVE4	3 (2 control points, 1 endpoint)	Draw a cubic Bézier curve from the current position, with the given control points, to the given end point.
CLOSEPOLY	(point itself is ignored)	Draw a line segment to the start point of the current polyline.

### Bézier example

Some of the path components require multiple vertices to specify them: for example CURVE 3 is a [bézier](#) curve with one control point and one end point, and CURVE4 has three vertices for the two control points and the end point. The example below shows a CURVE4 Bézier spline – the bézier curve will be contained in the convex hull of the start point, the two control points, and the end point

```
verts = [  
    (0., 0.), # P0  
    (0.2, 1.), # P1  
    (1., 0.8), # P2  
    (0.8, 0.), # P3  
]  
  
codes = [  
    Path.MOVETO,  
    Path.CURVE4,  
    Path.CURVE4,  
    Path.CURVE4,  
]  
  
path = Path(verts, codes)  
  
fig, ax = plt.subplots()  
patch = patches.PathPatch(path, facecolor='none', lw=2)  
ax.add_patch(patch)  
  
xs, ys = zip(*verts)  
ax.plot(xs, ys, 'x--', lw=2, color='black', ms=10)  
  
ax.text(-0.05, -0.05, 'P0')  
ax.text(0.15, 1.05, 'P1')  
ax.text(1.05, 0.85, 'P2')  
ax.text(0.85, -0.05, 'P3')  
  
ax.set_xlim(-0.1, 1.1)  
ax.set_ylim(-0.1, 1.1)  
plt.show()
```



### Compound paths

All of the simple patch primitives in matplotlib, `Rectangle`, `Circle`, `Polygon`, etc, are implemented with simple path. Plotting functions like `hist()` and `bar()`, which create a number of primitives, e.g., a bunch of `Rectangles`, can usually be implemented more efficiently using a compound path. The reason `bar` creates a list of rectangles and not a compound path is largely historical: the `Path` code is comparatively new and `bar` predates it. While we could change it now, it would break old code, so here we will cover how to create compound paths, replacing the functionality in `bar`, in case you need to do so in your own code for efficiency reasons, e.g., you are creating an animated bar plot.

We will make the histogram chart by creating a series of rectangles for each histogram bar: the rectangle width is the bin width and the rectangle height is the number of datapoints in that bin. First we'll create some random normally distributed data and compute the histogram. Because numpy returns the bin edges and not centers, the length of bins is 1 greater than the length of `n` in the example below:

```
# histogram our data with numpy
data = np.random.randn(1000)
n, bins = np.histogram(data, 100)
```

We'll now extract the corners of the rectangles. Each of the `left`, `bottom`, etc, arrays below is `len(n)`, where `n` is the array of counts for each histogram bar:

```
# get the corners of the rectangles for the histogram
left = np.array(bins[:-1])
right = np.array(bins[1:])
bottom = np.zeros(len(left))
top = bottom + n
```

Now we have to construct our compound path, which will consist of a series of MOVETO, LINETO and CLOSEPOLY for each rectangle. For each rectangle, we need 5 vertices: 1 for the MOVETO, 3 for the LINETO, and 1 for the CLOSEPOLY. As indicated in the table above, the vertex for the closepoly is ignored but we still need it to keep the codes aligned with the vertices:

```
nverts = nrects*(1+3+1)
verts = np.zeros((nverts, 2))
codes = np.ones(nverts, int) * path.Path.LINETO
codes[0::5] = path.Path.MOVETO
codes[4::5] = path.Path.CLOSEPOLY
verts[0::5,0] = left
verts[0::5,1] = bottom
verts[1::5,0] = left
verts[1::5,1] = top
verts[2::5,0] = right
verts[2::5,1] = top
verts[3::5,0] = right
verts[3::5,1] = bottom
```

All that remains is to create the path, attach it to a PathPatch, and add it to our axes:

```
barpath = path.Path(verts, codes)
patch = patches.PathPatch(barpath, facecolor='green',
    edgecolor='yellow', alpha=0.5)
ax.add_patch(patch)
```

```
import numpy as np
import matplotlib.patches as patches
import matplotlib.path as path

fig, ax = plt.subplots()
# Fixing random state for reproducibility
np.random.seed(19680801)

# histogram our data with numpy
data = np.random.randn(1000)
n, bins = np.histogram(data, 100)

# get the corners of the rectangles for the histogram
left = np.array(bins[:-1])
right = np.array(bins[1:])
bottom = np.zeros(len(left))
top = bottom + n
nrects = len(left)

nverts = nrects*(1+3+1)
verts = np.zeros((nverts, 2))
```

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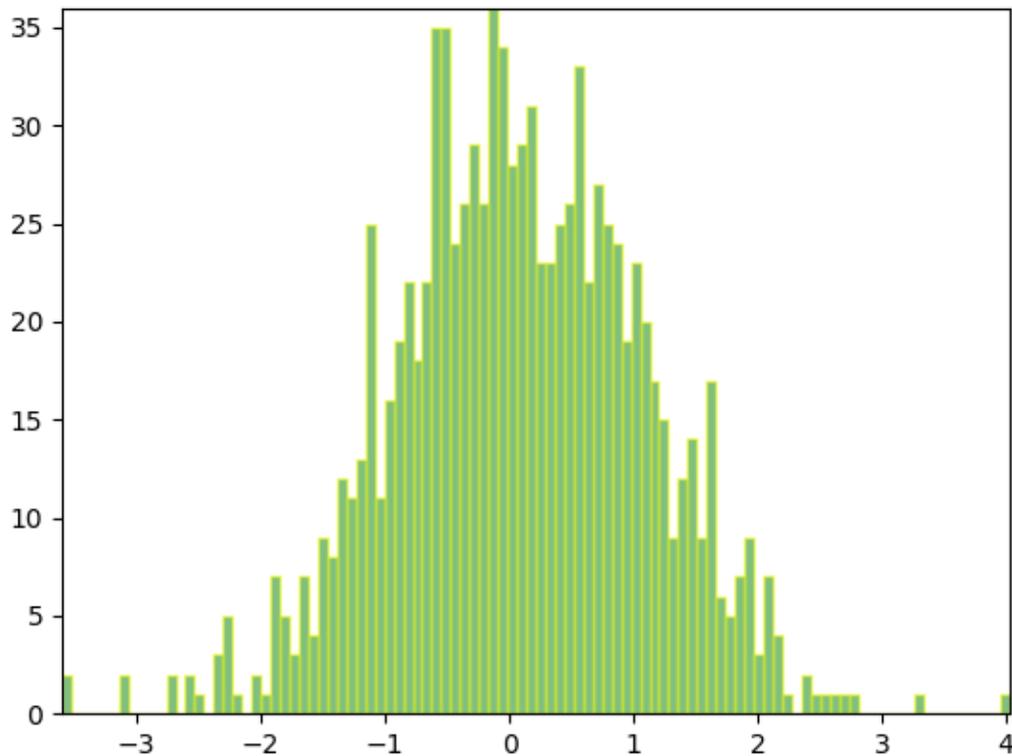
(continued from previous page)

```
codes = np.ones(nverts, int) * path.Path.LINETO
codes[0::5] = path.Path.MOVETO
codes[4::5] = path.Path.CLOSEPOLY
verts[0::5, 0] = left
verts[0::5, 1] = bottom
verts[1::5, 0] = left
verts[1::5, 1] = top
verts[2::5, 0] = right
verts[2::5, 1] = top
verts[3::5, 0] = right
verts[3::5, 1] = bottom

barpath = path.Path(verts, codes)
patch = patches.PathPatch(barpath, facecolor='green',
                          edgecolor='yellow', alpha=0.5)
ax.add_patch(patch)

ax.set_xlim(left[0], right[-1])
ax.set_ylim(bottom.min(), top.max())

plt.show()
```



**Note:** Click [here](#) to download the full example code

---

### 2.3.2 Path effects guide

Defining paths that objects follow on a canvas.

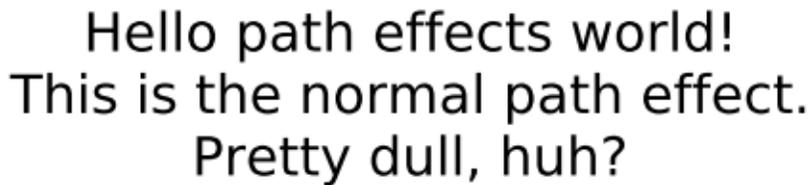
Matplotlib's *patheffects* module provides functionality to apply a multiple draw stage to any Artist which can be rendered via a *Path*.

Artists which can have a path effect applied to them include *Patch*, *Line2D*, *Collection* and even *Text*. Each artist's path effects can be controlled via the `set_path_effects` method (`set_path_effects`), which takes an iterable of *AbstractPathEffect* instances.

The simplest path effect is the *Normal* effect, which simply draws the artist without any effect:

```
import matplotlib.pyplot as plt
import matplotlib.patheffects as path_effects

fig = plt.figure(figsize=(5, 1.5))
text = fig.text(0.5, 0.5, 'Hello path effects world!\nThis is the normal '
                'path effect.\nPretty dull, huh?',
                ha='center', va='center', size=20)
text.set_path_effects([path_effects.Normal()])
plt.show()
```



Whilst the plot doesn't look any different to what you would expect without any path effects, the drawing of the text now been changed to use the path effects framework, opening up the possibilities for more interesting examples.

#### Adding a shadow

A far more interesting path effect than *Normal* is the drop-shadow, which we can apply to any of our path based artists. The classes *SimplePatchShadow* and *SimpleLineShadow* do precisely this by drawing either a filled patch or a line patch below the original artist:

```
import matplotlib.patheffects as path_effects

text = plt.text(0.5, 0.5, 'Hello path effects world!',
                path_effects=[path_effects.withSimplePatchShadow()])

plt.plot([0, 3, 2, 5], linewidth=5, color='blue',
```

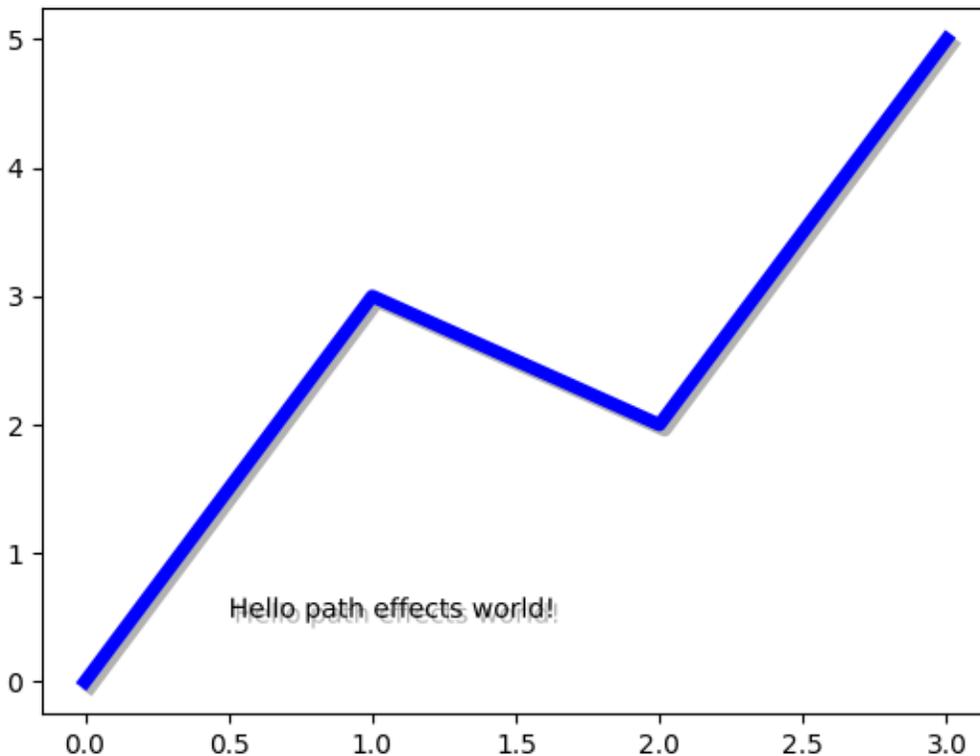
(continues on next page)

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```

path_effects=[path_effects.SimpleLineShadow(),
              path_effects.Normal())
plt.show()

```



Notice the two approaches to setting the path effects in this example. The first uses the `with*` classes to include the desired functionality automatically followed with the “normal” effect, whereas the latter explicitly defines the two path effects to draw.

### Making an artist stand out

One nice way of making artists visually stand out is to draw an outline in a bold color below the actual artist. The `Stroke` path effect makes this a relatively simple task:

```

fig = plt.figure(figsize=(7, 1))
text = fig.text(0.5, 0.5, 'This text stands out because of\n'
                'its black border.', color='white',
                ha='center', va='center', size=30)
text.set_path_effects([path_effects.Stroke(linewidth=3, foreground='black'),
                      path_effects.Normal()])
plt.show()

```

# This text stands out because of its black border.

It is important to note that this effect only works because we have drawn the text path twice; once with a thick black line, and then once with the original text path on top.

You may have noticed that the keywords to *Stroke* and *SimplePatchShadow* and *SimpleLineShadow* are not the usual Artist keywords (such as *facecolor* and *edgecolor* etc.). This is because with these path effects we are operating at lower level of matplotlib. In fact, the keywords which are accepted are those for a *matplotlib.backend\_bases.GraphicsContextBase* instance, which have been designed for making it easy to create new backends - and not for its user interface.

## Greater control of the path effect artist

As already mentioned, some of the path effects operate at a lower level than most users will be used to, meaning that setting keywords such as *facecolor* and *edgecolor* raise an *AttributeError*. Luckily there is a generic *PathPatchEffect* path effect which creates a *PathPatch* class with the original path. The keywords to this effect are identical to those of *PathPatch*:

```
fig = plt.figure(figsize=(8, 1))
t = fig.text(0.02, 0.5, 'Hatch shadow', fontsize=75, weight=1000, va='center')
t.set_path_effects([path_effects.PathPatchEffect(offset=(4, -4), hatch='xxxx',
                                                facecolor='gray'),
                  path_effects.PathPatchEffect(edgecolor='white', linewidth=1.1,
                                                facecolor='black')])
plt.show()
```



The image shows the text "Hatch shadow" in a large, bold, black font. The text has a thick black outline and a gray hatch pattern shadow, giving it a 3D effect. The background is white.

---

**Note:** Click [here](#) to download the full example code

---

## 2.3.3 Transformations Tutorial

Like any graphics packages, Matplotlib is built on top of a transformation framework to easily move between coordinate systems, the userland data coordinate system, the axes coordinate system, the figure coordinate system, and the display coordinate system. In 95% of your plotting, you won't need to think about this, as it happens under the hood, but as you push the limits of custom figure generation, it helps to have an understanding of these objects so you can reuse the existing transformations Matplotlib makes available to you, or create your own (see *matplotlib.transforms*). The table below summarizes the some useful coordinate systems, the transformation object you should use to work in that coordinate system, and the description of that system. In the Transformation Object column, *ax* is a *Axes* instance, and *fig* is a *Figure* instance.

Coordinates	Transformation object	Description
"data"	<code>ax.transData</code>	The coordinate system for the data, controlled by <code>xlim</code> and <code>ylim</code> .
"axes"	<code>ax.transAxes</code>	The coordinate system of the <i>Axes</i> ; (0, 0) is bottom left of the axes, and (1, 1) is top right of the axes.
"figure"	<code>fig.transFigure</code>	The coordinate system of the <i>Figure</i> ; (0, 0) is bottom left of the figure, and (1, 1) is top right of the figure.
"figure-inches"	<code>fig.dpi_scale_trans</code>	The coordinate system of the <i>Figure</i> in inches; (0, 0) is bottom left of the figure, and (width, height) is the top right of the figure in inches.
"display"	None, or <code>IdentityTransform()</code>	The pixel coordinate system of the display window; (0, 0) is bottom left of the window, and (width, height) is top right of the display window in pixels.
"xaxis", "yaxis"	<code>ax.get_xaxis_transform()</code> , <code>ax.get_yaxis_transform()</code>	Blended coordinate systems; use data coordinates on one of the axis and axes coordinates on the other.

All of the transformation objects in the table above take inputs in their coordinate system, and transform the input to the `display` coordinate system. That is why the `display` coordinate system has `None` for the Transformation Object column - it already is in display coordinates. The transformations also know how to invert themselves, to go from `display` back to the native coordinate system. This is particularly useful when processing events from the user interface, which typically occur in display space, and you want to know where the mouse click or key-press occurred in your data coordinate system.

Note that specifying objects in `display` coordinates will change their location if the `dpi` of the figure changes. This can cause confusion when printing or changing screen resolution, because the object can change location and size. Therefore it is most common for artists placed in an axes or figure to have their transform set to something *other* than the `IdentityTransform()`; the default when an artist is placed on an axes using `add_artist` is for the transform to be `ax.transData`.

### Data coordinates

Let's start with the most commonly used coordinate, the data coordinate system. Whenever you add data to the axes, Matplotlib updates the datalimits, most commonly updated with the `set_xlim()` and `set_ylim()` methods. For example, in the figure below, the data limits stretch from 0 to 10 on the x-axis, and -1 to 1 on the y-axis.

```
import numpy as np
import matplotlib.pyplot as plt
import matplotlib.patches as mpatches

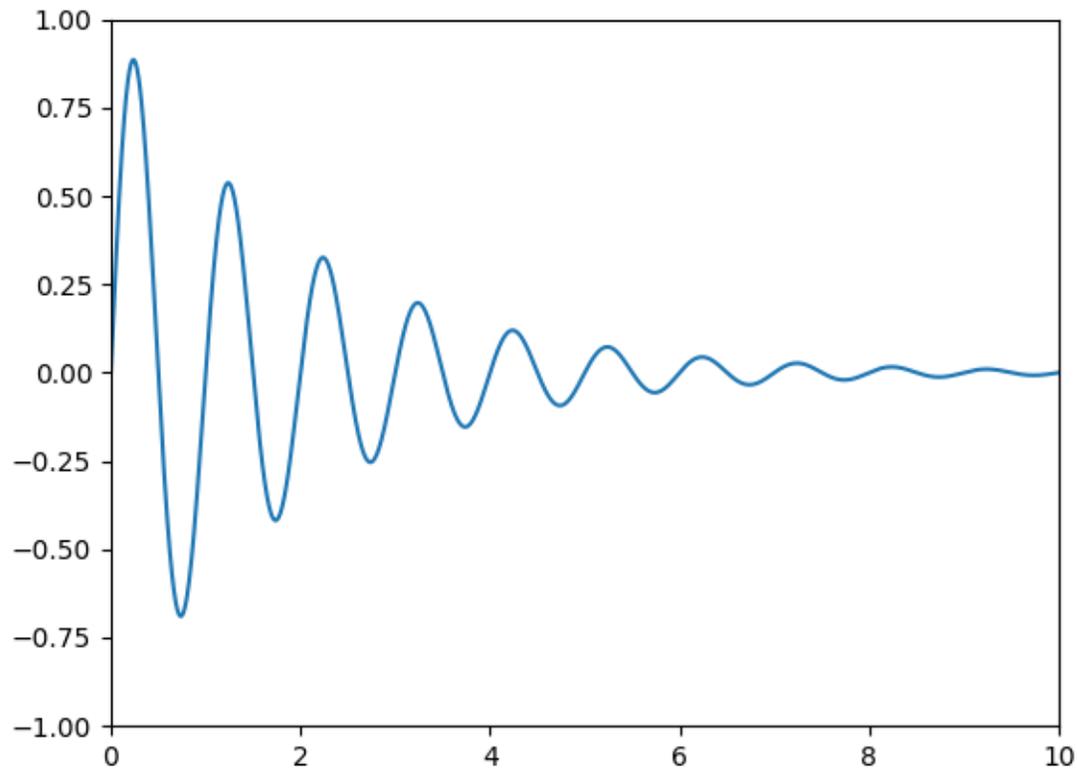
x = np.arange(0, 10, 0.005)
y = np.exp(-x/2.) * np.sin(2*np.pi*x)

fig, ax = plt.subplots()
ax.plot(x, y)
ax.set_xlim(0, 10)
ax.set_ylim(-1, 1)
```

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```
plt.show()
```



You can use the `ax.transData` instance to transform from your data to your display coordinate system, either a single point or a sequence of points as shown below:

```
In [14]: type(ax.transData)
Out[14]: <class 'matplotlib.transforms.CompositeGenericTransform'>

In [15]: ax.transData.transform((5, 0))
Out[15]: array([ 335.175,  247.   ])

In [16]: ax.transData.transform([(5, 0), (1, 2)])
Out[16]:
array([[ 335.175,  247.   ],
       [ 132.435,  642.2 ]])
```

You can use the `inverted()` method to create a transform which will take you from display to data coordinates:

```
In [41]: inv = ax.transData.inverted()

In [42]: type(inv)
```

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```
Out[42]: <class 'matplotlib.transforms.CompositeGenericTransform'>
```

```
In [43]: inv.transform((335.175, 247.))
```

```
Out[43]: array([ 5.,  0.]
```

If you are typing along with this tutorial, the exact values of the display coordinates may differ if you have a different window size or dpi setting. Likewise, in the figure below, the display labeled points are probably not the same as in the ipython session because the documentation figure size defaults are different.

```
x = np.arange(0, 10, 0.005)
y = np.exp(-x/2.) * np.sin(2*np.pi*x)

fig, ax = plt.subplots()
ax.plot(x, y)
ax.set_xlim(0, 10)
ax.set_ylim(-1, 1)

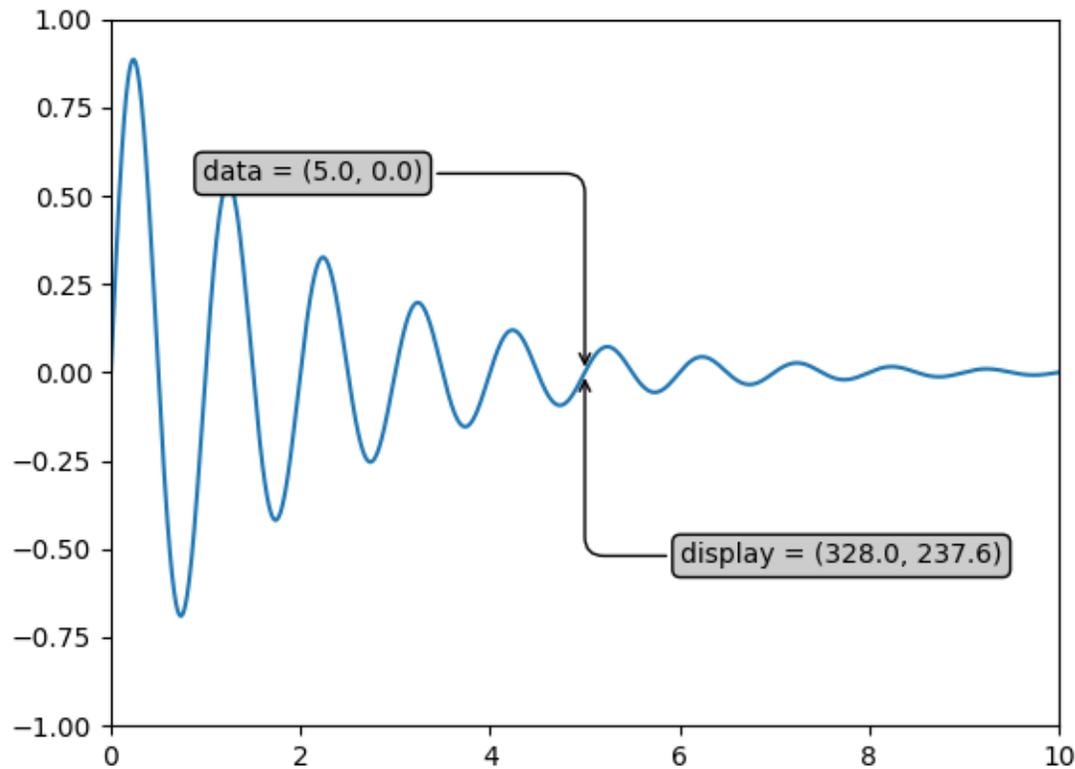
xdata, ydata = 5, 0
xdisplay, ydisplay = ax.transData.transform_point((xdata, ydata))

bbox = dict(boxstyle="round", fc="0.8")
arrowprops = dict(
    arrowstyle="->",
    connectionstyle="angle,angleA=0,angleB=90,rad=10")

offset = 72
ax.annotate('data = (%.1f, %.1f)' % (xdata, ydata),
            (xdata, ydata), xytext=(-2*offset, offset), textcoords='offset points',
            bbox=bbox, arrowprops=arrowprops)

disp = ax.annotate('display = (%.1f, %.1f)' % (xdisplay, ydisplay),
                  (xdisplay, ydisplay), xytext=(0.5*offset, -offset),
                  xycoords='figure pixels',
                  textcoords='offset points',
                  bbox=bbox, arrowprops=arrowprops)

plt.show()
```



**Note:** If you run the source code in the example above in a GUI backend, you may also find that the two arrows for the `data` and `display` annotations do not point to exactly the same point. This is because the `display` point was computed before the figure was displayed, and the GUI backend may slightly resize the figure when it is created. The effect is more pronounced if you resize the figure yourself. This is one good reason why you rarely want to work in display space, but you can connect to the `'on_draw'` *Event* to update figure coordinates on figure draws; see *Event handling and picking*.

When you change the x or y limits of your axes, the data limits are updated so the transformation yields a new display point. Note that when we just change the `ylim`, only the y-display coordinate is altered, and when we change the `xlim` too, both are altered. More on this later when we talk about the *Bbox*.

```
In [54]: ax.transData.transform((5, 0))
Out[54]: array([ 335.175, 247.   ])

In [55]: ax.set_ylim(-1, 2)
Out[55]: (-1, 2)

In [56]: ax.transData.transform((5, 0))
Out[56]: array([ 335.175      , 181.13333333])
```

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```
In [57]: ax.set_xlim(10, 20)
Out[57]: (10, 20)

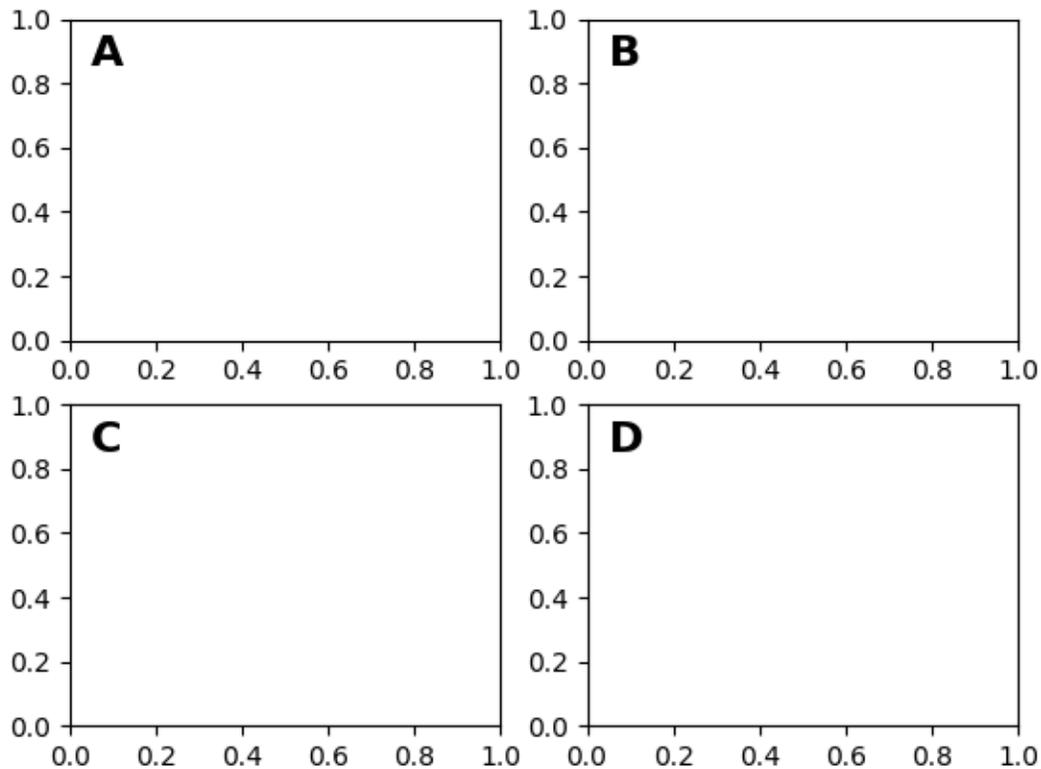
In [58]: ax.transData.transform((5, 0))
Out[58]: array([-171.675      ,  181.13333333])
```

### Axes coordinates

After the data coordinate system, `axes` is probably the second most useful coordinate system. Here the point (0, 0) is the bottom left of your axes or subplot, (0.5, 0.5) is the center, and (1.0, 1.0) is the top right. You can also refer to points outside the range, so (-0.1, 1.1) is to the left and above your axes. This coordinate system is extremely useful when placing text in your axes, because you often want a text bubble in a fixed, location, e.g., the upper left of the axes pane, and have that location remain fixed when you pan or zoom. Here is a simple example that creates four panels and labels them 'A', 'B', 'C', 'D' as you often see in journals.

```
fig = plt.figure()
for i, label in enumerate(('A', 'B', 'C', 'D')):
    ax = fig.add_subplot(2, 2, i+1)
    ax.text(0.05, 0.95, label, transform=ax.transAxes,
           fontsize=16, fontweight='bold', va='top')

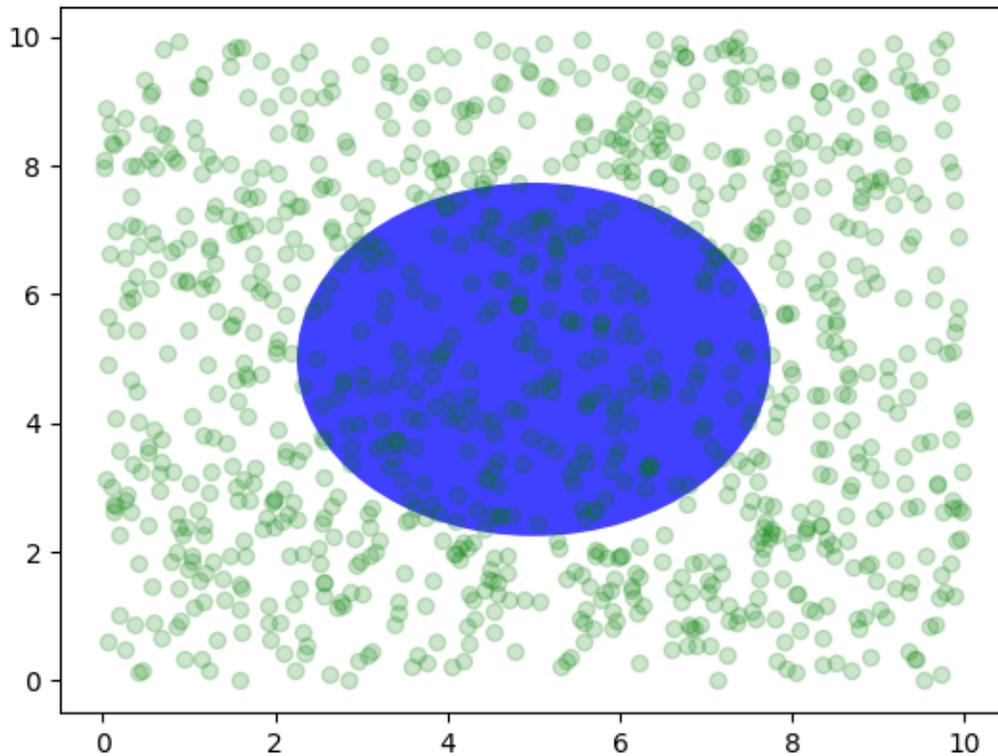
plt.show()
```



You can also make lines or patches in the axes coordinate system, but this is less useful in my experience than using `ax.transAxes` for placing text. Nonetheless, here is a silly example which plots some random dots in data space, and overlays a semi-transparent *Circle* centered in the middle of the axes with a radius one quarter of the axes - if your axes does not preserve aspect ratio (see `set_aspect()`), this will look like an ellipse. Use the pan/zoom tool to move around, or manually change the data xlim and ylim, and you will see the data move, but the circle will remain fixed because it is not in data coordinates and will always remain at the center of the axes.

```
fig, ax = plt.subplots()
x, y = 10*np.random.rand(2, 1000)
ax.plot(x, y, 'go', alpha=0.2) # plot some data in data coordinates

circ = mpatches.Circle((0.5, 0.5), 0.25, transform=ax.transAxes,
                       facecolor='blue', alpha=0.75)
ax.add_patch(circ)
plt.show()
```



### Blended transformations

Drawing in blended coordinate spaces which mix axes with data coordinates is extremely useful, for example to create a horizontal span which highlights some region of the y-data but spans across the x-axis regardless of the data limits, pan or zoom level, etc. In fact these blended lines and spans are so useful, we have built in functions to make them easy to plot (see `axhline()`, `axvline()`, `axhspan()`, `axvspan()`) but for didactic purposes we will implement the horizontal span here using a blended transformation. This trick only works for separable transformations, like you see in normal Cartesian coordinate systems, but not on inseparable transformations like the `PolarTransform`.

```
import matplotlib.transforms as transforms

fig, ax = plt.subplots()
x = np.random.randn(1000)

ax.hist(x, 30)
ax.set_title(r'$\sigma=1 \vee \dots \vee \sigma=2$', fontsize=16)

# the x coords of this transformation are data, and the
# y coord are axes
trans = transforms.blended_transform_factory(
```

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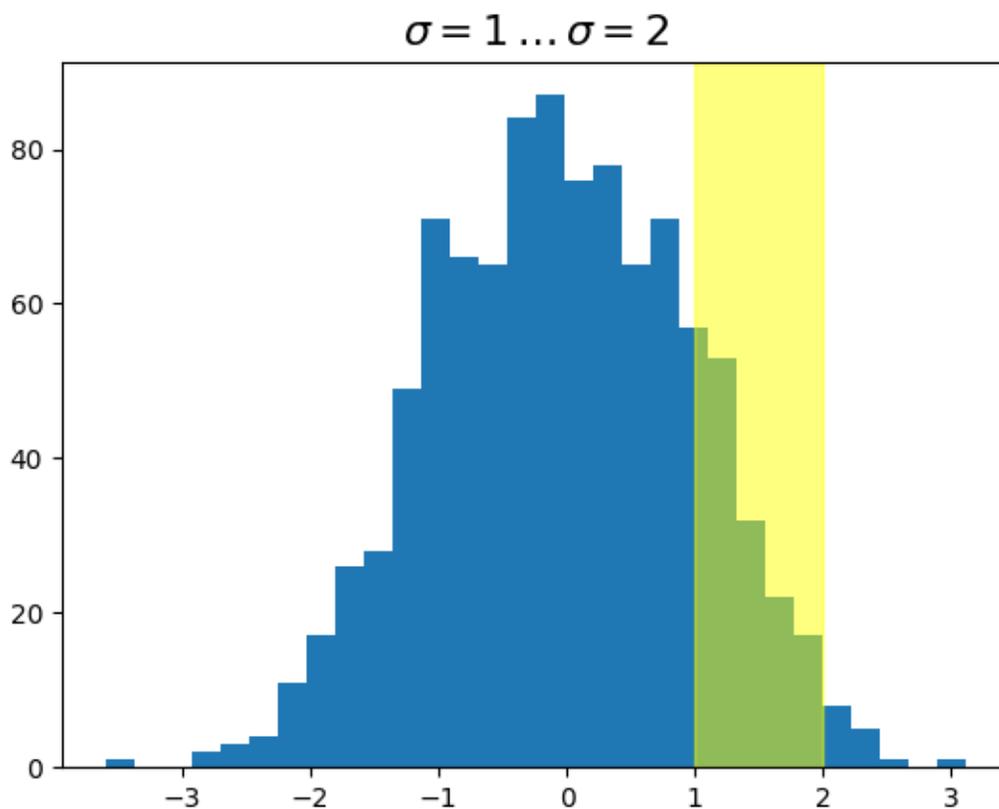
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```
ax.transData, ax.transAxes)

# highlight the 1..2 stddev region with a span.
# We want x to be in data coordinates and y to
# span from 0..1 in axes coords
rect = mpatches.Rectangle((1, 0), width=1, height=1,
                           transform=trans, color='yellow',
                           alpha=0.5)

ax.add_patch(rect)

plt.show()
```



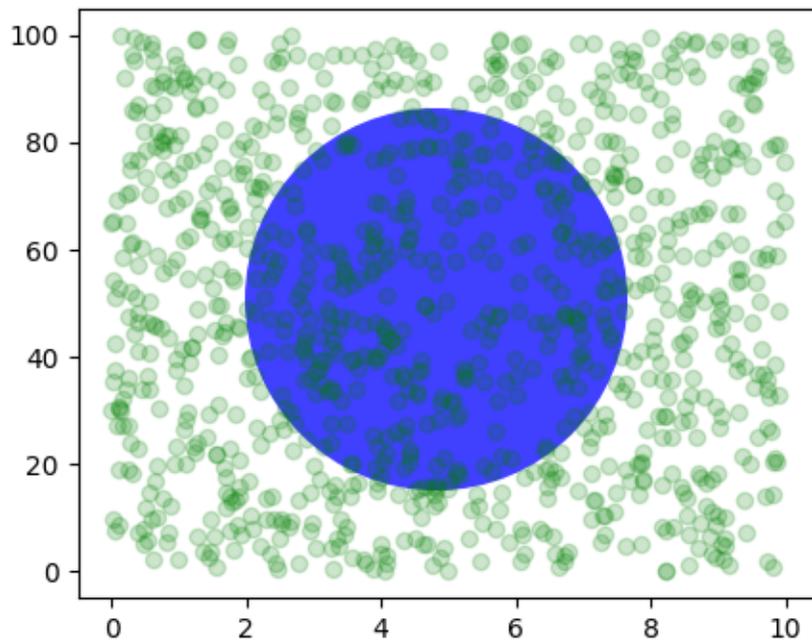
**Note:** The blended transformations where x is in data coords and y in axes coordinates is so useful that we have helper methods to return the versions mpl uses internally for drawing ticks, ticklabels, etc. The methods are `matplotlib.axes.Axes.get_xaxis_transform()` and `matplotlib.axes.Axes.get_yaxis_transform()`. So in the example above, the call to `blended_transform_factory()` can be replaced by `get_xaxis_transform`:

```
trans = ax.get_xaxis_transform()
```

### Plotting in physical units

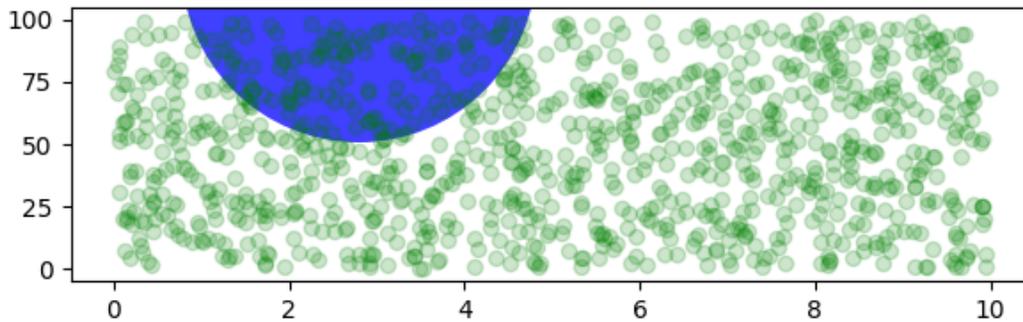
Sometimes we want an object to be a certain physical size on the plot. Here we draw the same circle as above, but in physical units. If done interactively, you can see that changing the size of the figure does not change the offset of the circle from the lower-left corner, does not change its size, and the circle remains a circle regardless of the aspect ratio of the axes.

```
fig, ax = plt.subplots(figsize=(5, 4))
x, y = 10*np.random.rand(2, 1000)
ax.plot(x, y*10., 'go', alpha=0.2) # plot some data in data coordinates
# add a circle in fixed-units
circ = mpatches.Circle((2.5, 2), 1.0, transform=fig.dpi_scale_trans,
                       facecolor='blue', alpha=0.75)
ax.add_patch(circ)
plt.show()
```



If we change the figure size, the circle does not change its absolute position and is cropped.

```
fig, ax = plt.subplots(figsize=(7, 2))
x, y = 10*np.random.rand(2, 1000)
ax.plot(x, y*10., 'go', alpha=0.2) # plot some data in data coordinates
# add a circle in fixed-units
circ = mpatches.Circle((2.5, 2), 1.0, transform=fig.dpi_scale_trans,
                       facecolor='blue', alpha=0.75)
ax.add_patch(circ)
plt.show()
```



Another use is putting a patch with a set physical dimension around a data point on the axes. Here we add together two transforms. The first sets the scaling of how large the ellipse should be and the second sets its position. The ellipse is then placed at the origin, and then we use the helper transform *ScaledTranslation* to move it to the right place in the `ax.transData` coordinate system. This helper is instantiated with:

```
trans = ScaledTranslation(xt, yt, scale_trans)
```

where `xt` and `yt` are the translation offsets, and `scale_trans` is a transformation which scales `xt` and `yt` at transformation time before applying the offsets.

Note the use of the plus operator on the transforms below. This code says: first apply the scale transformation `fig.dpi_scale_trans` to make the ellipse the proper size, but still centered at (0, 0), and then translate the data to `xdata[0]` and `ydata[0]` in data space.

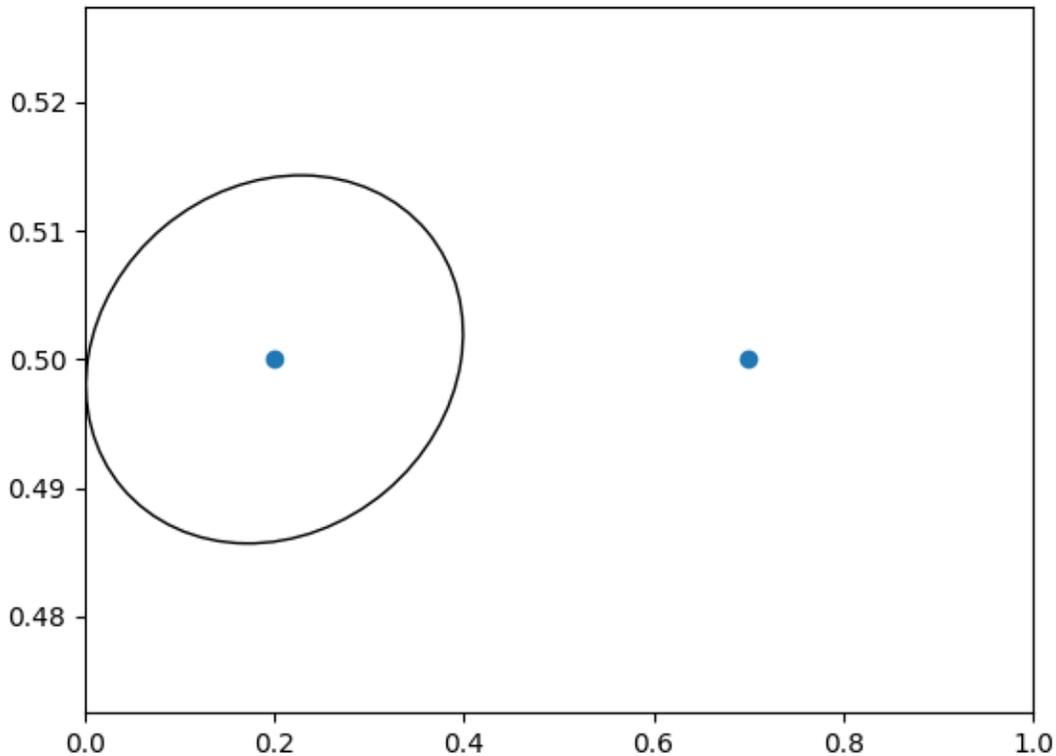
In interactive use, the ellipse stays the same size even if the axes limits are changed via zoom.

```
fig, ax = plt.subplots()
xdata, ydata = (0.2, 0.7), (0.5, 0.5)
ax.plot(xdata, ydata, "o")
ax.set_xlim((0, 1))

trans = (fig.dpi_scale_trans +
        transforms.ScaledTranslation(xdata[0], ydata[0], ax.transData))

# plot an ellipse around the point that is 150 x 130 points in diameter...
circle = mpatches.Ellipse((0, 0), 150/72, 130/72, angle=40,
                          fill=None, transform=trans)

ax.add_patch(circle)
plt.show()
```




---

**Note:** The order of transformation matters. Here the ellipse is given the right dimensions in display space *first* and then moved in data space to the correct spot. If we had done the `ScaledTranslation` first, then `xdata[0]` and `ydata[0]` would first be transformed to display coordinates ([ 358.4 475.2] on a 200-dpi monitor) and then those coordinates would be scaled by `fig.dpi_scale_trans` pushing the center of the ellipse well off the screen (i.e. [ 71680. 95040.]).

---

### Using offset transforms to create a shadow effect

Another use of `ScaledTranslation` is to create a new transformation that is offset from another transformation, e.g., to place one object shifted a bit relative to another object. Typically you want the shift to be in some physical dimension, like points or inches rather than in data coordinates, so that the shift effect is constant at different zoom levels and dpi settings.

One use for an offset is to create a shadow effect, where you draw one object identical to the first just to the right of it, and just below it, adjusting the zorder to make sure the shadow is drawn first and then the object it is shadowing above it.

Here we apply the transforms in the *opposite* order to the use of `ScaledTranslation` above. The plot is first made in data units (`ax.transData`) and then shifted by `dx` and `dy` points using `fig.dpi_scale_trans`. (In typography, a ‘point’ [https://en.wikipedia.org/wiki/Point\\_%28typography%29](https://en.wikipedia.org/wiki/Point_%28typography%29) is 1/72 inches, and by specifying your offsets in points, your figure

will look the same regardless of the dpi resolution it is saved in.)

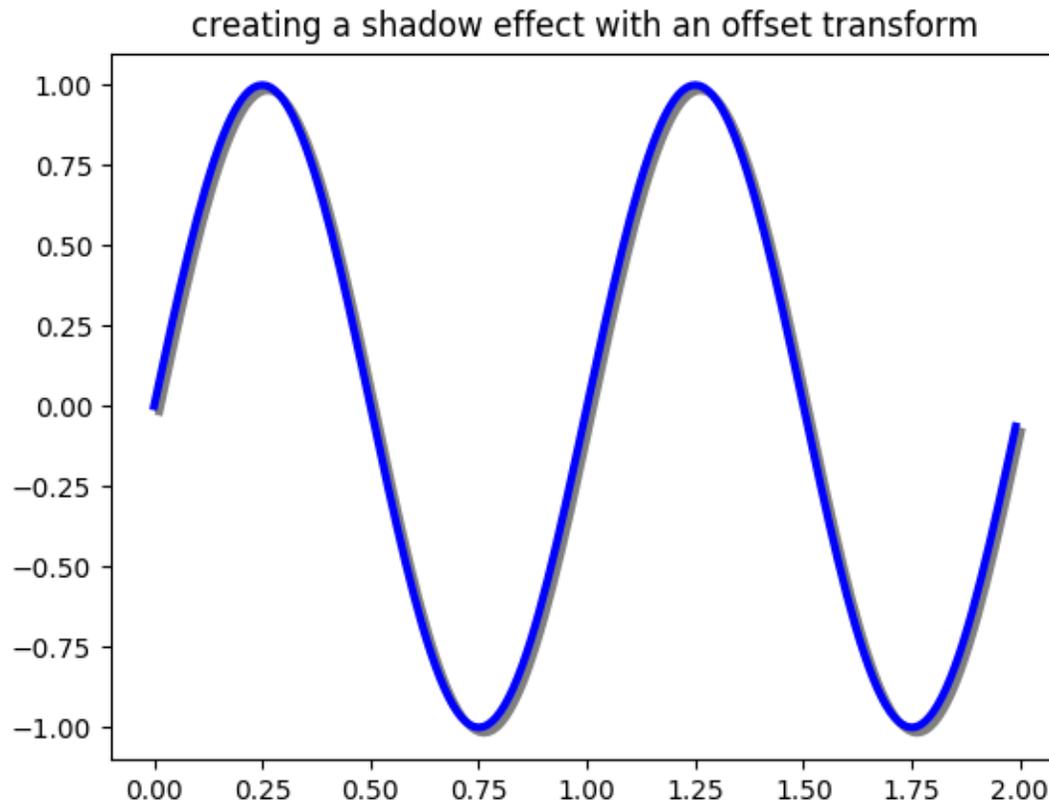
```
fig, ax = plt.subplots()

# make a simple sine wave
x = np.arange(0., 2., 0.01)
y = np.sin(2*np.pi*x)
line, = ax.plot(x, y, lw=3, color='blue')

# shift the object over 2 points, and down 2 points
dx, dy = 2/72., -2/72.
offset = transforms.ScaledTranslation(dx, dy, fig.dpi_scale_trans)
shadow_transform = ax.transData + offset

# now plot the same data with our offset transform;
# use the zorder to make sure we are below the line
ax.plot(x, y, lw=3, color='gray',
        transform=shadow_transform,
        zorder=0.5*line.get_zorder())

ax.set_title('creating a shadow effect with an offset transform')
plt.show()
```



**Note:** The dpi and inches offset is a common-enough use case that we have a special helper

function to create it in `matplotlib.transforms.offset_copy()`, which returns a new transform with an added offset. So above we could have done:

```
shadow_transform = transforms.offset_copy(ax.transData,
    fig=fig, dx, dy, units='inches')
```

### The transformation pipeline

The `ax.transData` transform we have been working with in this tutorial is a composite of three different transformations that comprise the transformation pipeline from data -> display coordinates. Michael Droettboom implemented the transformations framework, taking care to provide a clean API that segregated the nonlinear projections and scales that happen in polar and logarithmic plots, from the linear affine transformations that happen when you pan and zoom. There is an efficiency here, because you can pan and zoom in your axes which affects the affine transformation, but you may not need to compute the potentially expensive nonlinear scales or projections on simple navigation events. It is also possible to multiply affine transformation matrices together, and then apply them to coordinates in one step. This is not true of all possible transformations.

Here is how the `ax.transData` instance is defined in the basic separable axis `Axes` class:

```
self.transData = self.transScale + (self.transLimits + self.transAxes)
```

We've been introduced to the `transAxes` instance above in *Axes coordinates*, which maps the (0, 0), (1, 1) corners of the axes or subplot bounding box to display space, so let's look at these other two pieces.

`self.transLimits` is the transformation that takes you from data to axes coordinates; i.e., it maps your view `xlim` and `ylim` to the unit space of the axes (and `transAxes` then takes that unit space to display space). We can see this in action here

```
In [80]: ax = subplot(111)

In [81]: ax.set_xlim(0, 10)
Out[81]: (0, 10)

In [82]: ax.set_ylim(-1, 1)
Out[82]: (-1, 1)

In [84]: ax.transLimits.transform((0, -1))
Out[84]: array([ 0.,  0.])

In [85]: ax.transLimits.transform((10, -1))
Out[85]: array([ 1.,  0.])

In [86]: ax.transLimits.transform((10, 1))
Out[86]: array([ 1.,  1.])

In [87]: ax.transLimits.transform((5, 0))
Out[87]: array([ 0.5,  0.5])
```

and we can use this same inverted transformation to go from the unit axes coordinates back to data coordinates.

```
In [90]: inv.transform((0.25, 0.25))
Out[90]: array([ 2.5, -0.5])
```

The final piece is the `self.transScale` attribute, which is responsible for the optional non-linear scaling of the data, e.g., for logarithmic axes. When an Axes is initially setup, this is just set to the identity transform, since the basic Matplotlib axes has linear scale, but when you call a logarithmic scaling function like `semilogx()` or explicitly set the scale to logarithmic with `set_xscale()`, then the `ax.transScale` attribute is set to handle the nonlinear projection. The scales transforms are properties of the respective `xaxis` and `yaxis` *Axis* instances. For example, when you call `ax.set_xscale('log')`, the `xaxis` updates its scale to a `matplotlib.scale.LogScale` instance.

For non-separable axes the `PolarAxes`, there is one more piece to consider, the projection transformation. The `transData` `matplotlib.projections.polar.PolarAxes` is similar to that for the typical separable matplotlib Axes, with one additional piece `transProjection`:

```
self.transData = self.transScale + self.transProjection + \
    (self.transProjectionAffine + self.transAxes)
```

`transProjection` handles the projection from the space, e.g., latitude and longitude for map data, or radius and theta for polar data, to a separable Cartesian coordinate system. There are several projection examples in the `matplotlib.projections` package, and the best way to learn more is to open the source for those packages and see how to make your own, since Matplotlib supports extensible axes and projections. Michael Droettboom has provided a nice tutorial example of creating a Hammer projection axes; see `/gallery/misc/custom_projection`.

## 2.4 Colors

Matplotlib has support for visualizing information with a wide array of colors and colormaps. These tutorials cover the basics of how these colormaps look, how you can create your own, and how you can customize colormaps for your use case.

For even more information see the examples page.

---

**Note:** Click [here](#) to download the full example code

---

### 2.4.1 Specifying Colors

Matplotlib recognizes the following formats to specify a color:

- an RGB or RGBA (red, green, blue, alpha) tuple of float values in `[0, 1]` (e.g., `(0.1, 0.2, 0.5)` or `(0.1, 0.2, 0.5, 0.3)`);
- a hex RGB or RGBA string (e.g., `#0f0f0f` or `#0f0f0f80`; case-insensitive);
- a string representation of a float value in `[0, 1]` inclusive for gray level (e.g., `'0.5'`);
- one of `{'b', 'g', 'r', 'c', 'm', 'y', 'k', 'w'}`;
- a X11/CSS4 color name (case-insensitive);
- a name from the [xkcd color survey](#), prefixed with `'xkcd:'` (e.g., `'xkcd:sky blue'`; case insensitive);

- one of the Tableau Colors from the 'T10' categorical palette (the default color cycle): {'tab:blue', 'tab:orange', 'tab:green', 'tab:red', 'tab:purple', 'tab:brown', 'tab:pink', 'tab:gray', 'tab:olive', 'tab:cyan'} (case-insensitive);
- a "CN" color spec, i.e. 'C' followed by a number, which is an index into the default property cycle (`matplotlib.rcParams['axes.prop_cycle']`); the indexing is intended to occur at rendering time, and defaults to black if the cycle does not include color.

"Red", "Green", and "Blue" are the intensities of those colors, the combination of which span the colorspace.

How "Alpha" behaves depends on the zorder of the Artist. Higher zorder Artists are drawn on top of lower Artists, and "Alpha" determines whether the lower artist is covered by the higher. If the old RGB of a pixel is `RGBold` and the RGB of the pixel of the Artist being added is `RGBnew` with Alpha `alpha`, then the RGB of the pixel is updated to:  $RGB = RGBold * (1 - Alpha) + RGBnew * Alpha$ . Alpha of 1 means the old color is completely covered by the new Artist, Alpha of 0 means that pixel of the Artist is transparent.

For more information on colors in matplotlib see

- the `/gallery/color/color_demo` example;
- the `matplotlib.colors` API;
- the `/gallery/color/named_colors` example.

### "CN" color selection

"CN" colors are converted to RGBA as soon as the artist is created. For example,

```
import numpy as np
import matplotlib.pyplot as plt
import matplotlib as mpl

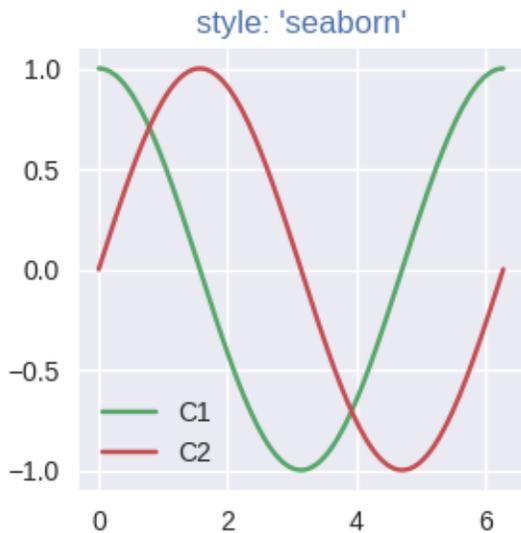
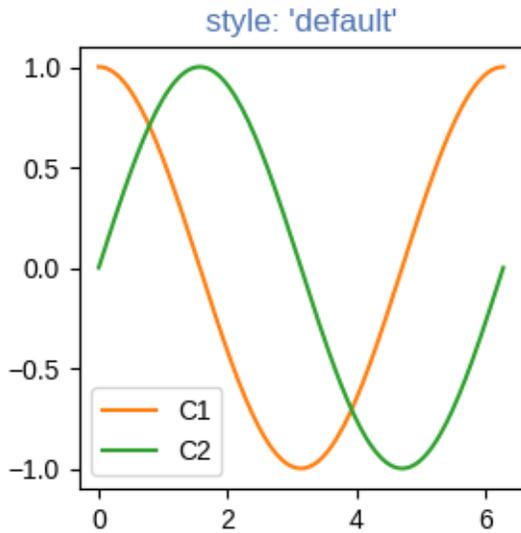
th = np.linspace(0, 2*np.pi, 128)

def demo(sty):
    mpl.style.use(sty)
    fig, ax = plt.subplots(figsize=(3, 3))

    ax.set_title('style: {!r}'.format(sty), color='C0')

    ax.plot(th, np.cos(th), 'C1', label='C1')
    ax.plot(th, np.sin(th), 'C2', label='C2')
    ax.legend()

demo('default')
demo('seaborn')
```



will use the first color for the title and then plot using the second and third colors of each style's `mpl.rcParams['axes.prop_cycle']`.

### xkcd v X11/CSS4

The xkcd colors are derived from a user survey conducted by the webcomic xkcd. [Details of the survey](#) are available on the xkcd blog.

Out of 148 colors in the CSS color list, there are 95 name collisions between the X11/CSS4 names and the xkcd names, all but 3 of which have different hex values. For example 'blue' maps to '#0000FF' where as 'xkcd:blue' maps to '#0343DF'. Due to these name collisions all of the xkcd colors have 'xkcd:' prefixed. As noted in the blog post, while it might be interesting to re-define the X11/CSS4 names based on such a survey, we do not do so unilaterally.

The name collisions are shown in the table below; the color names where the hex values agree are shown in bold.

```
import matplotlib._color_data as mcd
import matplotlib.patches as mpatch

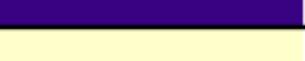
overlap = {name for name in mcd.CSS4_COLORS
           if "xkcd:" + name in mcd.XKCD_COLORS}

fig = plt.figure(figsize=[4.8, 16])
ax = fig.add_axes([0, 0, 1, 1])

for j, n in enumerate(sorted(overlap, reverse=True)):
    weight = None
    cn = mcd.CSS4_COLORS[n]
    xkcd = mcd.XKCD_COLORS["xkcd:" + n].upper()
    if cn == xkcd:
        weight = 'bold'

    r1 = mpatch.Rectangle((0, j), 1, 1, color=cn)
    r2 = mpatch.Rectangle((1, j), 1, 1, color=xkcd)
    txt = ax.text(2, j+.5, ' ' + n, va='center', fontsize=10,
                 weight=weight)
    ax.add_patch(r1)
    ax.add_patch(r2)
    ax.axhline(j, color='k')

ax.text(.5, j + 1.5, 'X11', ha='center', va='center')
ax.text(1.5, j + 1.5, 'xkcd', ha='center', va='center')
ax.set_xlim(0, 3)
ax.set_ylim(0, j + 2)
ax.axis('off')
```

X11	xkcd	
		aqua
		aquamarine
		azure
		beige
		<b>black</b>
		blue
		brown
		chartreuse
		chocolate
		coral
		crimson
		<b>cyan</b>
		darkblue
		darkgreen
		fuchsia
		gold
		goldenrod
		green
		grey
		indigo
		ivory
		khaki
		lavender
		lightblue
		lightgreen
		lime
		magenta
		maroon
		navy
		olive

---

**Note:** Click [here](#) to download the full example code

---

## 2.4.2 Customized Colorbars Tutorial

This tutorial shows how to build colorbars without an attached plot.

### Customized Colorbars

*ColorbarBase* puts a colorbar in a specified axes, and can make a colorbar for a given colormap; it does not need a mappable object like an image. In this tutorial we will explore what can be done with standalone colorbar.

#### Basic continuous colorbar

Set the colormap and norm to correspond to the data for which the colorbar will be used. Then create the colorbar by calling *ColorbarBase* and specify axis, colormap, norm and orientation as parameters. Here we create a basic continuous colorbar with ticks and labels. For more information see the *colorbar* API.

```
import matplotlib.pyplot as plt
import matplotlib as mpl

fig, ax = plt.subplots(figsize=(6, 1))
fig.subplots_adjust(bottom=0.5)

cmap = mpl.cm.cool
norm = mpl.colors.Normalize(vmin=5, vmax=10)

cb1 = mpl.colorbar.ColorbarBase(ax, cmap=cmap,
                               norm=norm,
                               orientation='horizontal')

cb1.set_label('Some Units')
fig.show()
```



#### Discrete intervals colorbar

The second example illustrates the use of a *ListedColormap* which generates a colormap from a set of listed colors, *colors.BoundaryNorm()* which generates a colormap index based on discrete intervals and extended ends to show the "over" and "under" value colors. Over and under

are used to display data outside of the normalized [0,1] range. Here we pass colors as gray shades as a string encoding a float in the 0-1 range.

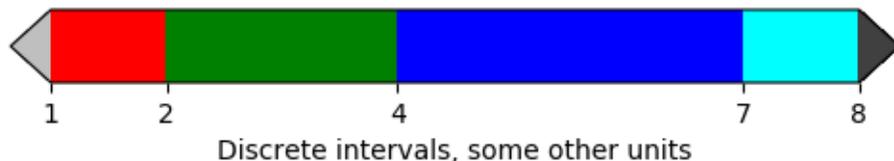
If a *ListedColormap* is used, the length of the bounds array must be one greater than the length of the color list. The bounds must be monotonically increasing.

This time we pass some more arguments in addition to previous arguments to *ColorbarBase*. For the out-of-range values to display on the colorbar, we have to use the *extend* keyword argument. To use *extend*, you must specify two extra boundaries. Finally spacing argument ensures that intervals are shown on colorbar proportionally.

```
fig, ax = plt.subplots(figsize=(6, 1))
fig.subplots_adjust(bottom=0.5)

cmap = mpl.colors.ListedColormap(['red', 'green', 'blue', 'cyan'])
cmap.set_over('0.25')
cmap.set_under('0.75')

bounds = [1, 2, 4, 7, 8]
norm = mpl.colors.BoundaryNorm(bounds, cmap.N)
cb2 = mpl.colorbar.ColorbarBase(ax, cmap=cmap,
                               norm=norm,
                               boundaries=[0] + bounds + [13],
                               extend='both',
                               ticks=bounds,
                               spacing='proportional',
                               orientation='horizontal')
cb2.set_label('Discrete intervals, some other units')
fig.show()
```



### Colorbar with custom extension lengths

Here we illustrate the use of custom length colorbar extensions, used on a colorbar with discrete intervals. To make the length of each extension the same as the length of the interior colors, use *extendfrac='auto'*.

```
fig, ax = plt.subplots(figsize=(6, 1))
fig.subplots_adjust(bottom=0.5)

cmap = mpl.colors.ListedColormap(['royalblue', 'cyan',
                                  'yellow', 'orange'])
cmap.set_over('red')
cmap.set_under('blue')

bounds = [-1.0, -0.5, 0.0, 0.5, 1.0]
norm = mpl.colors.BoundaryNorm(bounds, cmap.N)
```

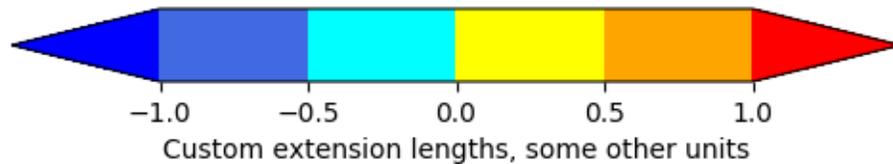
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```

cb3 = mpl.colorbar.ColorbarBase(ax, cmap=cmap,
                                norm=norm,
                                boundaries=[-10] + bounds + [10],
                                extend='both',
                                extendfrac='auto',
                                ticks=bounds,
                                spacing='uniform',
                                orientation='horizontal')
cb3.set_label('Custom extension lengths, some other units')
fig.show()

```



**Note:** Click [here](#) to download the full example code

### 2.4.3 Creating Colormaps in Matplotlib

Matplotlib has a number of built-in colormaps accessible via `matplotlib.cm.get_cmap`. There are also external libraries like `palettable` that have many extra colormaps.

However, we often want to create or manipulate colormaps in Matplotlib. This can be done using the class `ListedColormap` and a  $N \times 4$  numpy array of values between 0 and 1 to represent the RGBA values of the colormap. There is also a `LinearSegmentedColormap` class that allows colormaps to be specified with a few anchor points defining segments, and linearly interpolating between the anchor points.

#### Getting colormaps and accessing their values

First, getting a named colormap, most of which are listed in *Choosing Colormaps in Matplotlib* requires the use of `matplotlib.cm.get_cmap`, which returns a `matplotlib.colors.ListedColormap` object. The second argument gives the size of the list of colors used to define the colormap, and below we use a modest value of 12 so there are not a lot of values to look at.

```

import numpy as np
import matplotlib.pyplot as plt
from matplotlib import cm
from matplotlib.colors import ListedColormap, LinearSegmentedColormap

viridis = cm.get_cmap('viridis', 12)
print(viridis)

```

Out:

```
<matplotlib.colors.ListedColormap object at 0x7f7cb99ced30>
```

The object `viridis` is a callable, that when passed a float between 0 and 1 returns an RGBA value from the colormap:

```
print(viridis(0.56))
```

Out:

```
(0.119512, 0.607464, 0.540218, 1.0)
```

The list of colors that comprise the colormap can be directly accessed using the `colors` property, or it can be accessed indirectly by calling `viridis` with an array of values matching the length of the colormap. Note that the returned list is in the form of an RGBA  $N \times 4$  array, where  $N$  is the length of the colormap.

```
print('viridis.colors', viridis.colors)
print('viridis(range(12))', viridis(range(12)))
print('viridis(np.linspace(0, 1, 12))', viridis(np.linspace(0, 1, 12)))
```

Out:

```
viridis.colors [[0.267004 0.004874 0.329415 1.         ]
 [0.283072 0.130895 0.449241 1.         ]
 [0.262138 0.242286 0.520837 1.         ]
 [0.220057 0.343307 0.549413 1.         ]
 [0.177423 0.437527 0.557565 1.         ]
 [0.143343 0.522773 0.556295 1.         ]
 [0.119512 0.607464 0.540218 1.         ]
 [0.166383 0.690856 0.496502 1.         ]
 [0.319809 0.770914 0.411152 1.         ]
 [0.525776 0.833491 0.288127 1.         ]
 [0.762373 0.876424 0.137064 1.         ]
 [0.993248 0.906157 0.143936 1.         ]]
viridis(range(12)) [[0.267004 0.004874 0.329415 1.         ]
 [0.283072 0.130895 0.449241 1.         ]
 [0.262138 0.242286 0.520837 1.         ]
 [0.220057 0.343307 0.549413 1.         ]
 [0.177423 0.437527 0.557565 1.         ]
 [0.143343 0.522773 0.556295 1.         ]
 [0.119512 0.607464 0.540218 1.         ]
 [0.166383 0.690856 0.496502 1.         ]
 [0.319809 0.770914 0.411152 1.         ]
 [0.525776 0.833491 0.288127 1.         ]
 [0.762373 0.876424 0.137064 1.         ]
 [0.993248 0.906157 0.143936 1.         ]]
viridis(np.linspace(0, 1, 12)) [[0.267004 0.004874 0.329415 1.         ]
 [0.283072 0.130895 0.449241 1.         ]
 [0.262138 0.242286 0.520837 1.         ]
 [0.220057 0.343307 0.549413 1.         ]
 [0.177423 0.437527 0.557565 1.         ]
 [0.143343 0.522773 0.556295 1.         ]
 [0.119512 0.607464 0.540218 1.         ]
 [0.166383 0.690856 0.496502 1.         ]
 [0.319809 0.770914 0.411152 1.         ]
 [0.525776 0.833491 0.288127 1.         ]
```

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```
[0.762373 0.876424 0.137064 1.      ]
[0.993248 0.906157 0.143936 1.      ]]
```

The colormap is a lookup table, so "oversampling" the colormap returns nearest-neighbor interpolation (note the repeated colors in the list below)

```
print('viridis(np.linspace(0, 1, 15))', viridis(np.linspace(0, 1, 15)))
```

Out:

```
viridis(np.linspace(0, 1, 15)) [[0.267004 0.004874 0.329415 1.      ]
 [0.267004 0.004874 0.329415 1.      ]
 [0.283072 0.130895 0.449241 1.      ]
 [0.262138 0.242286 0.520837 1.      ]
 [0.220057 0.343307 0.549413 1.      ]
 [0.177423 0.437527 0.557565 1.      ]
 [0.143343 0.522773 0.556295 1.      ]
 [0.119512 0.607464 0.540218 1.      ]
 [0.119512 0.607464 0.540218 1.      ]
 [0.166383 0.690856 0.496502 1.      ]
 [0.319809 0.770914 0.411152 1.      ]
 [0.525776 0.833491 0.288127 1.      ]
 [0.762373 0.876424 0.137064 1.      ]
 [0.993248 0.906157 0.143936 1.      ]
 [0.993248 0.906157 0.143936 1.      ]]
```

### Creating listed colormaps

This is essentially the inverse operation of the above where we supply a Nx4 numpy array with all values between 0 and 1, to *ListedColormap* to make a new colormap. This means that any numpy operations that we can do on a Nx4 array make carpentry of new colormaps from existing colormaps quite straight forward.

Suppose we want to make the first 25 entries of a 256-length "viridis" colormap pink for some reason:

```
viridis = cm.get_cmap('viridis', 256)
newcolors = viridis(np.linspace(0, 1, 256))
pink = np.array([248/256, 24/256, 148/256, 1])
newcolors[:25, :] = pink
newcmap = ListedColormap(newcolors)

def plot_examples(cms):
    """
    helper function to plot two colormaps
    """
    np.random.seed(19680801)
    data = np.random.randn(30, 30)

    fig, axs = plt.subplots(1, 2, figsize=(6, 3), constrained_layout=True)
```

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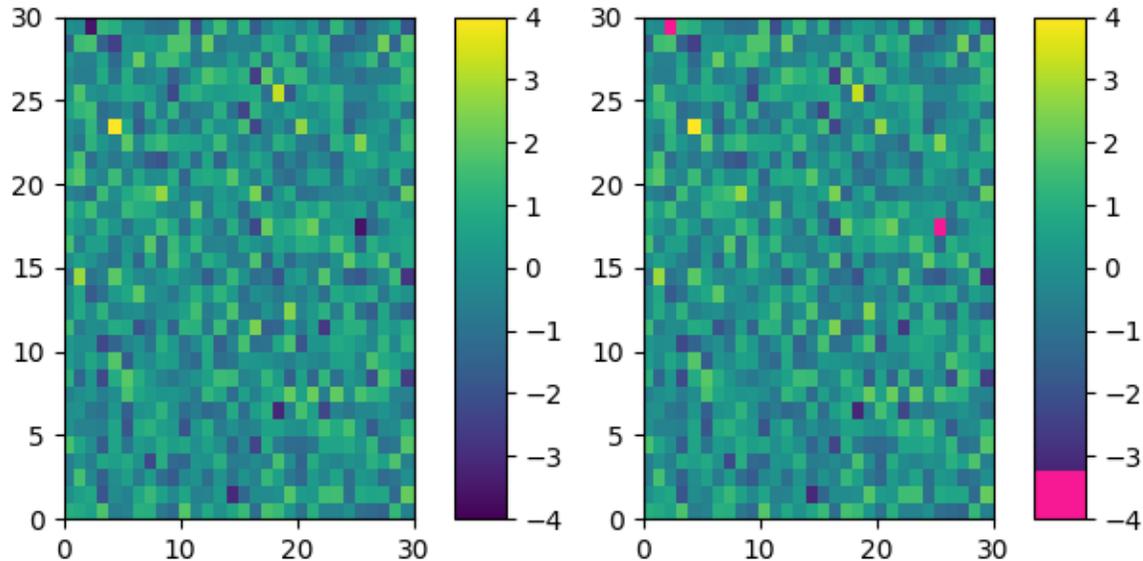
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```

for [ax, cmap] in zip(axes, cms):
    psm = ax.pcolormesh(data, cmap=cmap, rasterized=True, vmin=-4, vmax=4)
    fig.colorbar(psm, ax=ax)
plt.show()

plot_examples([viridis, newcmp])

```

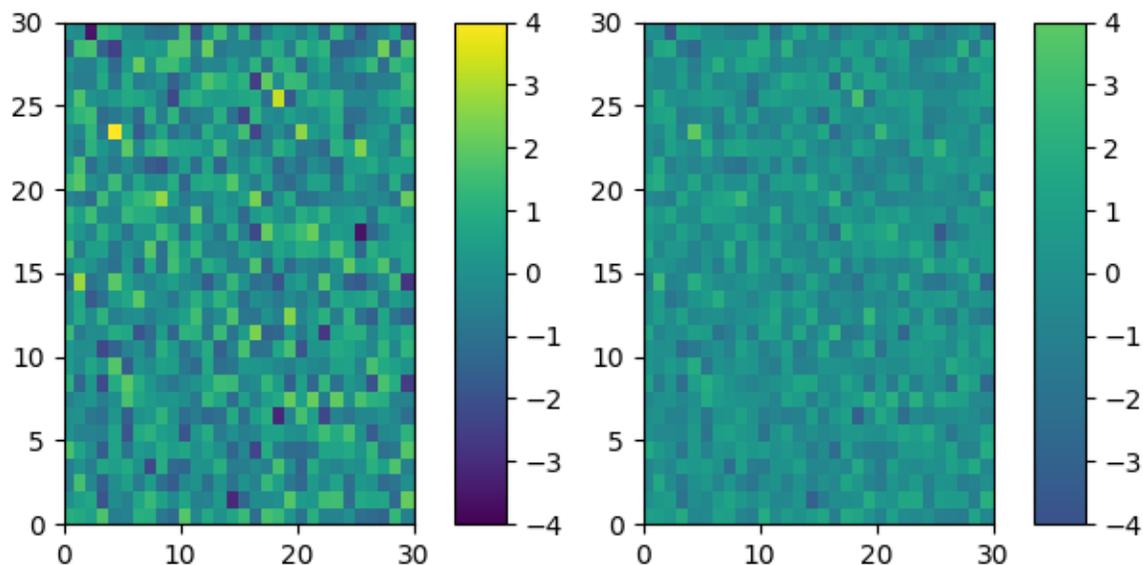


We can easily reduce the dynamic range of a colormap; here we choose the middle 0.5 of the colormap. However, we need to interpolate from a larger colormap, otherwise the new colormap will have repeated values.

```

viridisBig = cm.get_cmap('viridis', 512)
newcmp = ListedColormap(viridisBig(np.linspace(0.25, 0.75, 256)))
plot_examples([viridis, newcmp])

```



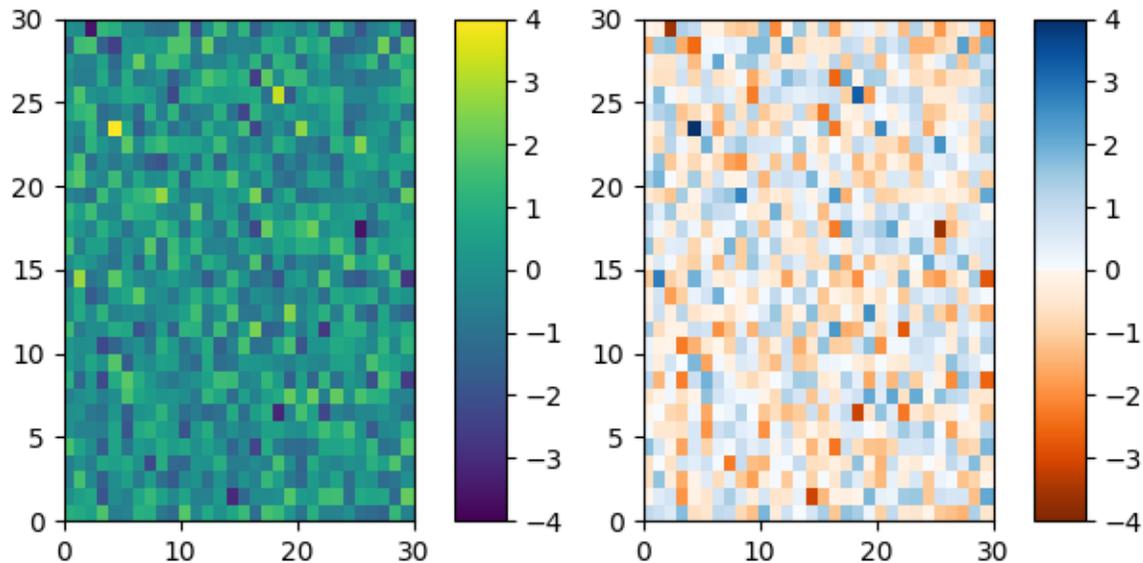
and we can easily concatenate two colormaps:

```

top = cm.get_cmap('Oranges_r', 128)
bottom = cm.get_cmap('Blues', 128)

newcolors = np.vstack((top(np.linspace(0, 1, 128)),
                        bottom(np.linspace(0, 1, 128))))
newcmp = ListedColormap(newcolors, name='OrangeBlue')
plot_examples([viridis, newcmp])

```

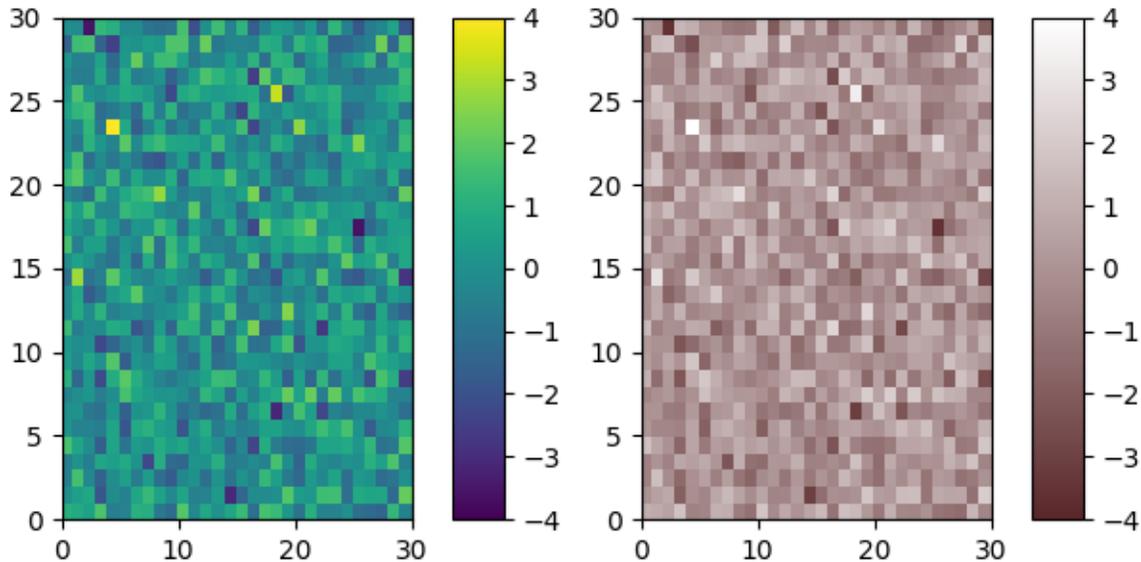


Of course we need not start from a named colormap, we just need to create the  $N \times 4$  array to pass to *ListedColormap*. Here we create a brown colormap that goes to white....

```

N = 256
vals = np.ones((N, 4))
vals[:, 0] = np.linspace(90/256, 1, N)
vals[:, 1] = np.linspace(39/256, 1, N)
vals[:, 2] = np.linspace(41/256, 1, N)
newcmp = ListedColormap(vals)
plot_examples([viridis, newcmp])

```



### Creating linear segmented colormaps

*LinearSegmentedColormap* class specifies colormaps using anchor points between which RGB(A) values are interpolated.

The format to specify these colormaps allows discontinuities at the anchor points. Each anchor point is specified as a row in a matrix of the form  $[x[i] \ yleft[i] \ yright[i]]$ , where  $x[i]$  is the anchor, and  $yleft[i]$  and  $yright[i]$  are the values of the color on either side of the anchor point.

If there are no discontinuities, then  $yleft[i]=yright[i]$ :

```
cdict = {'red':   [[0.0,  0.0,  0.0],
                  [0.5,  1.0,  1.0],
                  [1.0,  1.0,  1.0]],
         'green': [[0.0,  0.0,  0.0],
                  [0.25, 0.0,  0.0],
                  [0.75, 1.0,  1.0],
                  [1.0,  1.0,  1.0]],
         'blue':  [[0.0,  0.0,  0.0],
                  [0.5,  0.0,  0.0],
                  [1.0,  1.0,  1.0]]}

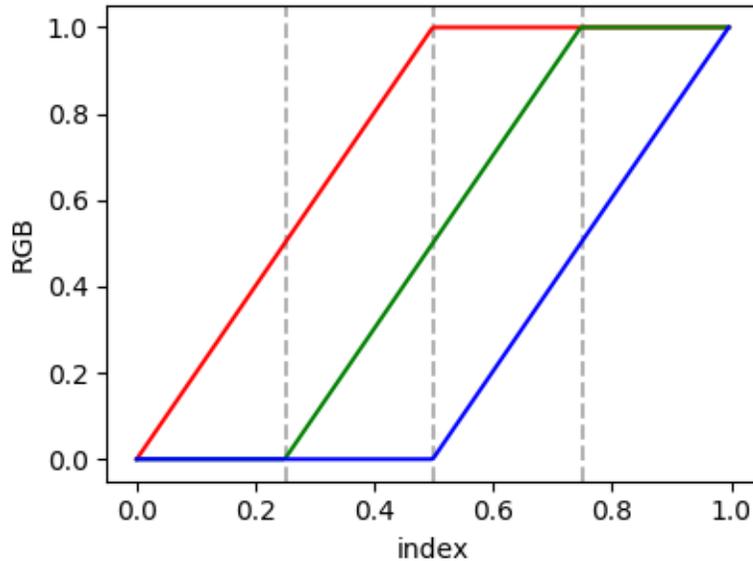
def plot_linearmap(cdict):
    newcmp = LinearSegmentedColormap('testCmap', segmentdata=cdict, N=256)
    rgba = newcmp(np.linspace(0, 1, 256))
    fig, ax = plt.subplots(figsize=(4, 3), constrained_layout=True)
    col = ['r', 'g', 'b']
    for xx in [0.25, 0.5, 0.75]:
        ax.axvline(xx, color='0.7', linestyle='--')
    for i in range(3):
        ax.plot(np.arange(256)/256, rgba[:, i], color=col[i])
    ax.set_xlabel('index')
```

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```
ax.set_ylabel('RGB')
plt.show()

plot_linearmap(cdect)
```



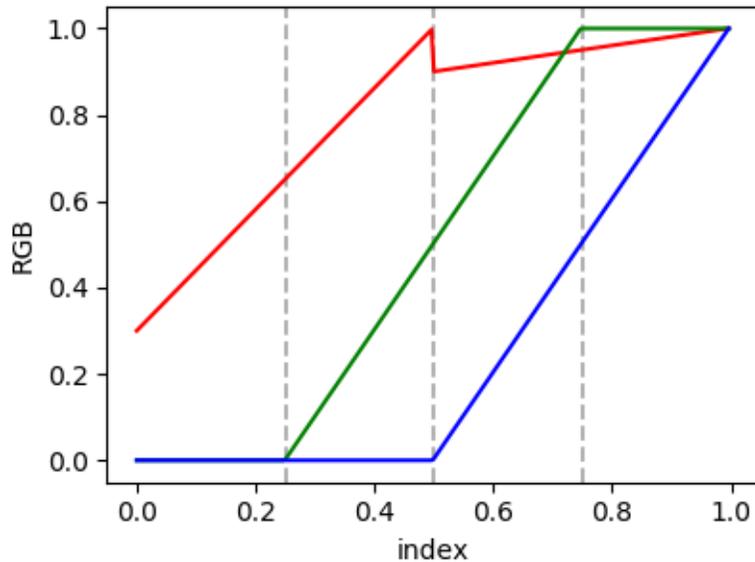
In order to make a discontinuity at an anchor point, the third column is different than the second. The matrix for each of "red", "green", "blue", and optionally "alpha" is set up as:

```
cdict['red'] = [...
                [x[i]      yleft[i]   yright[i]],
                [x[i+1]    yleft[i+1] yright[i+1]],
                ...]
```

and for values passed to the colormap between  $x[i]$  and  $x[i+1]$ , the interpolation is between  $yright[i]$  and  $yleft[i+1]$ .

In the example below there is a discontinuity in red at 0.5. The interpolation between 0 and 0.5 goes from 0.3 to 1, and between 0.5 and 1 it goes from 0.9 to 1. Note that `red[0, 1]`, and `red[2, 2]` are both superfluous to the interpolation because `red[0, 1]` is the value to the left of 0, and `red[2, 2]` is the value to the right of 1.0.

```
cdict['red'] = [[0.0, 0.0, 0.3],
                [0.5, 1.0, 0.9],
                [1.0, 1.0, 1.0]]
plot_linearmap(cdect)
```



## References

The use of the following functions, methods, classes and modules is shown in this example:

```
import matplotlib
matplotlib.axes.Axes.pcolormesh
matplotlib.figure.Figure.colorbar
matplotlib.colors
matplotlib.colors.LinearSegmentedColormap
matplotlib.colors.ListedColormap
matplotlib.cm
matplotlib.cm.get_cmap
```

**Note:** Click [here](#) to download the full example code

## 2.4.4 Colormap Normalization

Objects that use colormaps by default linearly map the colors in the colormap from data values  $vmin$  to  $vmax$ . For example:

```
pcm = ax.pcolormesh(x, y, Z, vmin=-1., vmax=1., cmap='RdBu_r')
```

will map the data in  $Z$  linearly from  $-1$  to  $+1$ , so  $Z=0$  will give a color at the center of the colormap *RdBu\_r* (white in this case).

Matplotlib does this mapping in two steps, with a normalization from  $[0,1]$  occurring first, and then mapping onto the indices in the colormap. Normalizations are classes defined in the `matplotlib.colors()` module. The default, linear normalization is `matplotlib.colors.Normalize()`.

Artists that map data to color pass the arguments `vmin` and `vmax` to construct a `matplotlib.colors.Normalize()` instance, then call it:

```
In [1]: import matplotlib as mpl

In [2]: norm = mpl.colors.Normalize(vmin=-1.,vmax=1.)

In [3]: norm(0.)
Out[3]: 0.5
```

However, there are sometimes cases where it is useful to map data to colormaps in a non-linear fashion.

### Logarithmic

One of the most common transformations is to plot data by taking its logarithm (to the base-10). This transformation is useful to display changes across disparate scales. Using `colors.LogNorm()` normalizes the data via  $\log_{10}$ . In the example below, there are two bumps, one much smaller than the other. Using `colors.LogNorm()`, the shape and location of each bump can clearly be seen:

```
import numpy as np
import matplotlib.pyplot as plt
import matplotlib.colors as colors
import matplotlib.cbook as cbook

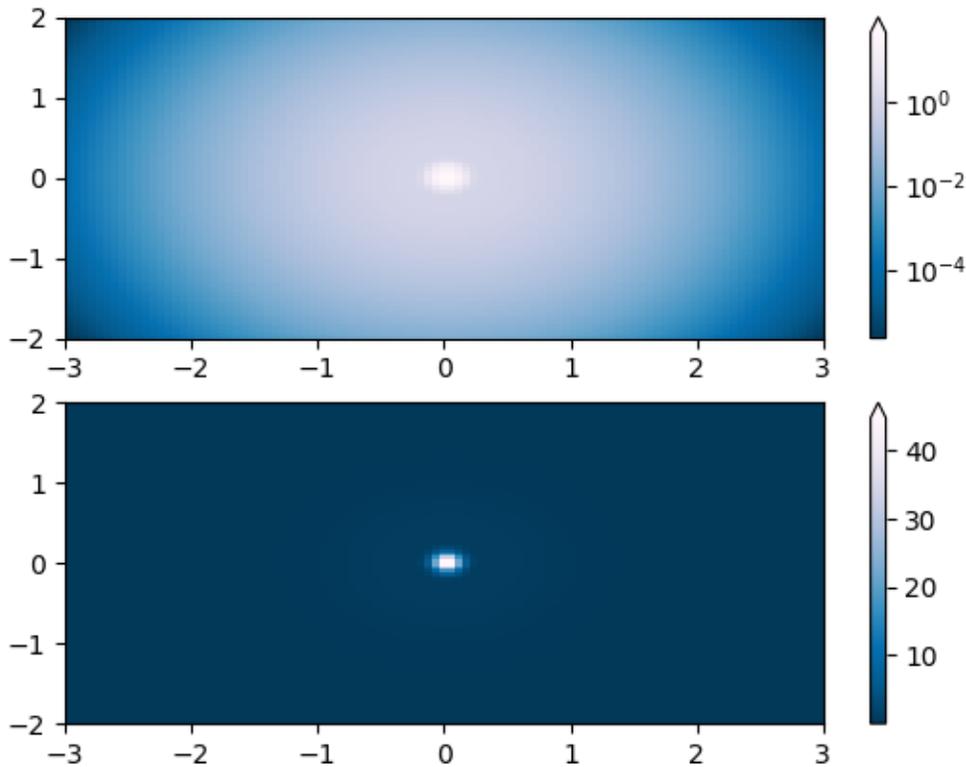
N = 100
X, Y = np.mgrid[-3:3:complex(0, N), -2:2:complex(0, N)]

# A low hump with a spike coming out of the top right. Needs to have
# z/colour axis on a log scale so we see both hump and spike. Linear
# scale only shows the spike.
Z1 = np.exp(-(X)**2 - (Y)**2)
Z2 = np.exp(-(X * 10)**2 - (Y * 10)**2)
Z = Z1 + 50 * Z2

fig, ax = plt.subplots(2, 1)

pcm = ax[0].pcolor(X, Y, Z,
                  norm=colors.LogNorm(vmin=Z.min(), vmax=Z.max()),
                  cmap='PuBu_r')
fig.colorbar(pcm, ax=ax[0], extend='max')

pcm = ax[1].pcolor(X, Y, Z, cmap='PuBu_r')
fig.colorbar(pcm, ax=ax[1], extend='max')
plt.show()
```



### Symmetric logarithmic

Similarly, it sometimes happens that there is data that is positive and negative, but we would still like a logarithmic scaling applied to both. In this case, the negative numbers are also scaled logarithmically, and mapped to smaller numbers; e.g., if `vmin=-vmax`, then they the negative numbers are mapped from 0 to 0.5 and the positive from 0.5 to 1.

Since the logarithm of values close to zero tends toward infinity, a small range around zero needs to be mapped linearly. The parameter `linthresh` allows the user to specify the size of this range (`-linthresh, linthresh`). The size of this range in the colormap is set by `linscale`. When `linscale == 1.0` (the default), the space used for the positive and negative halves of the linear range will be equal to one decade in the logarithmic range.

```
N = 100
X, Y = np.mgrid[-3:3:complex(0, N), -2:2:complex(0, N)]
Z1 = np.exp(-X**2 - Y**2)
Z2 = np.exp(-(X - 1)**2 - (Y - 1)**2)
Z = (Z1 - Z2) * 2

fig, ax = plt.subplots(2, 1)

pcm = ax[0].pcolormesh(X, Y, Z,
                      norm=colors.SymLogNorm(linthresh=0.03, linscale=0.03,
```

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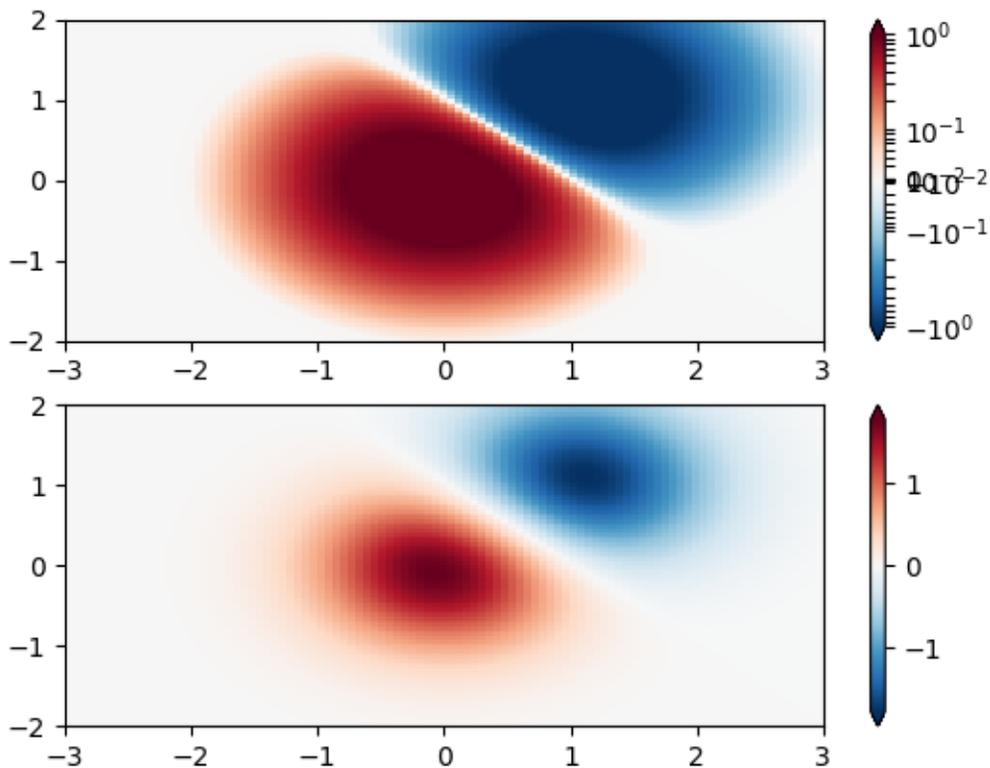
(continued from previous page)

```

                                vmin=-1.0, vmax=1.0),
                                cmap='RdBu_r')
fig.colorbar(pcm, ax=ax[0], extend='both')

pcm = ax[1].pcolormesh(X, Y, Z, cmap='RdBu_r', vmin=-np.max(Z))
fig.colorbar(pcm, ax=ax[1], extend='both')
plt.show()

```



### Power-law

Sometimes it is useful to remap the colors onto a power-law relationship (i.e.  $y = x^\gamma$ , where  $\gamma$  is the power). For this we use the `colors.PowerNorm()`. It takes as an argument *gamma* (*gamma* == 1.0 will just yield the default linear normalization):

---

**Note:** There should probably be a good reason for plotting the data using this type of transformation. Technical viewers are used to linear and logarithmic axes and data transformations. Power laws are less common, and viewers should explicitly be made aware that they have been used.

---

```

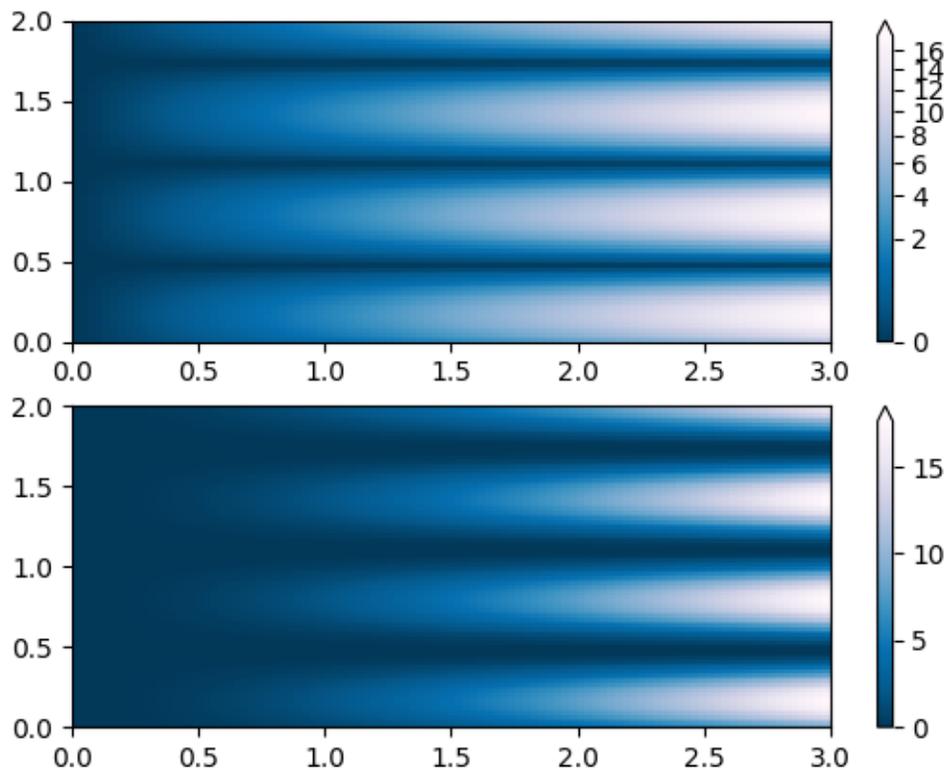
N = 100
X, Y = np.mgrid[0:3:complex(0, N), 0:2:complex(0, N)]
Z1 = (1 + np.sin(Y * 10.)) * X**(2.)

fig, ax = plt.subplots(2, 1)

pcm = ax[0].pcolormesh(X, Y, Z1, norm=colors.PowerNorm(gamma=0.5),
                      cmap='PuBu_r')
fig.colorbar(pcm, ax=ax[0], extend='max')

pcm = ax[1].pcolormesh(X, Y, Z1, cmap='PuBu_r')
fig.colorbar(pcm, ax=ax[1], extend='max')
plt.show()

```



### Discrete bounds

Another normalization that comes with Matplotlib is `colors.BoundaryNorm()`. In addition to *vmin* and *vmax*, this takes as arguments boundaries between which data is to be mapped. The colors are then linearly distributed between these “bounds”. For instance:

```
In [4]: import matplotlib.colors as colors
```

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```
In [5]: bounds = np.array([-0.25, -0.125, 0, 0.5, 1])
In [6]: norm = colors.BoundaryNorm(boundaries=bounds, ncolors=4)
In [7]: print(norm([-0.2,-0.15,-0.02, 0.3, 0.8, 0.99]))
[0 0 1 2 3 3]
```

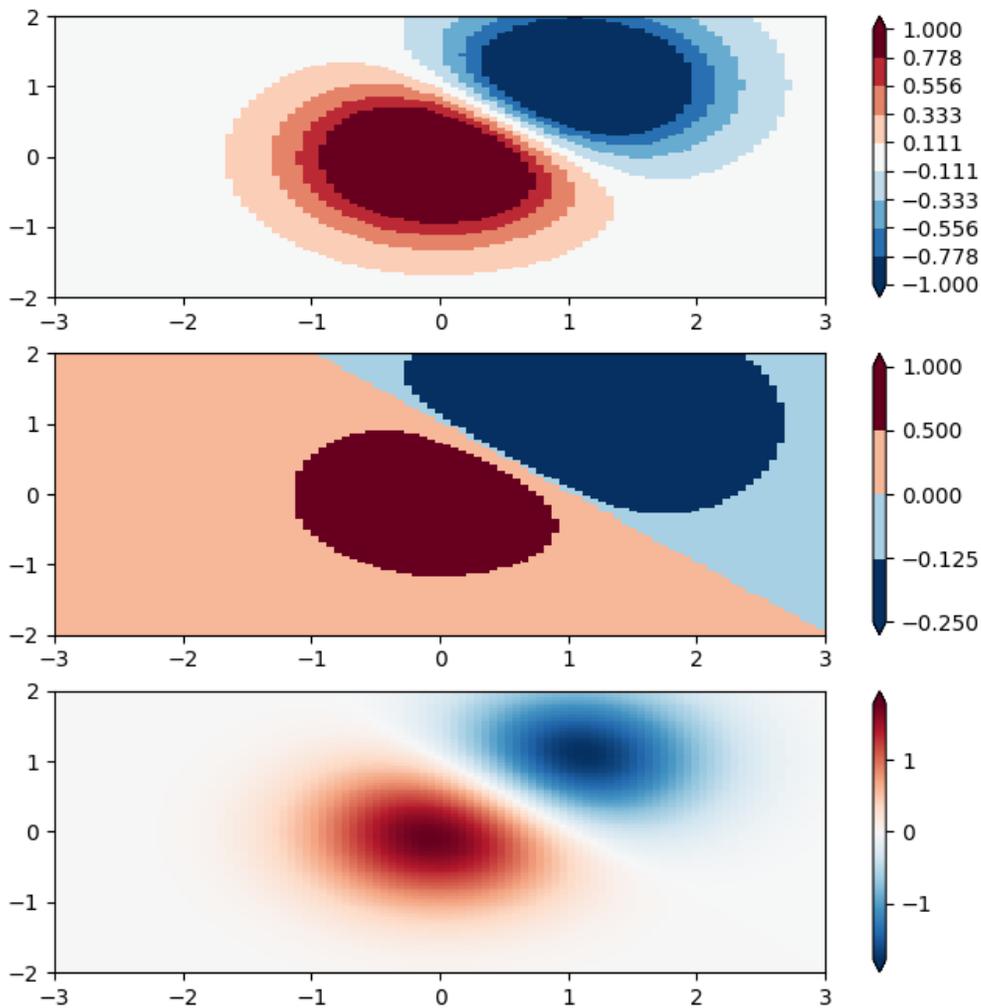
Note unlike the other norms, this norm returns values from 0 to *ncolors*-1.

```
N = 100
X, Y = np.mgrid[-3:3:complex(0, N), -2:2:complex(0, N)]
Z1 = np.exp(-X**2 - Y**2)
Z2 = np.exp(-(X - 1)**2 - (Y - 1)**2)
Z = (Z1 - Z2) * 2

fig, ax = plt.subplots(3, 1, figsize=(8, 8))
ax = ax.flatten()
# even bounds gives a contour-like effect
bounds = np.linspace(-1, 1, 10)
norm = colors.BoundaryNorm(boundaries=bounds, ncolors=256)
pcm = ax[0].pcolormesh(X, Y, Z,
                      norm=norm,
                      cmap='RdBu_r')
fig.colorbar(pcm, ax=ax[0], extend='both', orientation='vertical')

# uneven bounds changes the colormapping:
bounds = np.array([-0.25, -0.125, 0, 0.5, 1])
norm = colors.BoundaryNorm(boundaries=bounds, ncolors=256)
pcm = ax[1].pcolormesh(X, Y, Z, norm=norm, cmap='RdBu_r')
fig.colorbar(pcm, ax=ax[1], extend='both', orientation='vertical')

pcm = ax[2].pcolormesh(X, Y, Z, cmap='RdBu_r', vmin=-np.max(Z))
fig.colorbar(pcm, ax=ax[2], extend='both', orientation='vertical')
plt.show()
```



### DivergingNorm: Different mapping on either side of a center

Sometimes we want to have a different colormap on either side of a conceptual center point, and we want those two colormaps to have different linear scales. An example is a topographic map where the land and ocean have a center at zero, but land typically has a greater elevation range than the water has depth range, and they are often represented by a different colormap.

```
filename = cbook.get_sample_data('topobathy.npz', asfileobj=False)
with np.load(filename) as dem:
    topo = dem['topo']
    longitude = dem['longitude']
    latitude = dem['latitude']
```

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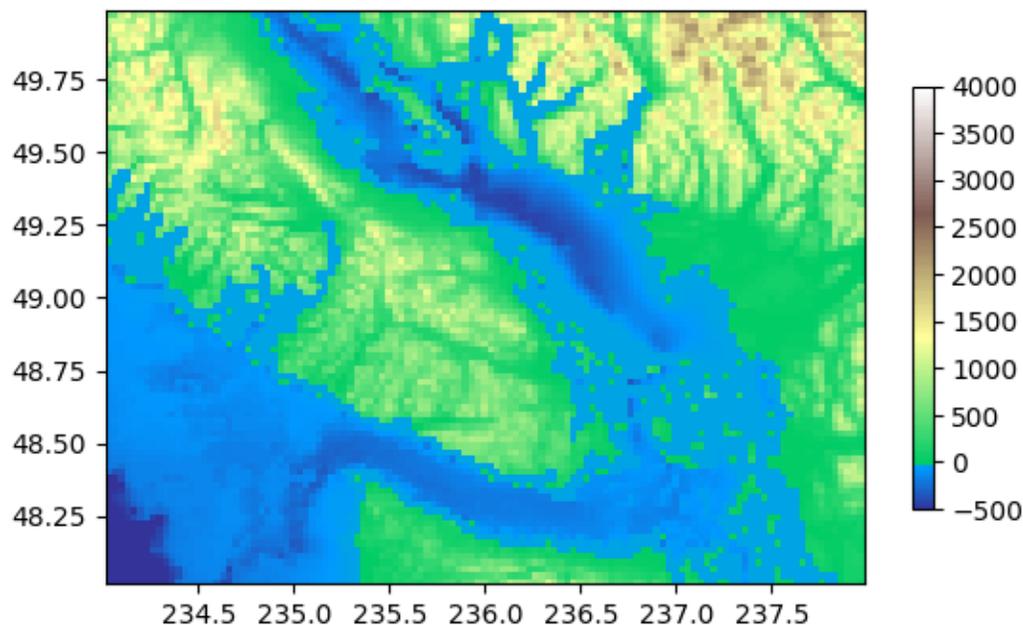
```

fig, ax = plt.subplots()
# make a colormap that has land and ocean clearly delineated and of the
# same length (256 + 256)
colors_undersea = plt.cm.terrain(np.linspace(0, 0.17, 256))
colors_land = plt.cm.terrain(np.linspace(0.25, 1, 256))
all_colors = np.vstack((colors_undersea, colors_land))
terrain_map = colors.LinearSegmentedColormap.from_list('terrain_map',
    all_colors)

# make the norm: Note the center is offset so that the land has more
# dynamic range:
divnorm = colors.DivergingNorm(vmin=-500., vcenter=0, vmax=4000)

pcm = ax.pcolormesh(longitude, latitude, topo, rasterized=True, norm=divnorm,
    cmap=terrain_map,)
# Simple geographic plot, set aspect ratio because distance between lines of
# longitude depends on latitude.
ax.set_aspect(1 / np.cos(np.deg2rad(49)))
fig.colorbar(pcm, shrink=0.6)
plt.show()

```



## Custom normalization: Manually implement two linear ranges

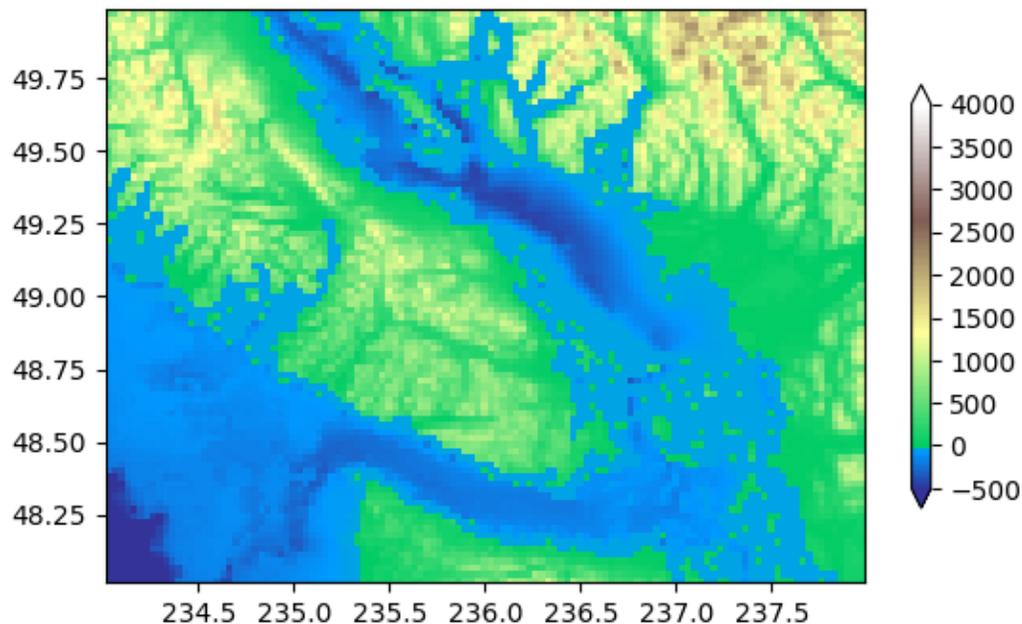
The *DivergingNorm* described above makes a useful example for defining your own norm.

```
class MidpointNormalize(colors.Normalize):
    def __init__(self, vmin=None, vmax=None, vcenter=None, clip=False):
        self.vcenter = vcenter
        colors.Normalize.__init__(self, vmin, vmax, clip)

    def __call__(self, value, clip=None):
        # I'm ignoring masked values and all kinds of edge cases to make a
        # simple example...
        x, y = [self.vmin, self.vcenter, self.vmax], [0, 0.5, 1]
        return np.ma.masked_array(np.interp(value, x, y))

fig, ax = plt.subplots()
midnorm = MidpointNormalize(vmin=-500., vcenter=0, vmax=4000)

pcm = ax.pcolormesh(longitude, latitude, topo, rasterized=True, norm=midnorm,
                    cmap=terrain_map)
ax.set_aspect(1 / np.cos(np.deg2rad(49)))
fig.colorbar(pcm, shrink=0.6, extend='both')
plt.show()
```



---

**Total running time of the script:** ( 0 minutes 1.126 seconds)

---

**Note:** Click [here](#) to download the full example code

---

## 2.4.5 Choosing Colormaps in Matplotlib

Matplotlib has a number of built-in colormaps accessible via `matplotlib.cm.get_cmap`. There are also external libraries like [\[?\]](#) and [\[?\]](#) that have many extra colormaps. Here we briefly discuss how to choose between the many options. For help on creating your own colormaps, see *Creating Colormaps in Matplotlib*.

### Overview

The idea behind choosing a good colormap is to find a good representation in 3D colorspace for your data set. The best colormap for any given data set depends on many things including:

- Whether representing form or metric data ([\[?\]](#))
- Your knowledge of the data set (*e.g.*, is there a critical value from which the other values deviate?)
- If there is an intuitive color scheme for the parameter you are plotting
- If there is a standard in the field the audience may be expecting

For many applications, a perceptually uniform colormap is the best choice — one in which equal steps in data are perceived as equal steps in the color space. Researchers have found that the human brain perceives changes in the lightness parameter as changes in the data much better than, for example, changes in hue. Therefore, colormaps which have monotonically increasing lightness through the colormap will be better interpreted by the viewer. A wonderful example of perceptually uniform colormaps is [\[?\]](#).

Color can be represented in 3D space in various ways. One way to represent color is using CIELAB. In CIELAB, color space is represented by lightness,  $L^*$ ; red-green,  $a^*$ ; and yellow-blue,  $b^*$ . The lightness parameter  $L^*$  can then be used to learn more about how the matplotlib colormaps will be perceived by viewers.

An excellent starting resource for learning about human perception of colormaps is from [\[?\]](#).

### Classes of colormaps

Colormaps are often split into several categories based on their function (see, *e.g.*, [\[?\]](#)):

1. Sequential: change in lightness and often saturation of color incrementally, often using a single hue; should be used for representing information that has ordering.
2. Diverging: change in lightness and possibly saturation of two different colors that meet in the middle at an unsaturated color; should be used when the information being plotted has a critical middle value, such as topography or when the data deviates around zero.
3. Cyclic: change in lightness of two different colors that meet in the middle and beginning/end at an unsaturated color; should be used for values that wrap around at the endpoints, such as phase angle, wind direction, or time of day.

4. Qualitative: often are miscellaneous colors; should be used to represent information which does not have ordering or relationships.

```
# sphinx_gallery_thumbnail_number = 2

import numpy as np
import matplotlib as mpl
import matplotlib.pyplot as plt
from matplotlib import cm
from colorspacious import cspace_converter
from collections import OrderedDict

cmaps = OrderedDict()
```

### Sequential

For the Sequential plots, the lightness value increases monotonically through the colormaps. This is good. Some of the  $L^*$  values in the colormaps span from 0 to 100 (binary and the other grayscale), and others start around  $L^* = 20$ . Those that have a smaller range of  $L^*$  will accordingly have a smaller perceptual range. Note also that the  $L^*$  function varies amongst the colormaps: some are approximately linear in  $L^*$  and others are more curved.

```
cmaps['Perceptually Uniform Sequential'] = [
    'viridis', 'plasma', 'inferno', 'magma', 'cividis']

cmaps['Sequential'] = [
    'Greys', 'Purples', 'Blues', 'Greens', 'Oranges', 'Reds',
    'YlOrBr', 'YlOrRd', 'OrRd', 'PuRd', 'RdPu', 'BuPu',
    'GnBu', 'PuBu', 'YlGnBu', 'PuBuGn', 'BuGn', 'YlGn']
```

### Sequential2

Many of the  $L^*$  values from the Sequential2 plots are monotonically increasing, but some (autumn, cool, spring, and winter) plateau or even go both up and down in  $L^*$  space. Others (afmhot, copper, gist\_heat, and hot) have kinks in the  $L^*$  functions. Data that is being represented in a region of the colormap that is at a plateau or kink will lead to a perception of banding of the data in those values in the colormap (see [?] for an excellent example of this).

```
cmaps['Sequential (2)'] = [
    'binary', 'gist_yarg', 'gist_gray', 'gray', 'bone', 'pink',
    'spring', 'summer', 'autumn', 'winter', 'cool', 'Wistia',
    'hot', 'afmhot', 'gist_heat', 'copper']
```

### Diverging

For the Diverging maps, we want to have monotonically increasing  $L^*$  values up to a maximum, which should be close to  $L^* = 100$ , followed by monotonically decreasing  $L^*$  values. We are looking for approximately equal minimum  $L^*$  values at opposite ends of the colormap. By these measures, BrBG and RdBu are good options. coolwarm is a good option, but it doesn't span a wide range of  $L^*$  values (see grayscale section below).

```
cmaps['Diverging'] = [
    'PiYG', 'PRGn', 'BrBG', 'PuOr', 'RdGy', 'RdBu',
    'RdYlBu', 'RdYlGn', 'Spectral', 'coolwarm', 'bwr', 'seismic']
```

### Cyclic

For Cyclic maps, we want to start and end on the same color, and meet a symmetric center point in the middle.  $L^*$  should change monotonically from start to middle, and inversely from middle to end. It should be symmetric on the increasing and decreasing side, and only differ in hue. At the ends and middle,  $L^*$  will reverse direction, which should be smoothed in  $L^*$  space to reduce artifacts. See [?] for more information on the design of cyclic maps.

The often-used HSV colormap is included in this set of colormaps, although it is not symmetric to a center point. Additionally, the  $L^*$  values vary widely throughout the colormap, making it a poor choice for representing data for viewers to see perceptually. See an extension on this idea at [?].

```
cmaps['Cyclic'] = ['twilight', 'twilight_shifted', 'hsv']
```

### Qualitative

Qualitative colormaps are not aimed at being perceptual maps, but looking at the lightness parameter can verify that for us. The  $L^*$  values move all over the place throughout the colormap, and are clearly not monotonically increasing. These would not be good options for use as perceptual colormaps.

```
cmaps['Qualitative'] = ['Pastel1', 'Pastel2', 'Paired', 'Accent',
    'Dark2', 'Set1', 'Set2', 'Set3',
    'tab10', 'tab20', 'tab20b', 'tab20c']
```

### Miscellaneous

Some of the miscellaneous colormaps have particular uses for which they have been created. For example, `gist_earth`, `ocean`, and `terrain` all seem to be created for plotting topography (green/brown) and water depths (blue) together. We would expect to see a divergence in these colormaps, then, but multiple kinks may not be ideal, such as in `gist_earth` and `terrain`. `CMRmap` was created to convert well to grayscale, though it does appear to have some small kinks in  $L^*$ . `cubehelix` was created to vary smoothly in both lightness and hue, but appears to have a small hump in the green hue area.

The often-used `jet` colormap is included in this set of colormaps. We can see that the  $L^*$  values vary widely throughout the colormap, making it a poor choice for representing data for viewers to see perceptually. See an extension on this idea at [?].

```
cmaps['Miscellaneous'] = [
    'flag', 'prism', 'ocean', 'gist_earth', 'terrain', 'gist_stern',
    'gnuplot', 'gnuplot2', 'CMRmap', 'cubehelix', 'brg',
    'gist_rainbow', 'rainbow', 'jet', 'nipy_spectral', 'gist_ncar']
```

First, we'll show the range of each colormap. Note that some seem to change more "quickly" than others.

```
nrows = max(len(cmap_list) for cmap_category, cmap_list in cmaps.items())
gradient = np.linspace(0, 1, 256)
gradient = np.vstack((gradient, gradient))

def plot_color_gradients(cmap_category, cmap_list, nrows):
    fig, axes = plt.subplots(nrows=nrows)
    fig.subplots_adjust(top=0.95, bottom=0.01, left=0.2, right=0.99)
    axes[0].set_title(cmap_category + ' colormaps', fontsize=14)

    for ax, name in zip(axes, cmap_list):
        ax.imshow(gradient, aspect='auto', cmap=plt.get_cmap(name))
        pos = list(ax.get_position().bounds)
        x_text = pos[0] - 0.01
        y_text = pos[1] + pos[3]/2.
        fig.text(x_text, y_text, name, va='center', ha='right', fontsize=10)

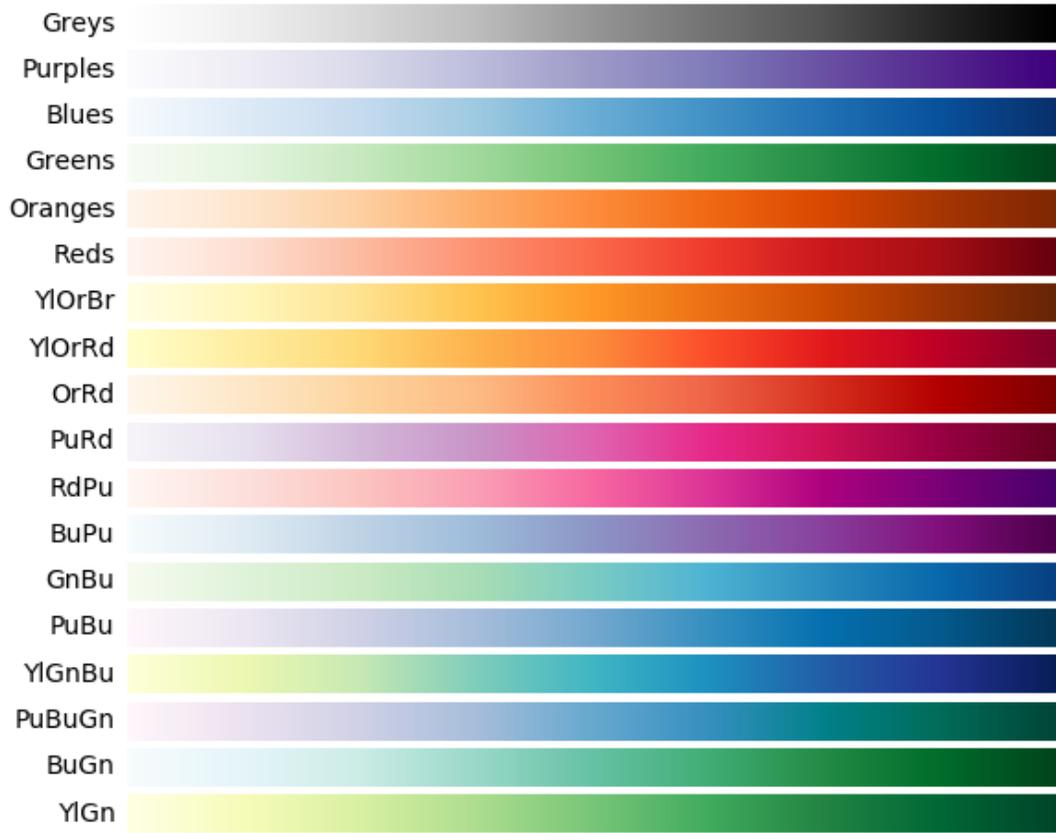
    # Turn off all ticks & spines, not just the ones with colormaps.
    for ax in axes:
        ax.set_axis_off()

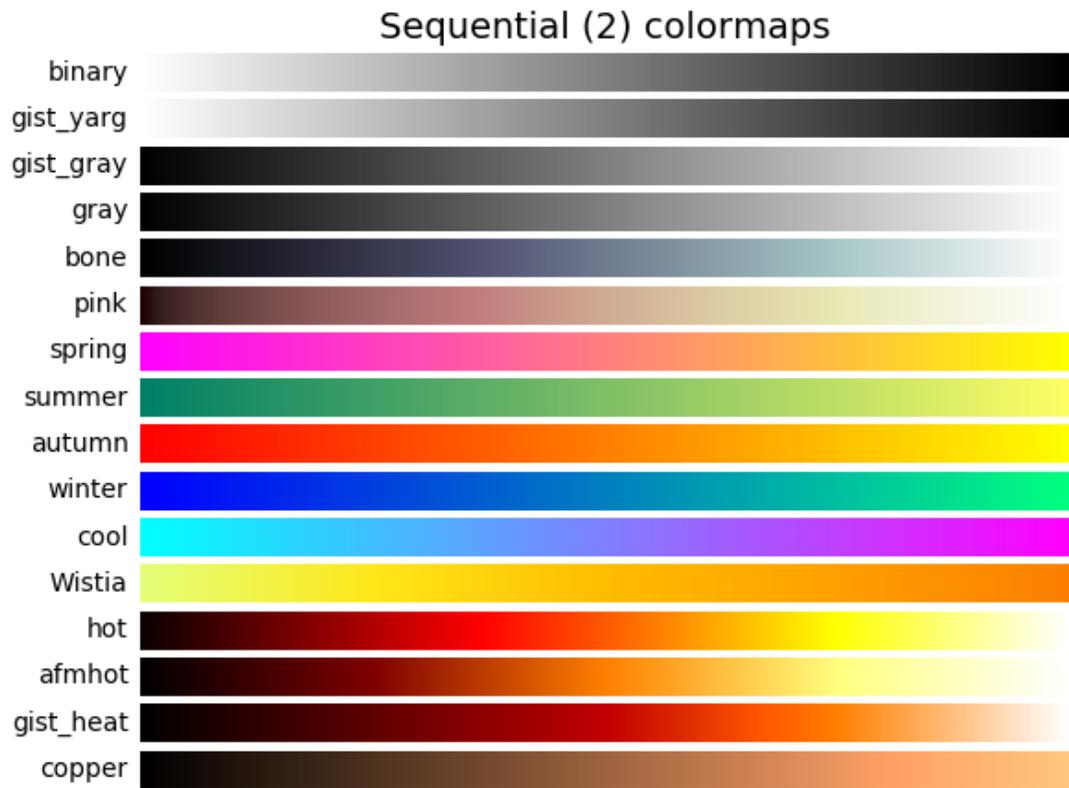
for cmap_category, cmap_list in cmaps.items():
    plot_color_gradients(cmap_category, cmap_list, nrows)

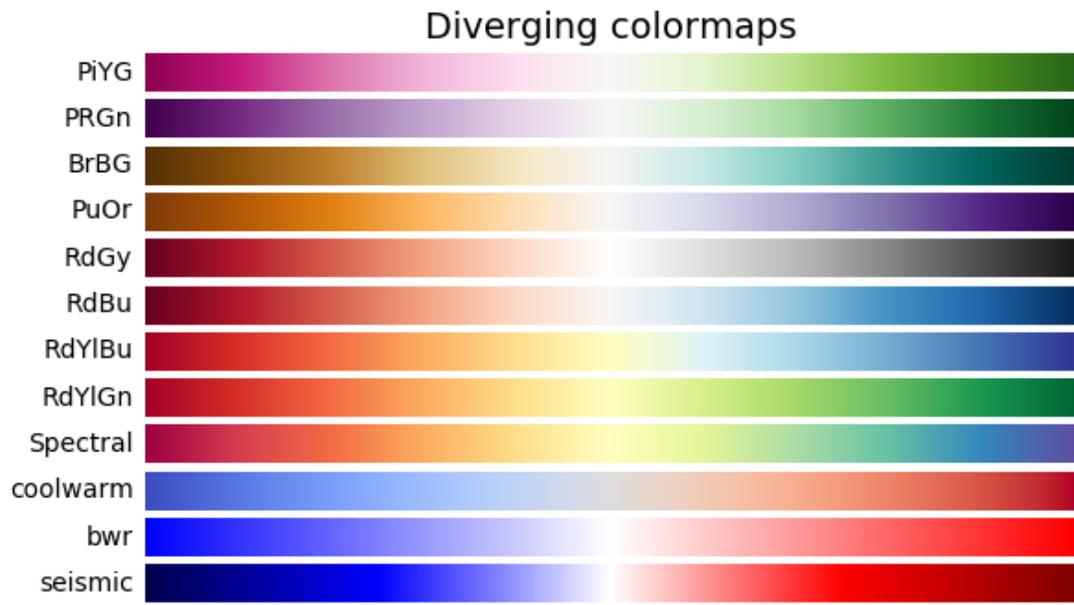
plt.show()
```

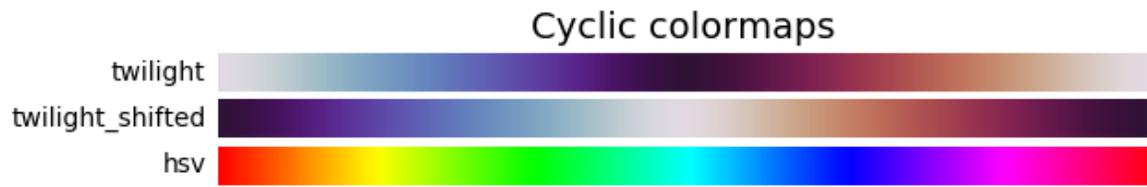


### Sequential colormaps

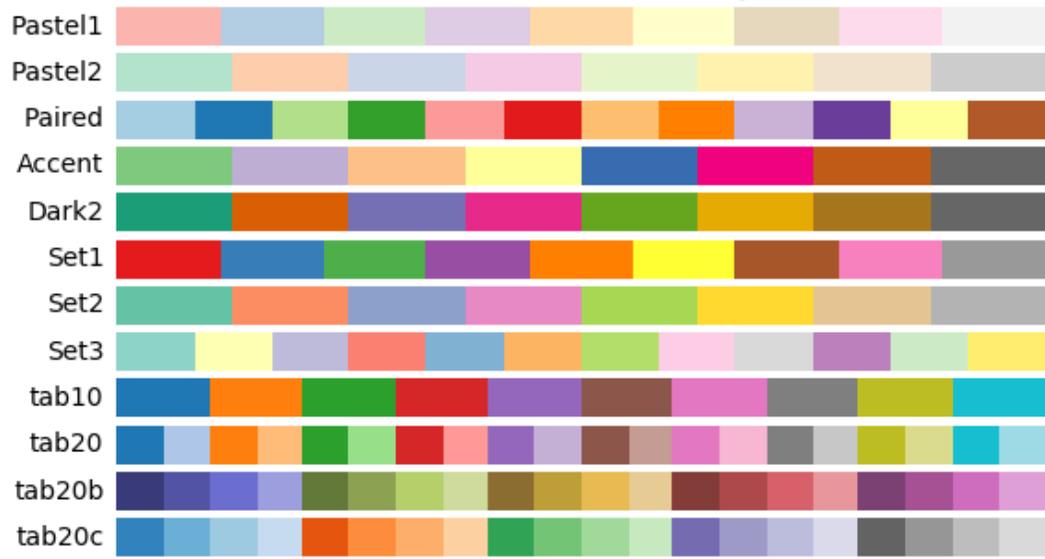


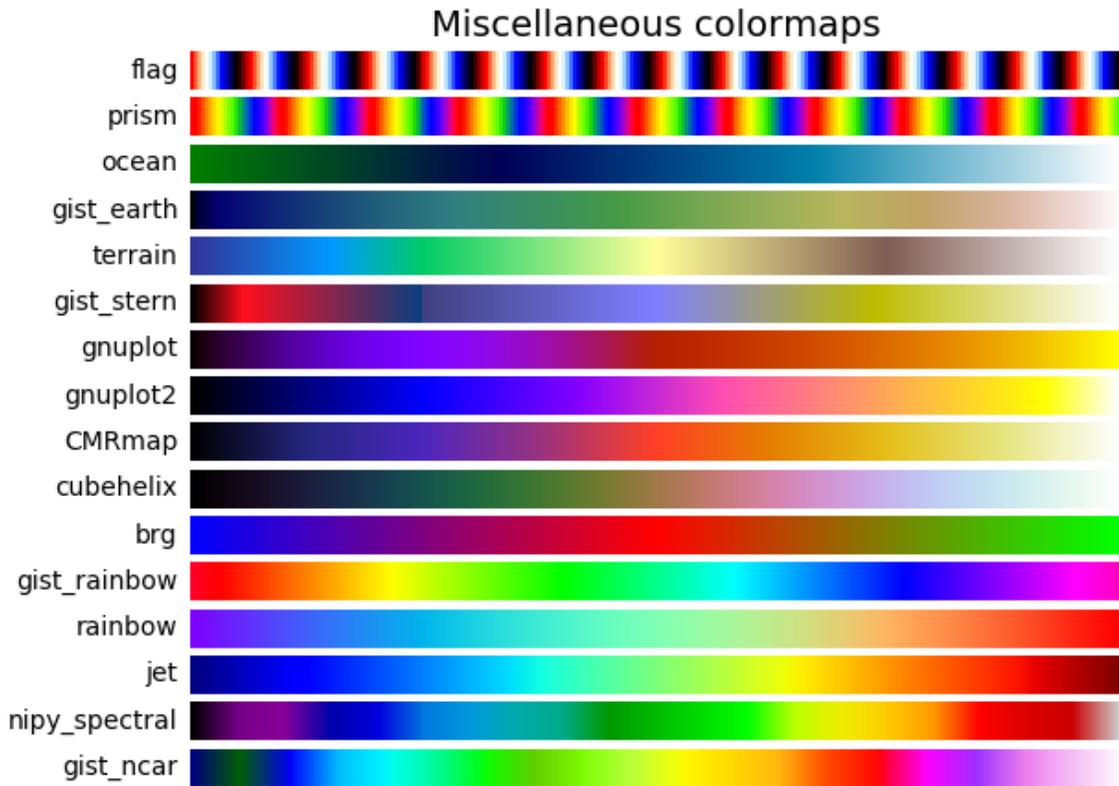






### Qualitative colormaps





•

### Lightness of matplotlib colormaps

Here we examine the lightness values of the matplotlib colormaps. Note that some documentation on the colormaps is available ([?]).

```
mpl.rcParams.update({'font.size': 12})

# Number of colormap per subplot for particular cmap categories
_DSUBS = {'Perceptually Uniform Sequential': 5, 'Sequential': 6,
         'Sequential (2)': 6, 'Diverging': 6, 'Cyclic': 3,
         'Qualitative': 4, 'Miscellaneous': 6}

# Spacing between the colormaps of a subplot
_DC = {'Perceptually Uniform Sequential': 1.4, 'Sequential': 0.7,
      'Sequential (2)': 1.4, 'Diverging': 1.4, 'Cyclic': 1.4,
      'Qualitative': 1.4, 'Miscellaneous': 1.4}

# Indices to step through colormap
x = np.linspace(0.0, 1.0, 100)

# Do plot
for cmap_category, cmap_list in cmaps.items():
```

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```

# Do subplots so that colormaps have enough space.
# Default is 6 colormaps per subplot.
dsub = _DSUBS.get(cmap_category, 6)
nsubplots = int(np.ceil(len(cmap_list) / dsub))

# squeeze=False to handle similarly the case of a single subplot
fig, axes = plt.subplots(nrows=nsubplots, squeeze=False,
                        figsize=(7, 2.6*nsubplots))

for i, ax in enumerate(axes.flat):

    locs = [] # locations for text labels

    for j, cmap in enumerate(cmap_list[i*dsub:(i+1)*dsub]):

        # Get RGB values for colormap and convert the colormap in
        # CAMO2-UCS colorspace. lab[0, :, 0] is the lightness.
        rgb = cm.get_cmap(cmap)(x)[np.newaxis, :, :3]
        lab = cspace_converter("sRGB1", "CAMO2-UCS")(rgb)

        # Plot colormap L values. Do separately for each category
        # so each plot can be pretty. To make scatter markers change
        # color along plot:
        # http://stackoverflow.com/questions/8202605/

        if cmap_category == 'Sequential':
            # These colormaps all start at high lightness but we want them
            # reversed to look nice in the plot, so reverse the order.
            y_ = lab[0, ::-1, 0]
            c_ = x[::-1]
        else:
            y_ = lab[0, :, 0]
            c_ = x

        dc = _DC.get(cmap_category, 1.4) # cmaps horizontal spacing
        ax.scatter(x + j*dc, y_, c=c_, cmap=cmap, s=300, linewidths=0.0)

        # Store locations for colormap labels
        if cmap_category in ('Perceptually Uniform Sequential',
                            'Sequential'):
            locs.append(x[-1] + j*dc)
        elif cmap_category in ('Diverging', 'Qualitative', 'Cyclic',
                               'Miscellaneous', 'Sequential (2)'):
            locs.append(x[int(x.size/2.)] + j*dc)

    # Set up the axis limits:
    # * the 1st subplot is used as a reference for the x-axis limits
    # * lightness values goes from 0 to 100 (y-axis limits)
    ax.set_xlim(axes[0, 0].get_xlim())
    ax.set_ylim(0.0, 100.0)

    # Set up labels for colormaps

```

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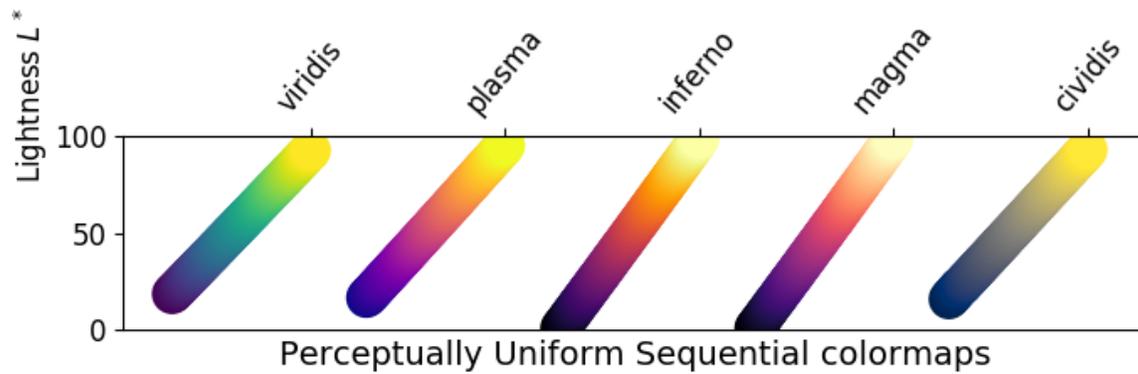
```

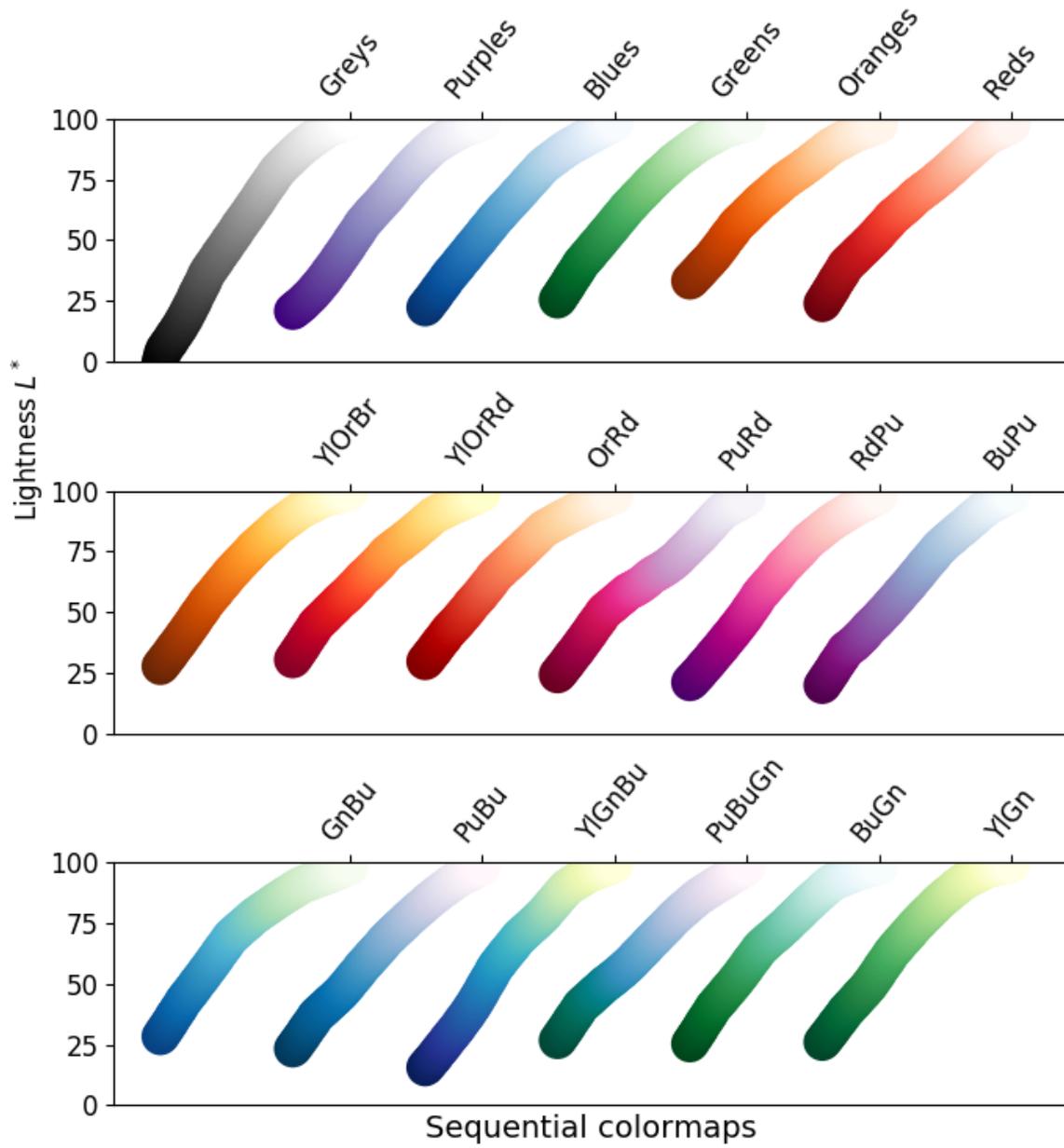
ax.xaxis.set_ticks_position('top')
ticker = mpl.ticker.FixedLocator(locs)
ax.xaxis.set_major_locator(ticker)
formatter = mpl.ticker.FixedFormatter(cmap_list[i*dsub:(i+1)*dsub])
ax.xaxis.set_major_formatter(formatter)
ax.xaxis.set_tick_params(rotation=50)

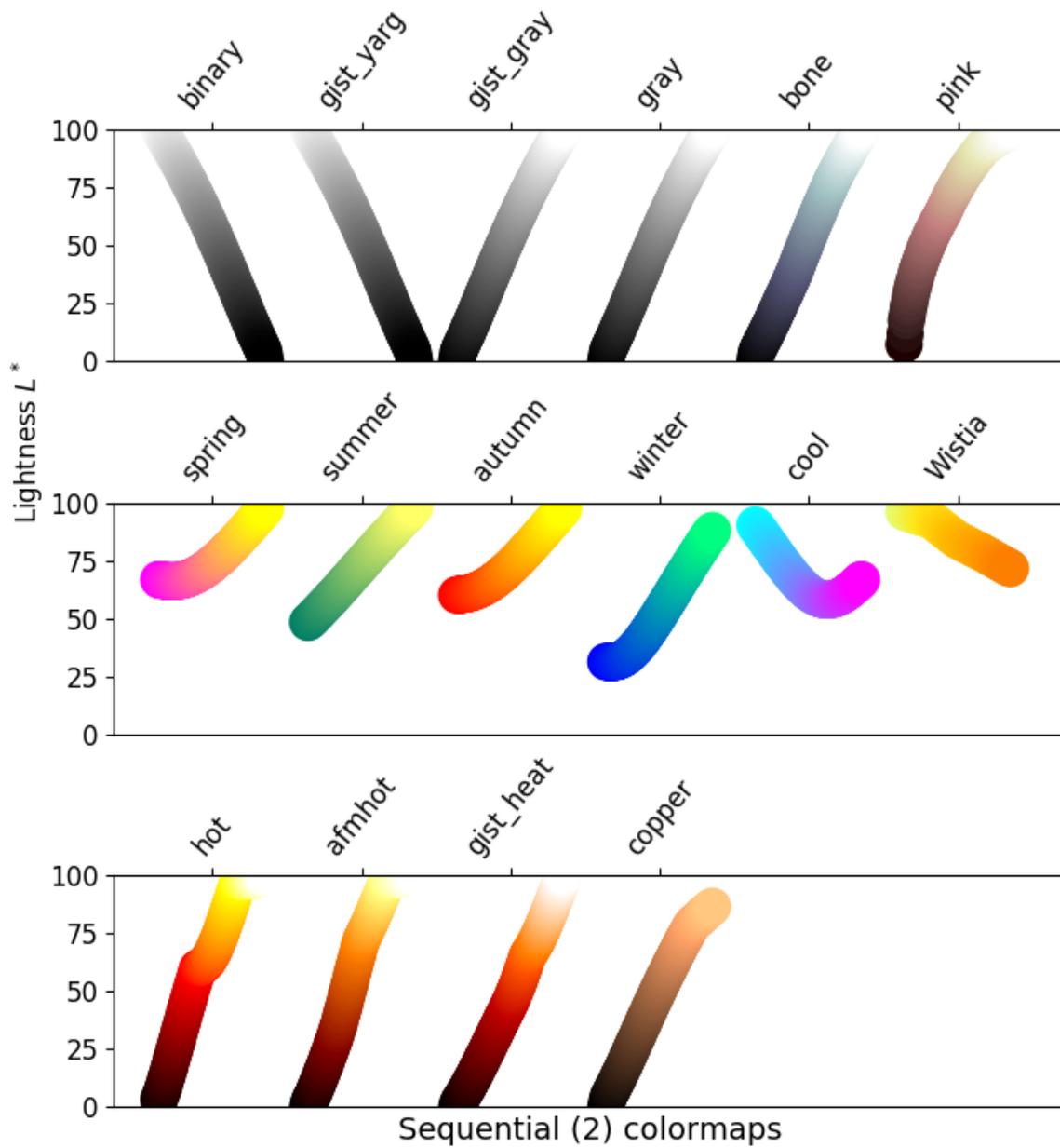
ax.set_xlabel(cmap_category + ' colormaps', fontsize=14)
fig.text(0.0, 0.55, 'Lightness  $L^*$ ', fontsize=12,
        transform=fig.transFigure, rotation=90)

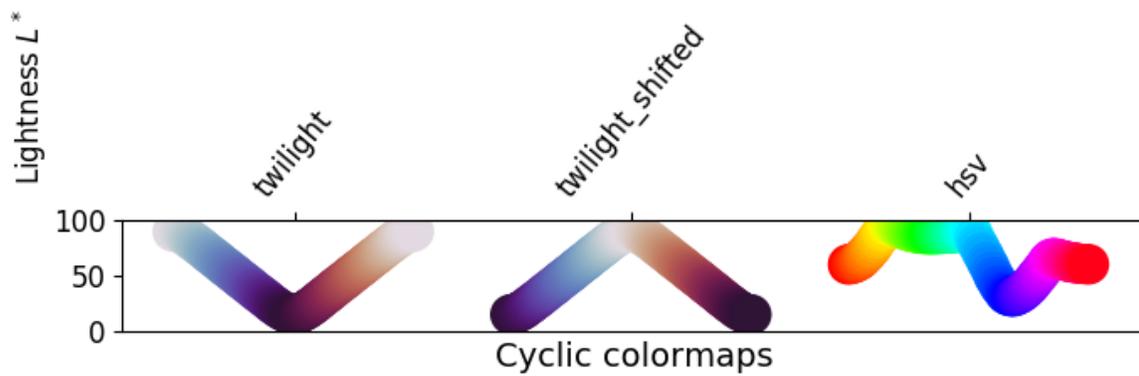
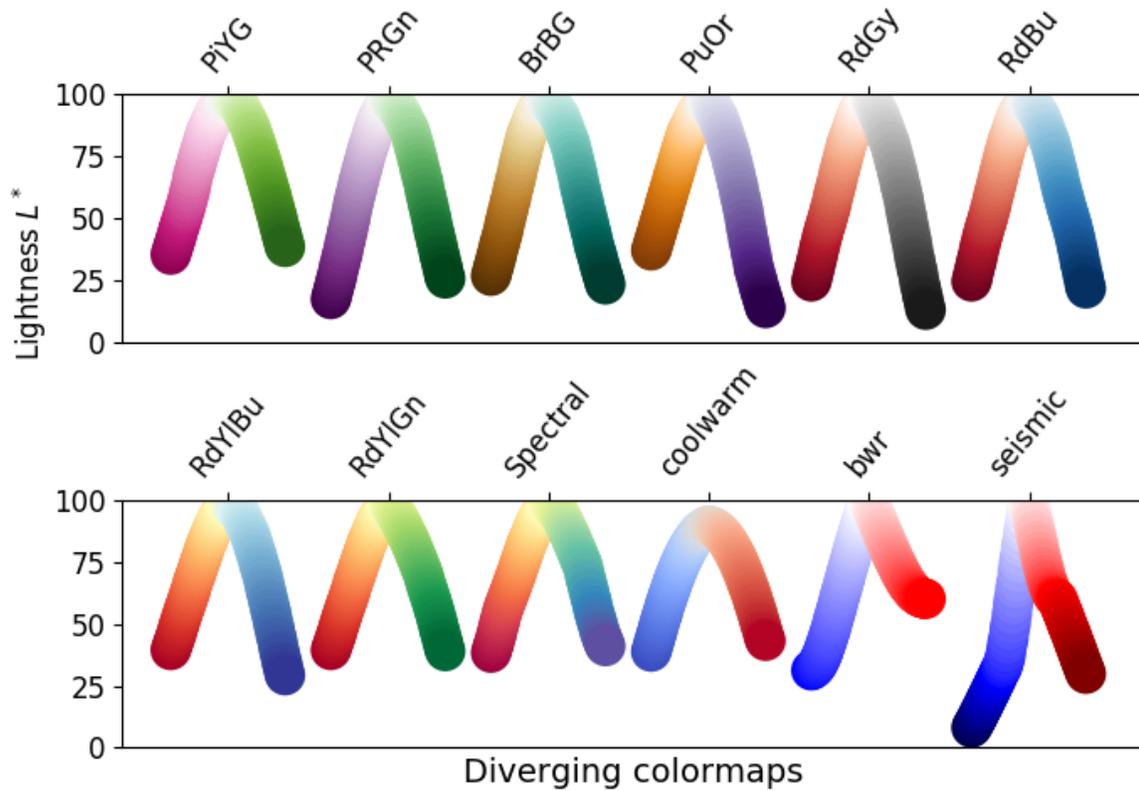
fig.tight_layout(h_pad=0.0, pad=1.5)
plt.show()

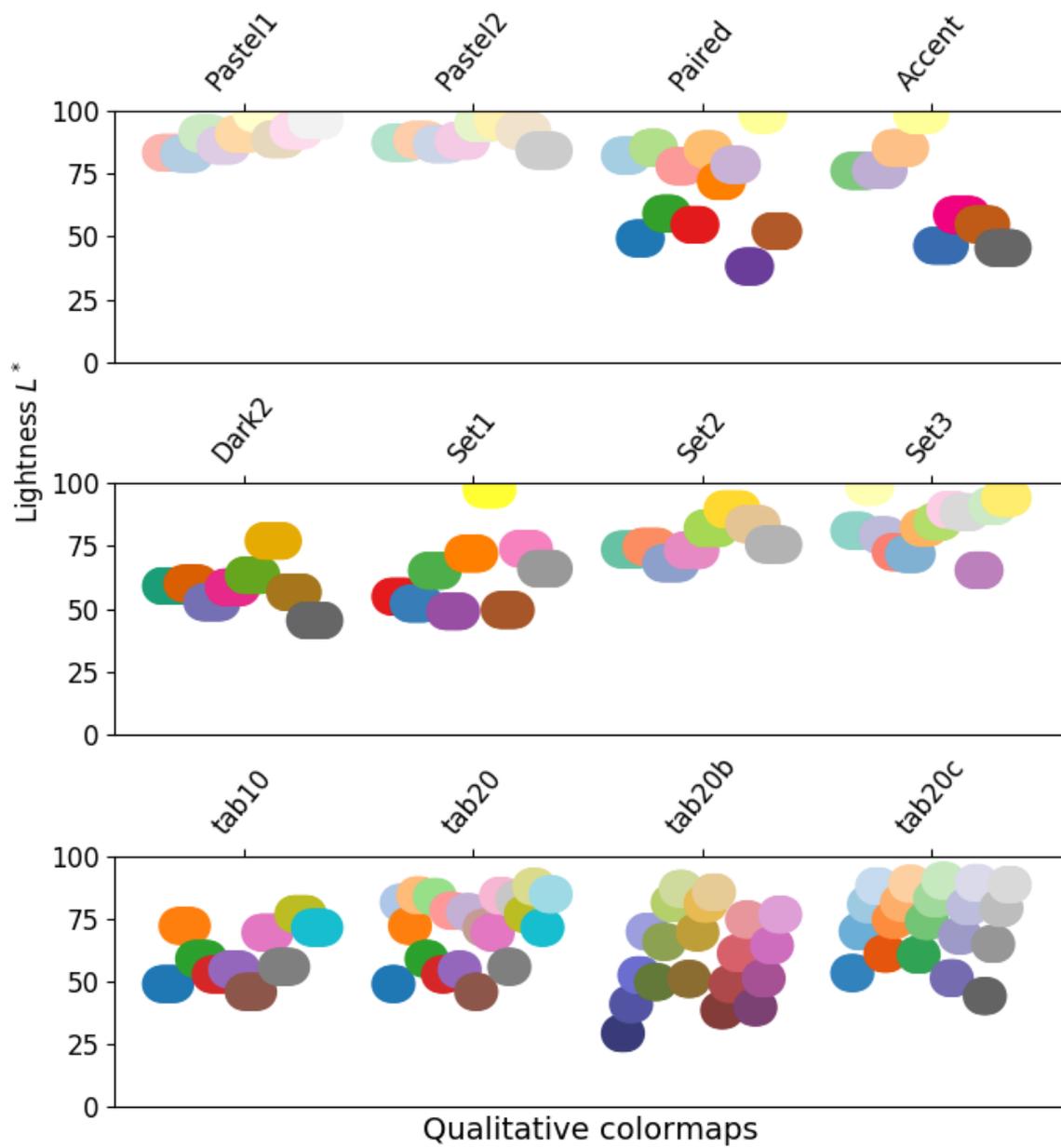
```

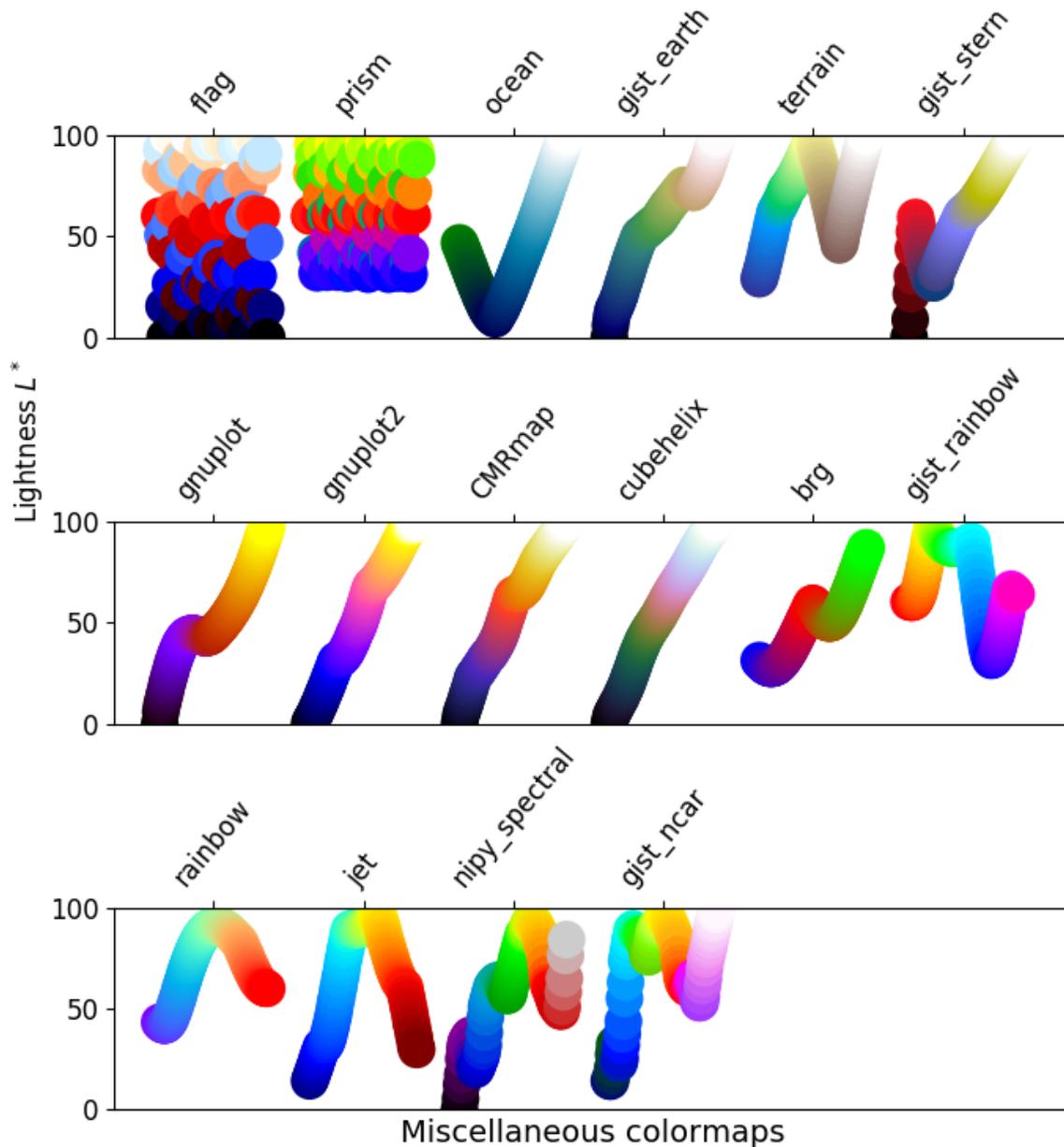












### Grayscale conversion

It is important to pay attention to conversion to grayscale for color plots, since they may be printed on black and white printers. If not carefully considered, your readers may end up with indecipherable plots because the grayscale changes unpredictably through the colormap.

Conversion to grayscale is done in many different ways [?]. Some of the better ones use a linear combination of the  $rgb$  values of a pixel, but weighted according to how we perceive color intensity. A nonlinear method of conversion to grayscale is to use the  $L^*$  values of the pixels. In general, similar principles apply for this question as they do for presenting one's information perceptually; that is, if a colormap is chosen that is monotonically increasing in

$L^*$  values, it will print in a reasonable manner to grayscale.

With this in mind, we see that the Sequential colormaps have reasonable representations in grayscale. Some of the Sequential2 colormaps have decent enough grayscale representations, though some (autumn, spring, summer, winter) have very little grayscale change. If a colormap like this was used in a plot and then the plot was printed to grayscale, a lot of the information may map to the same gray values. The Diverging colormaps mostly vary from darker gray on the outer edges to white in the middle. Some (PuOr and seismic) have noticeably darker gray on one side than the other and therefore are not very symmetric. coolwarm has little range of gray scale and would print to a more uniform plot, losing a lot of detail. Note that overlaid, labeled contours could help differentiate between one side of the colormap vs. the other since color cannot be used once a plot is printed to grayscale. Many of the Qualitative and Miscellaneous colormaps, such as Accent, hsv, and jet, change from darker to lighter and back to darker gray throughout the colormap. This would make it impossible for a viewer to interpret the information in a plot once it is printed in grayscale.

```
mpl.rcParams.update({'font.size': 14})

# Indices to step through colormap.
x = np.linspace(0.0, 1.0, 100)

gradient = np.linspace(0, 1, 256)
gradient = np.vstack((gradient, gradient))

def plot_color_gradients(cmap_category, cmap_list):
    fig, axes = plt.subplots(nrows=len(cmap_list), ncols=2)
    fig.subplots_adjust(top=0.95, bottom=0.01, left=0.2, right=0.99,
                        wspace=0.05)
    fig.suptitle(cmap_category + ' colormaps', fontsize=14, y=1.0, x=0.6)

    for ax, name in zip(axes, cmap_list):

        # Get RGB values for colormap.
        rgb = cm.get_cmap(plt.get_cmap(name))(x)[np.newaxis, :, :3]

        # Get colormap in CAM02-UCS colorspace. We want the lightness.
        lab = cspace_converter("sRGB1", "CAM02-UCS")(rgb)
        L = lab[0, :, 0]
        L = np.float32(np.vstack((L, L, L)))

        ax[0].imshow(gradient, aspect='auto', cmap=plt.get_cmap(name))
        ax[1].imshow(L, aspect='auto', cmap='binary_r', vmin=0., vmax=100.)
        pos = list(ax[0].get_position().bounds)
        x_text = pos[0] - 0.01
        y_text = pos[1] + pos[3]/2.
        fig.text(x_text, y_text, name, va='center', ha='right', fontsize=10)

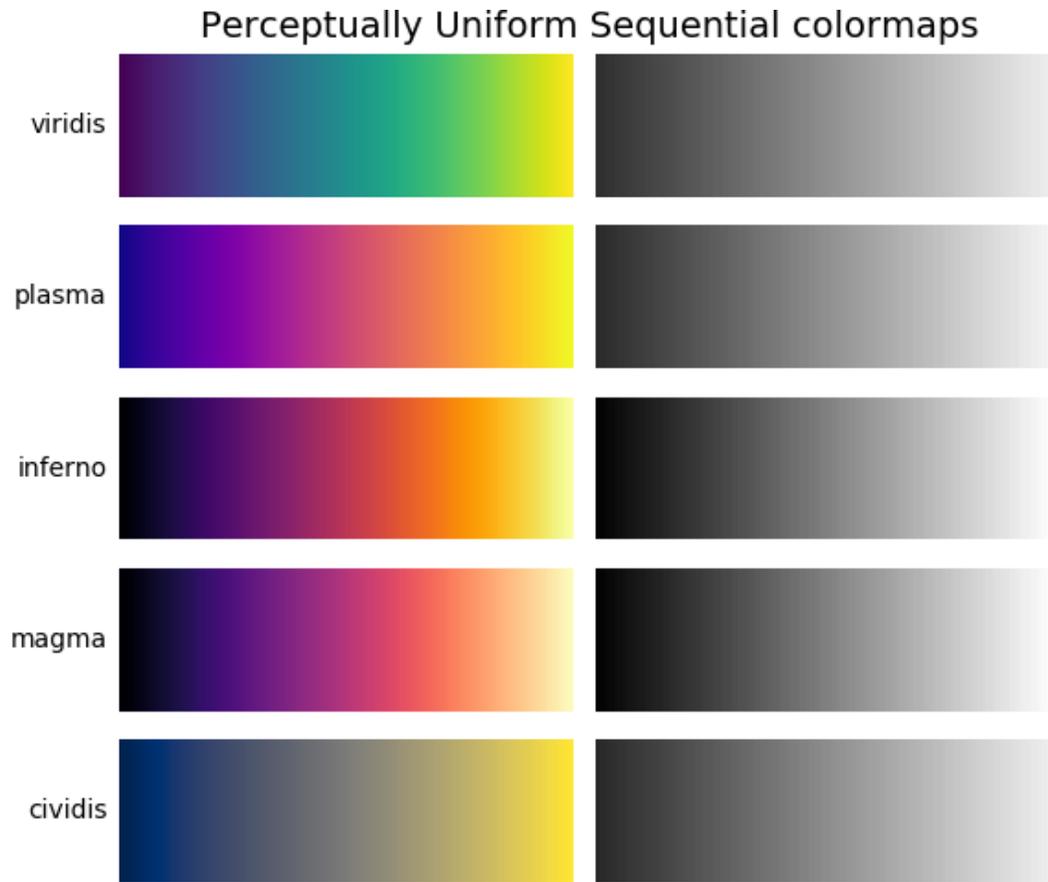
    # Turn off *all* ticks & spines, not just the ones with colormaps.
    for ax in axes.flat:
        ax.set_axis_off()

plt.show()
```

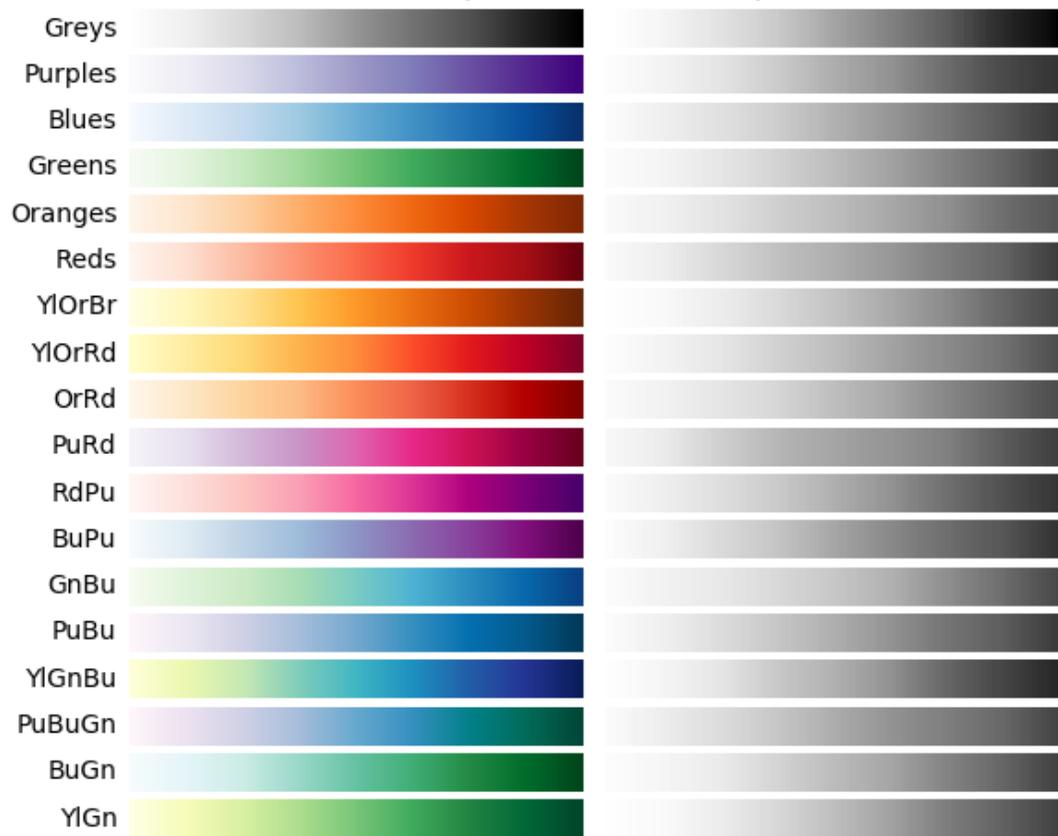
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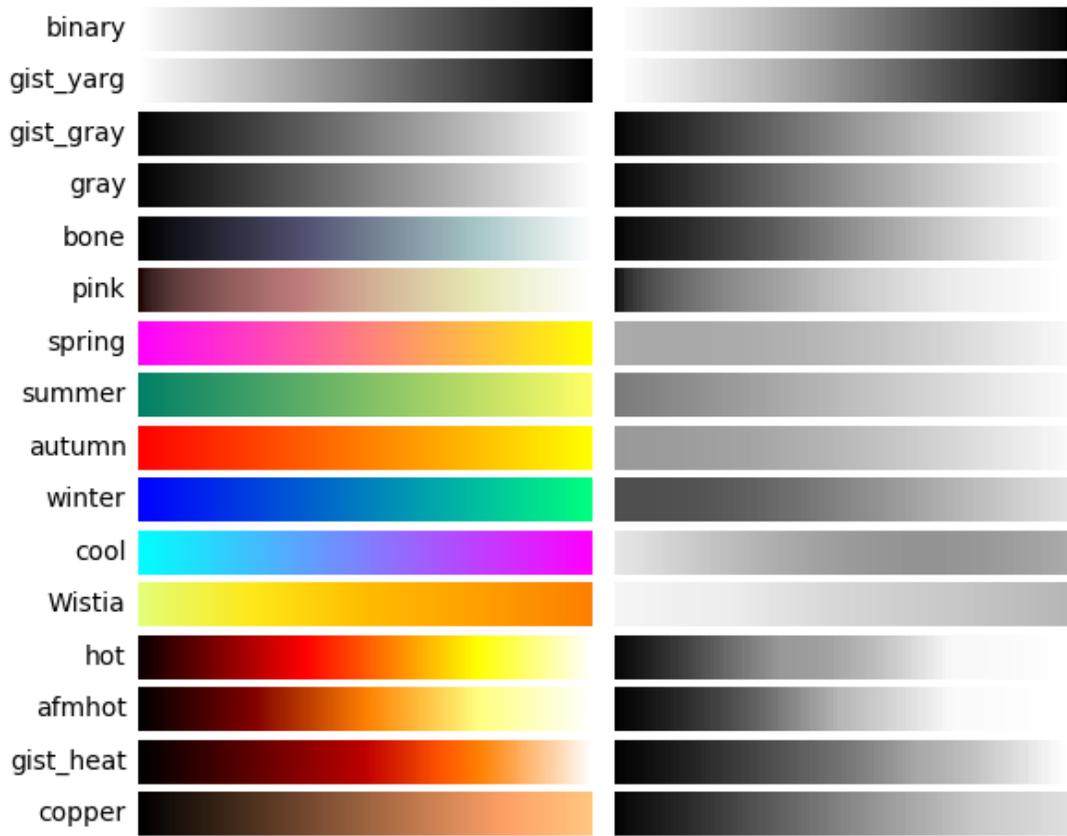
```
for cmap_category, cmap_list in cmaps.items():  
    plot_color_gradients(cmap_category, cmap_list)
```



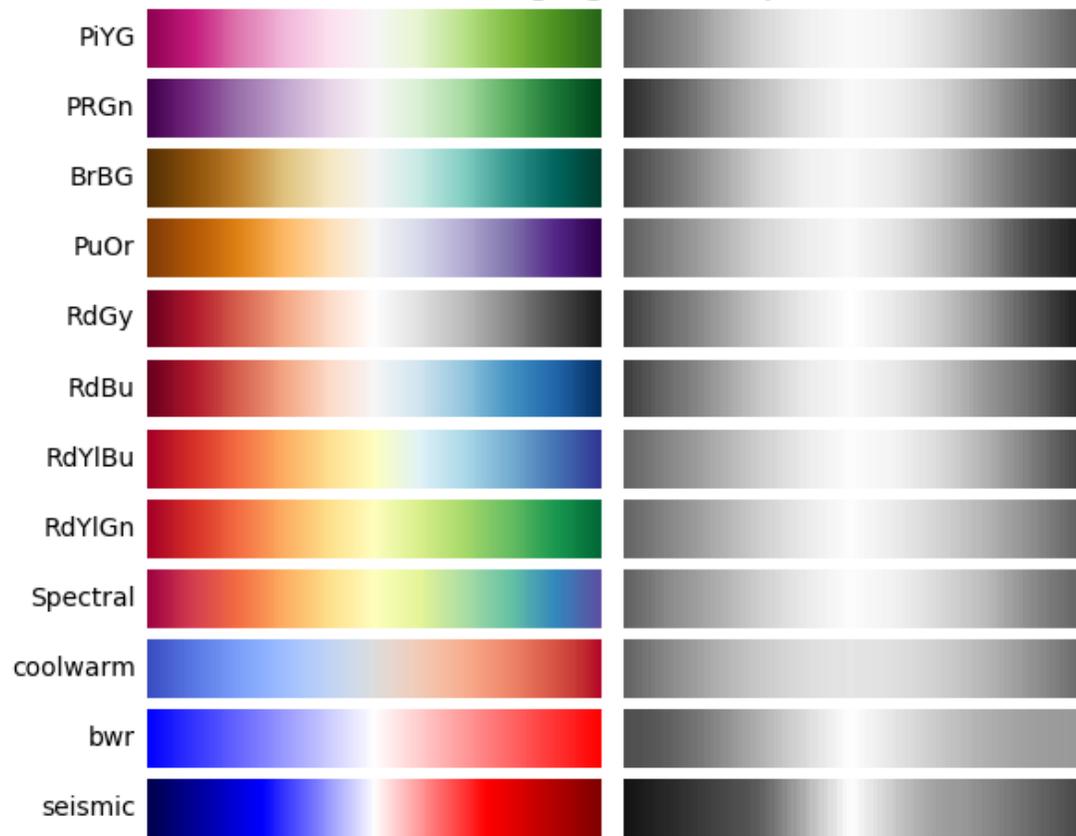
## Sequential colormaps



### Sequential (2) colormaps

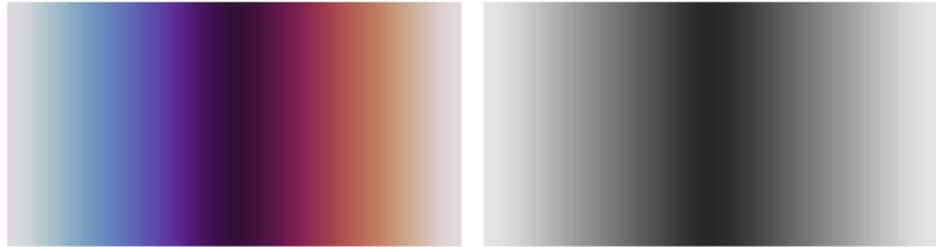


## Diverging colormaps

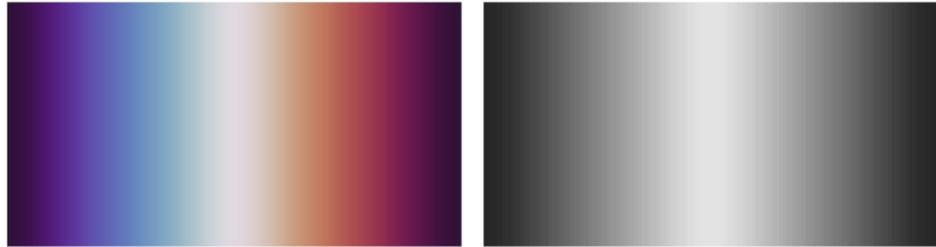


### Cyclic colormaps

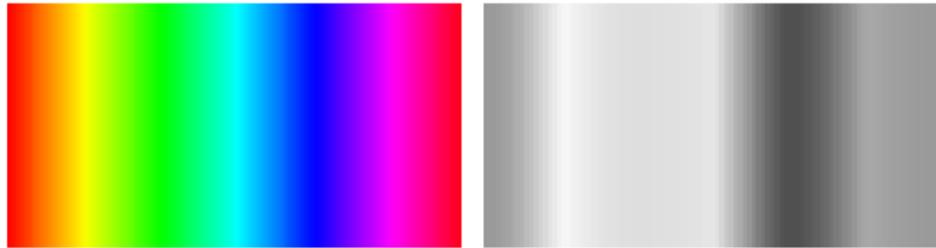
twilight



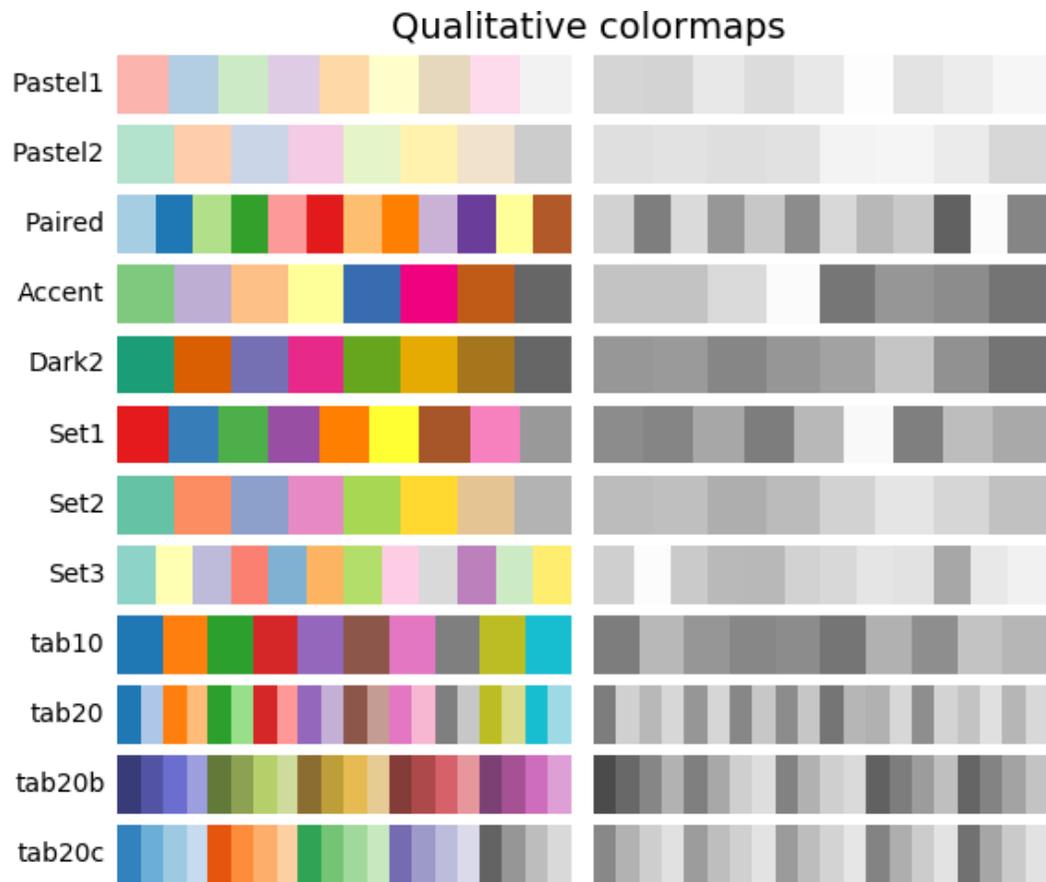
twilight\_shifted

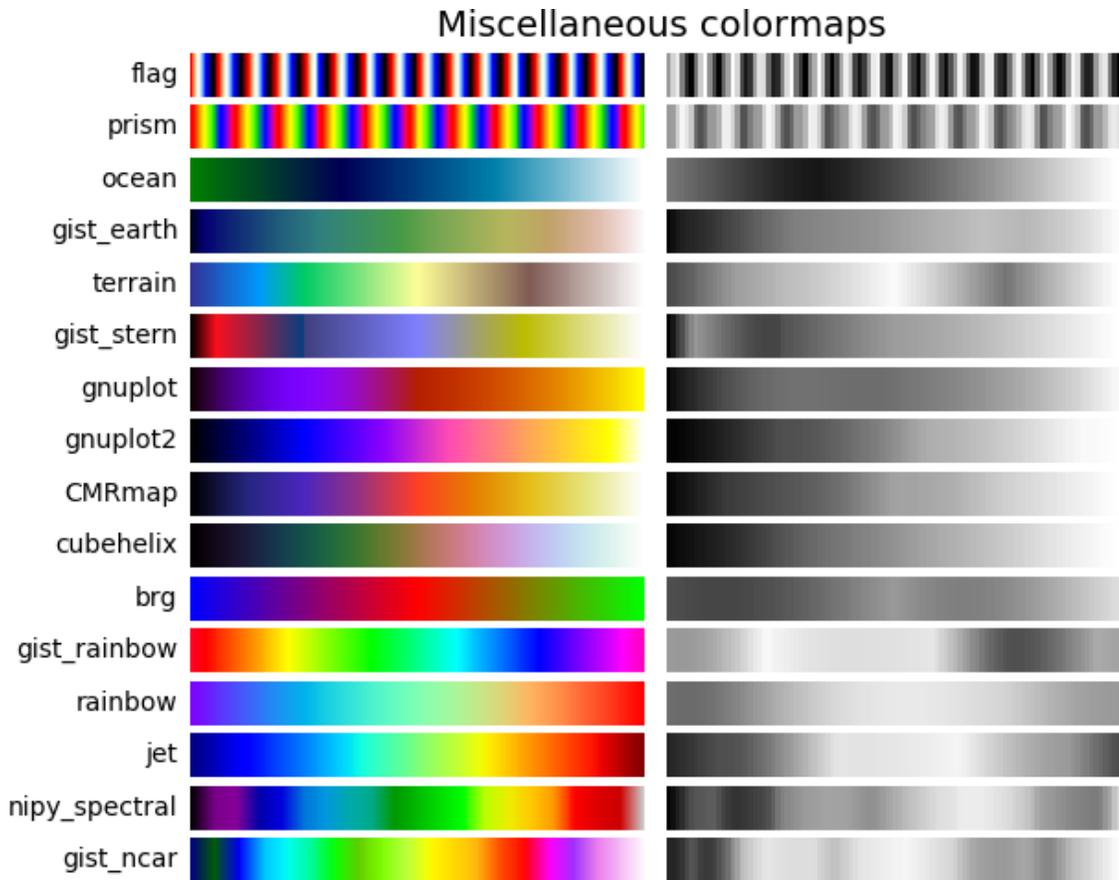


hsv



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### Color vision deficiencies

There is a lot of information available about color blindness (*e.g.*, [?]). Additionally, there are tools available to convert images to how they look for different types of color vision deficiencies.

The most common form of color vision deficiency involves differentiating between red and green. Thus, avoiding colormaps with both red and green will avoid many problems in general.

### References

**Total running time of the script:** ( 0 minutes 4.778 seconds)

## 2.5 Text

matplotlib has extensive text support, including support for mathematical expressions, true-type support for raster and vector outputs, newline separated text with arbitrary rotations, and unicode support. These tutorials cover the basics of working with text in Matplotlib.

---

**Note:** Click [here](#) to download the full example code

---

## 2.5.1 Text in Matplotlib Plots

Introduction to plotting and working with text in Matplotlib.

Matplotlib has extensive text support, including support for mathematical expressions, true-type support for raster and vector outputs, newline separated text with arbitrary rotations, and unicode support.

Because it embeds fonts directly in output documents, e.g., for postscript or PDF, what you see on the screen is what you get in the hardcopy. `FreeType` support produces very nice, antialiased fonts, that look good even at small raster sizes. Matplotlib includes its own `matplotlib.font_manager` (thanks to Paul Barrett), which implements a cross platform, W3C compliant font finding algorithm.

The user has a great deal of control over text properties (font size, font weight, text location and color, etc.) with sensible defaults set in the `rc file`. And significantly, for those interested in mathematical or scientific figures, Matplotlib implements a large number of TeX math symbols and commands, supporting *mathematical expressions* anywhere in your figure.

### Basic text commands

The following commands are used to create text in the pyplot interface and the object-oriented API:

<i>pyplot</i> API	OO API	description
<code>text</code>	<code>text</code>	Add text at an arbitrary location of the <i>Axes</i> .
<code>annotate</code>	<code>annotate</code>	Add an annotation, with an optional arrow, at an arbitrary location of the <i>Axes</i> .
<code>xlabel</code>	<code>set_xlabel</code>	Add a label to the <i>Axes</i> 's x-axis.
<code>ylabel</code>	<code>set_ylabel</code>	Add a label to the <i>Axes</i> 's y-axis.
<code>title</code>	<code>set_title</code>	Add a title to the <i>Axes</i> .
<code>figtext</code>	<code>text</code>	Add text at an arbitrary location of the <i>Figure</i> .
<code>suptitle</code>	<code>suptitle</code>	Add a title to the <i>Figure</i> .

All of these functions create and return a `Text` instance, which can be configured with a variety of font and other properties. The example below shows all of these commands in action, and more detail is provided in the sections that follow.

```
import matplotlib
import matplotlib.pyplot as plt

fig = plt.figure()
fig.suptitle('bold figure suptitle', fontsize=14, fontweight='bold')

ax = fig.add_subplot(111)
fig.subplots_adjust(top=0.85)
ax.set_title('axes title')
```

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```
ax.set_xlabel('xlabel')
ax.set_ylabel('ylabel')

ax.text(3, 8, 'boxed italics text in data coords', style='italic',
        bbox={'facecolor': 'red', 'alpha': 0.5, 'pad': 10})

ax.text(2, 6, r'an equation:  $E=mc^2$ ', fontsize=15)

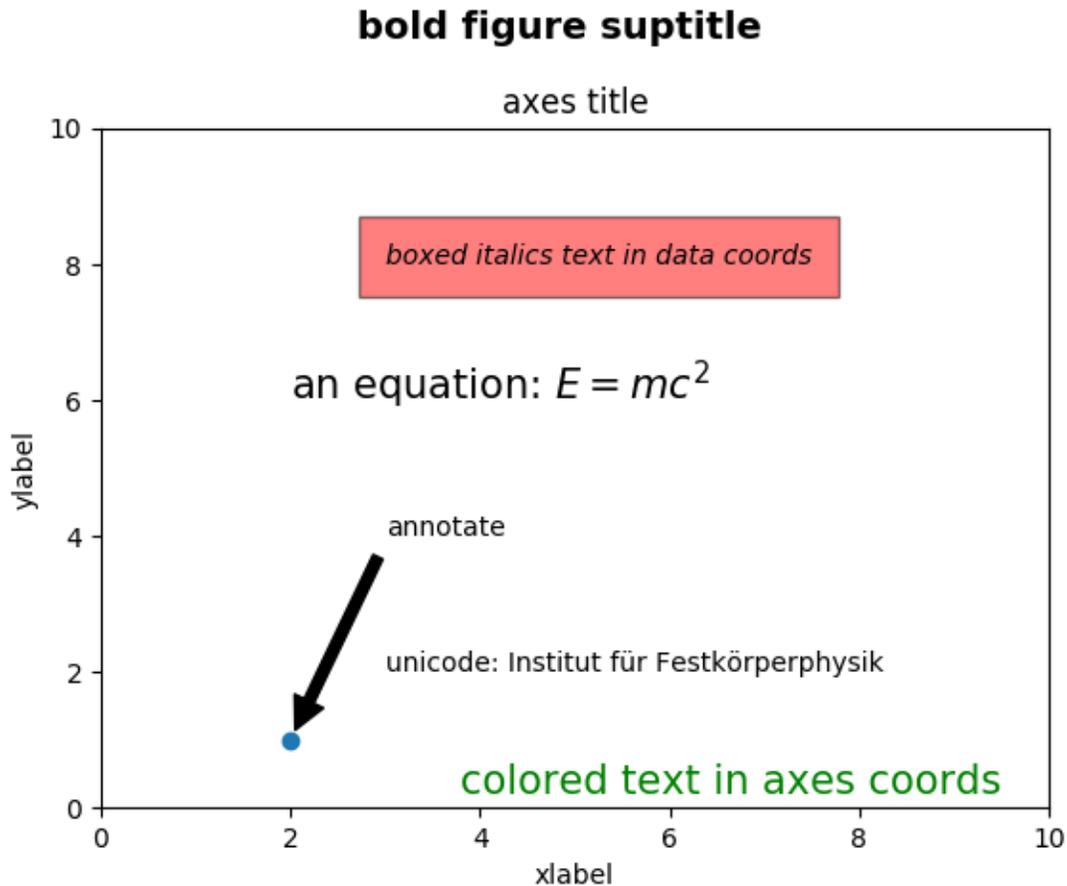
ax.text(3, 2, 'unicode: Institut für Festkörperphysik')

ax.text(0.95, 0.01, 'colored text in axes coords',
        verticalalignment='bottom', horizontalalignment='right',
        transform=ax.transAxes,
        color='green', fontsize=15)

ax.plot([2], [1], 'o')
ax.annotate('annotate', xy=(2, 1), xytext=(3, 4),
           arrowprops=dict(facecolor='black', shrink=0.05))

ax.axis([0, 10, 0, 10])

plt.show()
```



### Labels for x- and y-axis

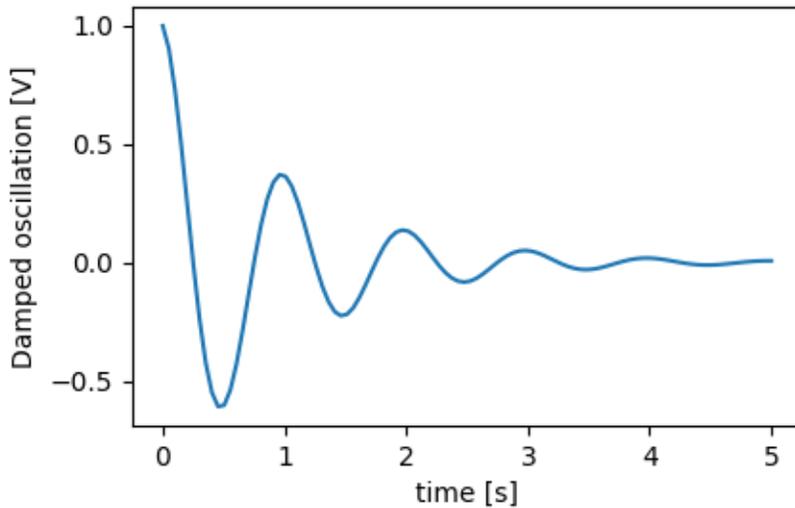
Specifying the labels for the x- and y-axis is straightforward, via the `set_xlabel` and `set_ylabel` methods.

```
import matplotlib.pyplot as plt
import numpy as np

x1 = np.linspace(0.0, 5.0, 100)
y1 = np.cos(2 * np.pi * x1) * np.exp(-x1)

fig, ax = plt.subplots(figsize=(5, 3))
fig.subplots_adjust(bottom=0.15, left=0.2)
ax.plot(x1, y1)
ax.set_xlabel('time [s]')
ax.set_ylabel('Damped oscillation [V]')

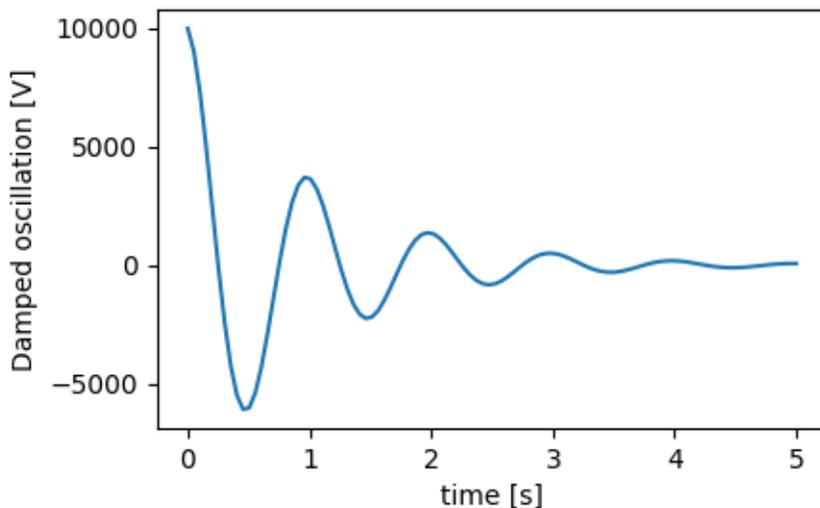
plt.show()
```



The x- and y-labels are automatically placed so that they clear the x- and y-ticklabels. Compare the plot below with that above, and note the y-label is to the left of the one above.

```
fig, ax = plt.subplots(figsize=(5, 3))
fig.subplots_adjust(bottom=0.15, left=0.2)
ax.plot(x1, y1*10000)
ax.set_xlabel('time [s]')
ax.set_ylabel('Damped oscillation [V]')

plt.show()
```



If you want to move the labels, you can specify the *labelpad* keyword argument, where the value is points (1/72", the same unit used to specify fontsizes).

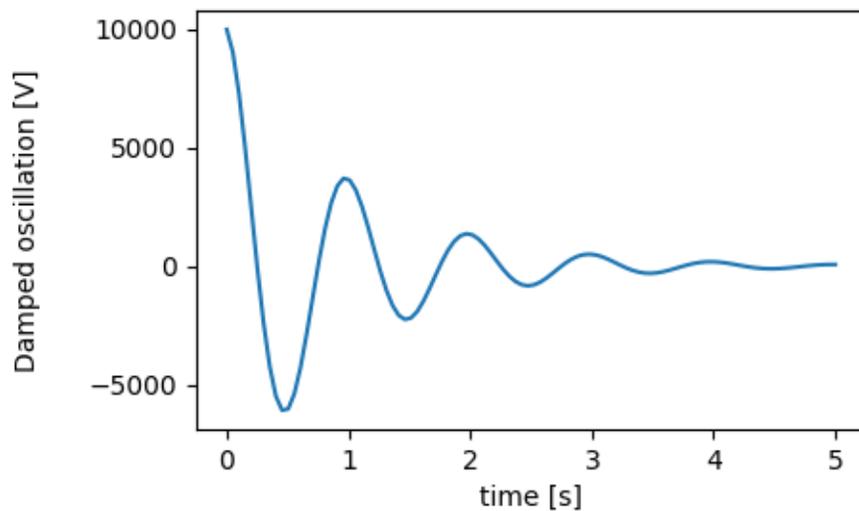
```
fig, ax = plt.subplots(figsize=(5, 3))
fig.subplots_adjust(bottom=0.15, left=0.2)
```

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```
ax.plot(x1, y1*10000)
ax.set_xlabel('time [s]')
ax.set_ylabel('Damped oscillation [V]', labelpad=18)

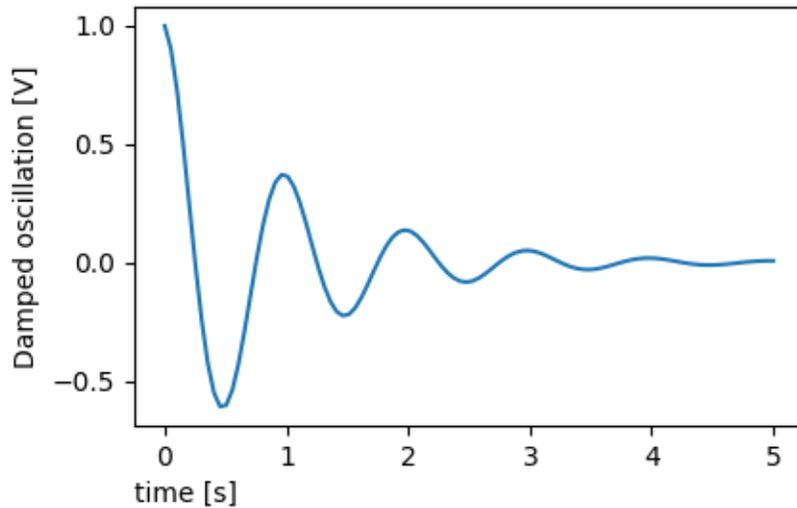
plt.show()
```



Or, the labels accept all the *Text* keyword arguments, including *position*, via which we can manually specify the label positions. Here we put the xlabel to the far left of the axis. Note, that the y-coordinate of this position has no effect - to adjust the y-position we need to use the *labelpad* kwarg.

```
fig, ax = plt.subplots(figsize=(5, 3))
fig.subplots_adjust(bottom=0.15, left=0.2)
ax.plot(x1, y1)
ax.set_xlabel('time [s]', position=(0., 1e6),
              horizontalalignment='left')
ax.set_ylabel('Damped oscillation [V]')

plt.show()
```



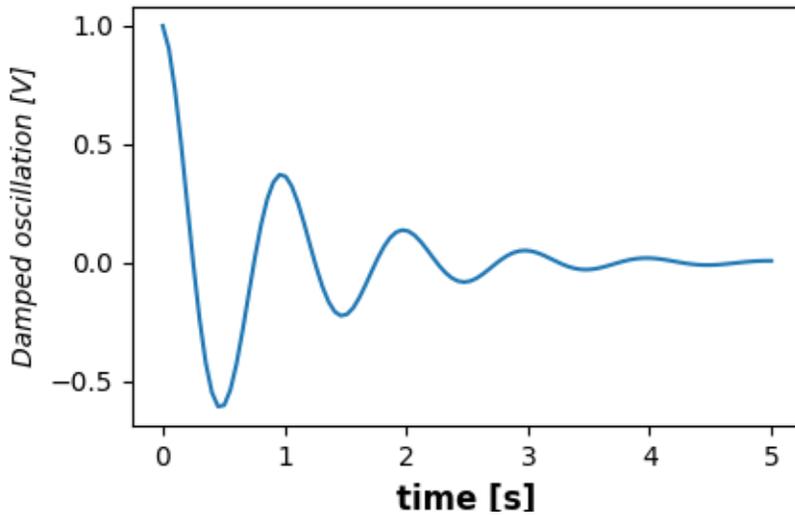
All the labelling in this tutorial can be changed by manipulating the `matplotlib.font_manager.FontProperties` method, or by named kwargs to `set_xlabel`

```
from matplotlib.font_manager import FontProperties

font = FontProperties()
font.set_family('serif')
font.set_name('Times New Roman')
font.set_style('italic')

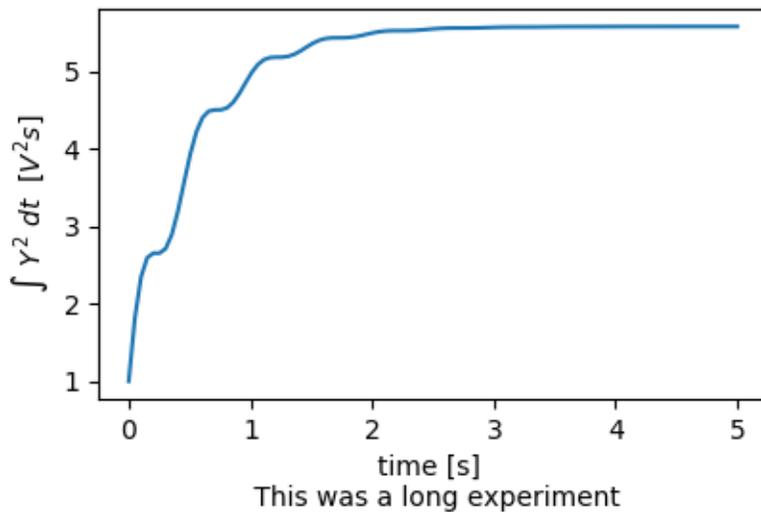
fig, ax = plt.subplots(figsize=(5, 3))
fig.subplots_adjust(bottom=0.15, left=0.2)
ax.plot(x1, y1)
ax.set_xlabel('time [s]', fontsize='large', fontweight='bold')
ax.set_ylabel('Damped oscillation [V]', fontproperties=font)

plt.show()
```



Finally, we can use native TeX rendering in all text objects and have multiple lines:

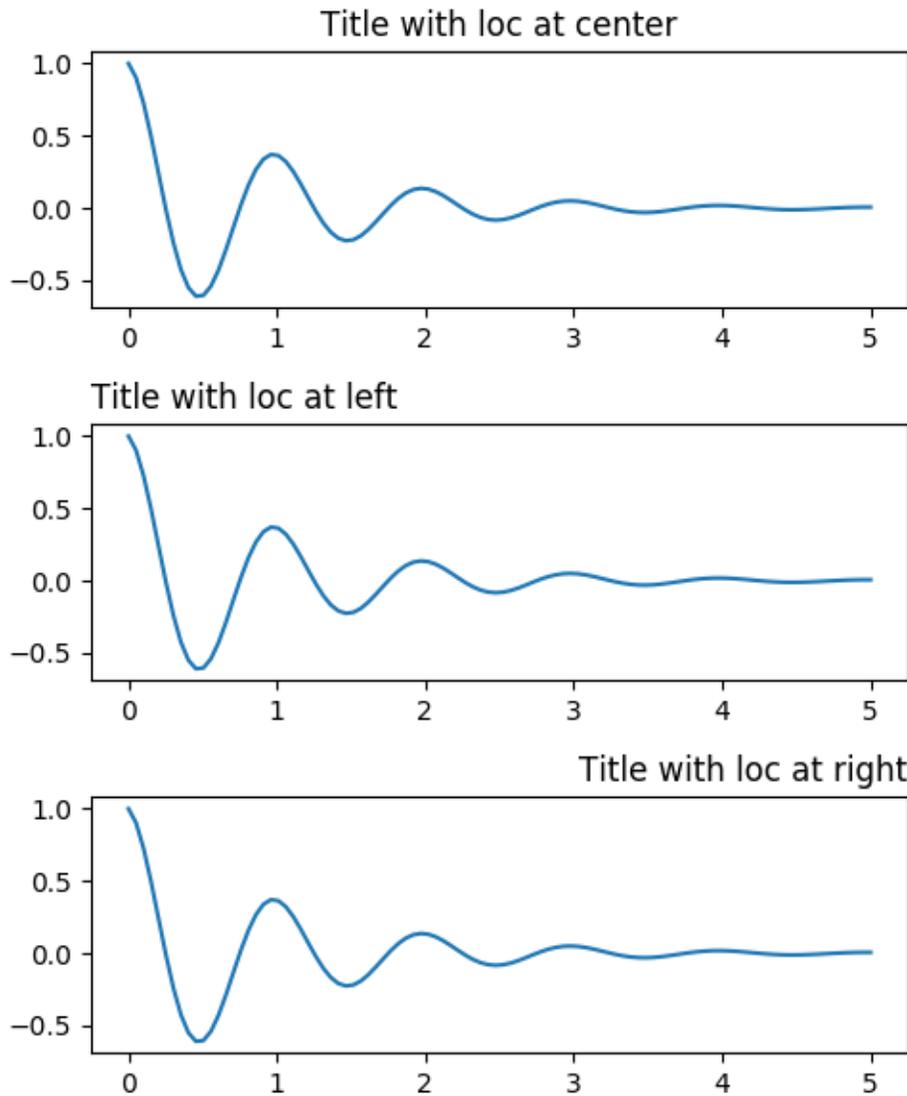
```
fig, ax = plt.subplots(figsize=(5, 3))
fig.subplots_adjust(bottom=0.2, left=0.2)
ax.plot(x1, np.cumsum(y1**2))
ax.set_xlabel('time [s] \n This was a long experiment')
ax.set_ylabel(r'$\int Y^2 dt$ [V^2 s]')
plt.show()
```



## Titles

Subplot titles are set in much the same way as labels, but there is the *loc* keyword arguments that can change the position and justification from the default value of *loc=center*.

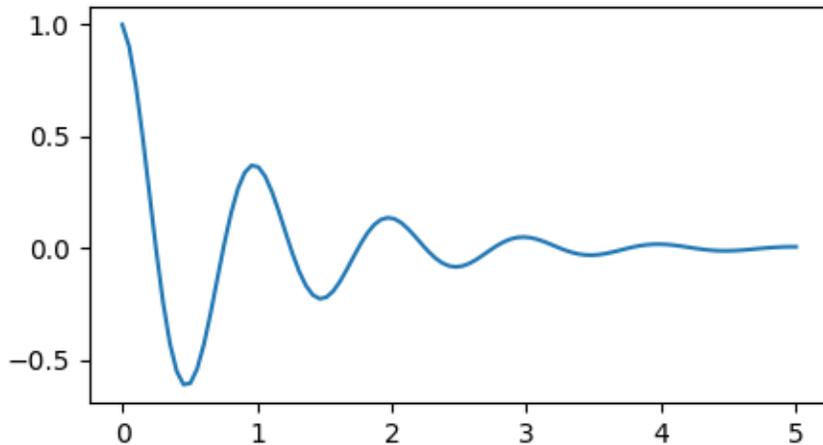
```
fig, axs = plt.subplots(3, 1, figsize=(5, 6), tight_layout=True)
locs = ['center', 'left', 'right']
for ax, loc in zip(axs, locs):
    ax.plot(x1, y1)
    ax.set_title('Title with loc at '+loc, loc=loc)
plt.show()
```



Vertical spacing for titles is controlled via `rcParams["axes.titlepad"]`, which defaults to 5 points. Setting to a different value moves the title.

```
fig, ax = plt.subplots(figsize=(5, 3))
fig.subplots_adjust(top=0.8)
ax.plot(x1, y1)
ax.set_title('Vertically offset title', pad=30)
plt.show()
```

## Vertically offset title



### Ticks and ticklabels

Placing ticks and ticklabels is a very tricky aspect of making a figure. Matplotlib does the best it can automatically, but it also offers a very flexible framework for determining the choices for tick locations, and how they are labelled.

### Terminology

*Axes* have an `matplotlib.axis` object for the `ax.xaxis` and `ax.yaxis` that contain the information about how the labels in the axis are laid out.

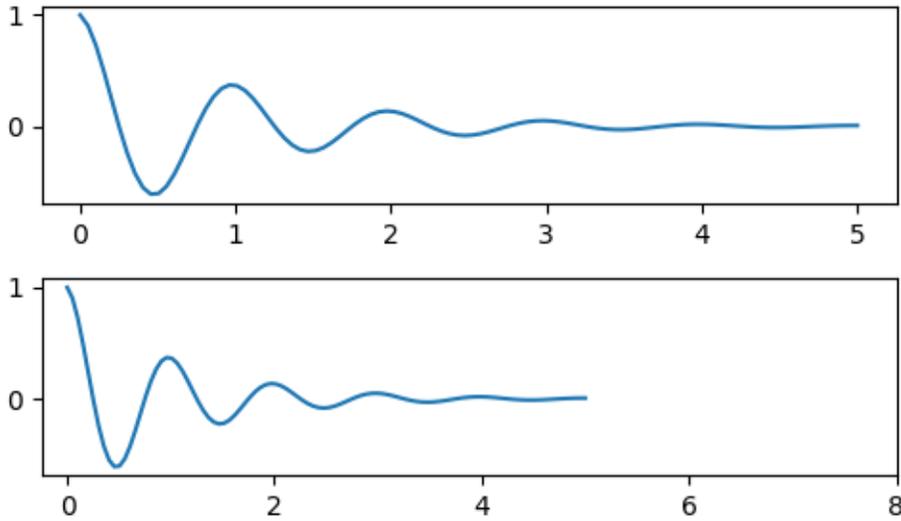
The axis API is explained in detail in the documentation to *axis*.

An Axis object has major and minor ticks. The Axis has a `matplotlib.xaxis.set_major_locator` and `matplotlib.xaxis.set_minor_locator` methods that use the data being plotted to determine the location of major and minor ticks. There are also `matplotlib.xaxis.set_major_formatter` and `matplotlib.xaxis.set_minor_formatters` methods that format the tick labels.

### Simple ticks

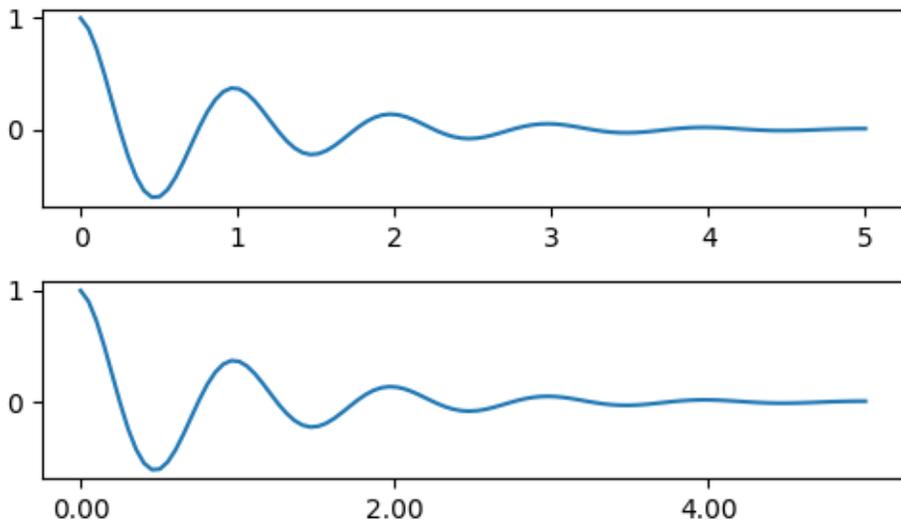
It often is convenient to simply define the tick values, and sometimes the tick labels, overriding the default locators and formatters. This is discouraged because it breaks interactive navigation of the plot. It also can reset the axis limits: note that the second plot has the ticks we asked for, including ones that are well outside the automatic view limits.

```
fig, axs = plt.subplots(2, 1, figsize=(5, 3), tight_layout=True)
axs[0].plot(x1, y1)
axs[1].plot(x1, y1)
axs[1].xaxis.set_ticks(np.arange(0., 8.1, 2.))
plt.show()
```



We can of course fix this after the fact, but it does highlight a weakness of hard-coding the ticks. This example also changes the format of the ticks:

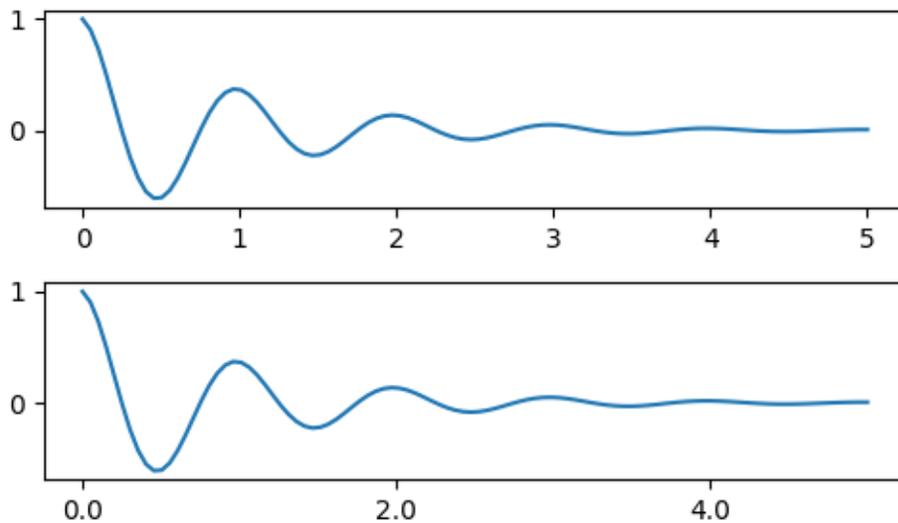
```
fig, axs = plt.subplots(2, 1, figsize=(5, 3), tight_layout=True)
axs[0].plot(x1, y1)
axs[1].plot(x1, y1)
ticks = np.arange(0., 8.1, 2.)
# list comprehension to get all tick labels...
tickla = ['%1.2f' % tick for tick in ticks]
axs[1].axis.set_ticks(ticks)
axs[1].axis.set_ticklabels(tickla)
axs[1].set_xlim(axs[0].get_xlim())
plt.show()
```



## Tick Locators and Formatters

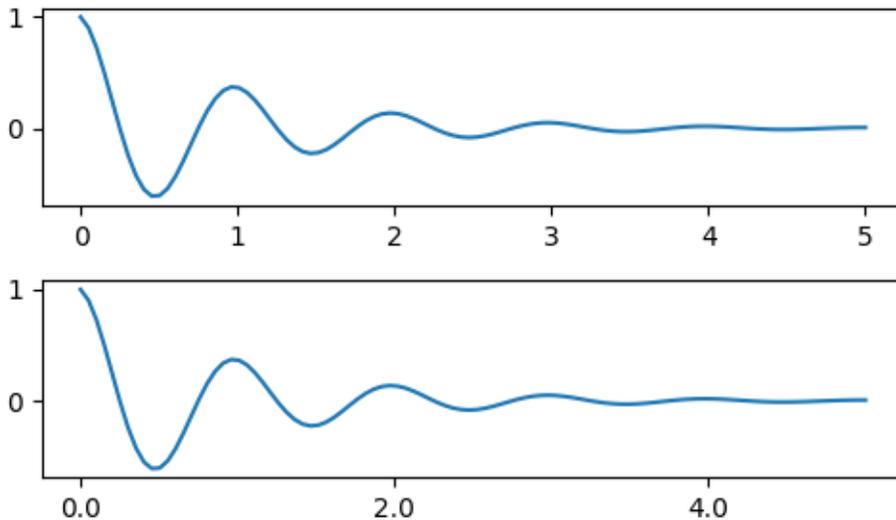
Instead of making a list of all the tick labels, we could have used a `matplotlib.ticker.FormatStrFormatter` and passed it to the `ax.xaxis`

```
fig, axs = plt.subplots(2, 1, figsize=(5, 3), tight_layout=True)
axs[0].plot(x1, y1)
axs[1].plot(x1, y1)
ticks = np.arange(0., 8.1, 2.)
# list comprehension to get all tick labels...
formatter = matplotlib.ticker.StrMethodFormatter('{x:1.1f}')
axs[1].xaxis.set_ticks(ticks)
axs[1].xaxis.set_major_formatter(formatter)
axs[1].set_xlim(axs[0].get_xlim())
plt.show()
```



And of course we could have used a non-default locator to set the tick locations. Note we still pass in the tick values, but the x-limit fix used above is *not* needed.

```
fig, axs = plt.subplots(2, 1, figsize=(5, 3), tight_layout=True)
axs[0].plot(x1, y1)
axs[1].plot(x1, y1)
formatter = matplotlib.ticker.FormatStrFormatter('%1.1f')
locator = matplotlib.ticker.FixedLocator(ticks)
axs[1].xaxis.set_major_locator(locator)
axs[1].xaxis.set_major_formatter(formatter)
plt.show()
```



The default formatter is the `matplotlib.ticker.MaxNLocator` called as `ticker.MaxNLocator(self, nbins='auto', steps=[1, 2, 2.5, 5, 10])`. The `steps` keyword contains a list of multiples that can be used for tick values. i.e. in this case, 2, 4, 6 would be acceptable ticks, as would 20, 40, 60 or 0.2, 0.4, 0.6. However, 3, 6, 9 would not be acceptable because 3 doesn't appear in the list of steps.

`nbins=auto` uses an algorithm to determine how many ticks will be acceptable based on how long the axis is. The fontsize of the ticklabel is taken into account, but the length of the tick string is not (because its not yet known.) In the bottom row, the ticklabels are quite large, so we set `nbins=4` to make the labels fit in the right-hand plot.

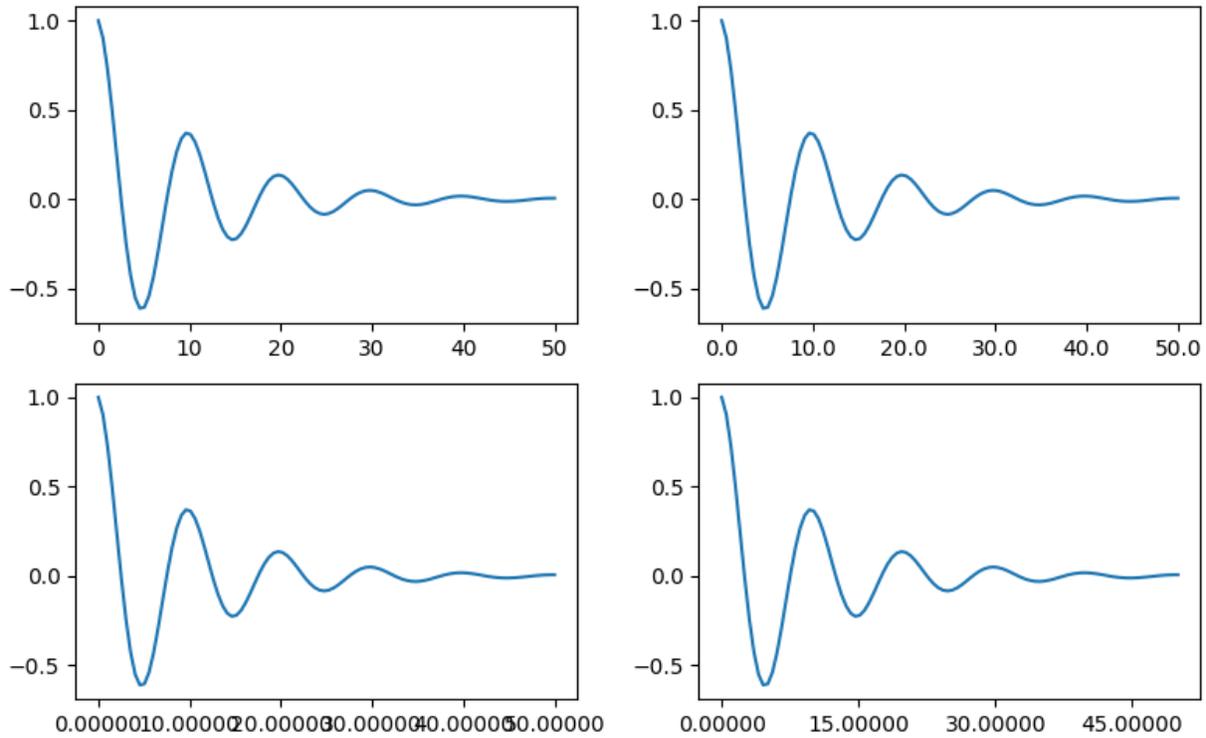
```
fig, axs = plt.subplots(2, 2, figsize=(8, 5), tight_layout=True)
for n, ax in enumerate(axs.flat):
    ax.plot(x1*10., y1)

formatter = matplotlib.ticker.FormatStrFormatter('%1.1f')
locator = matplotlib.ticker.MaxNLocator(nbins='auto', steps=[1, 4, 10])
axs[0, 1].xaxis.set_major_locator(locator)
axs[0, 1].xaxis.set_major_formatter(formatter)

formatter = matplotlib.ticker.FormatStrFormatter('%1.5f')
locator = matplotlib.ticker.AutoLocator()
axs[1, 0].xaxis.set_major_formatter(formatter)
axs[1, 0].xaxis.set_major_locator(locator)

formatter = matplotlib.ticker.FormatStrFormatter('%1.5f')
locator = matplotlib.ticker.MaxNLocator(nbins=4)
axs[1, 1].xaxis.set_major_formatter(formatter)
axs[1, 1].xaxis.set_major_locator(locator)

plt.show()
```

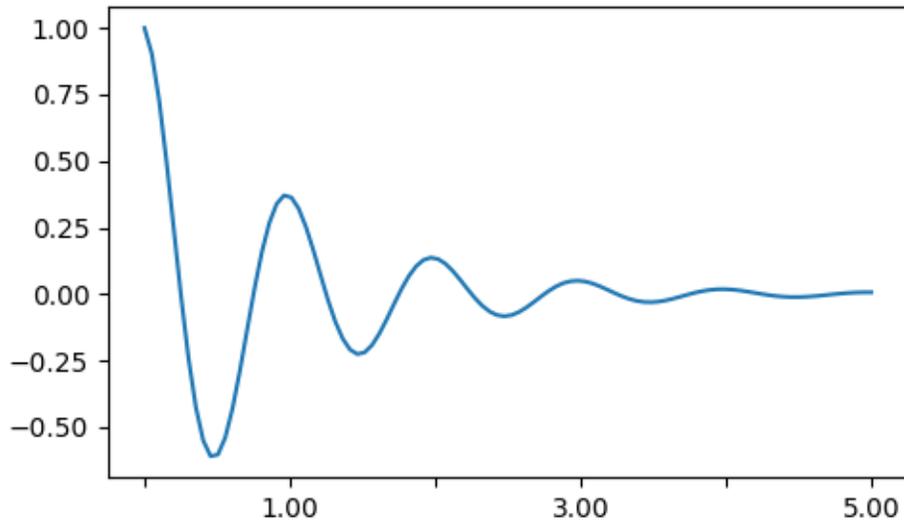


Finally, we can specify functions for the formatter using `matplotlib.ticker.FuncFormatter`.

```
def formatoddticks(x, pos):
    """Format odd tick positions
    """
    if x % 2:
        return '%1.2f' % x
    else:
        return ''

fig, ax = plt.subplots(figsize=(5, 3), tight_layout=True)
ax.plot(x1, y1)
formatter = matplotlib.ticker.FuncFormatter(formatoddticks)
locator = matplotlib.ticker.MaxNLocator(nbins=6)
ax.xaxis.set_major_formatter(formatter)
ax.xaxis.set_major_locator(locator)

plt.show()
```



### Dateticks

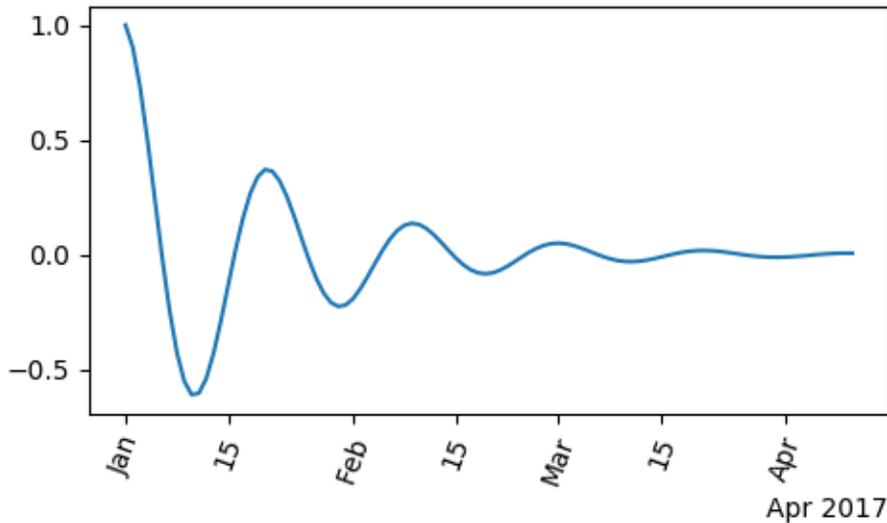
Matplotlib can accept `datetime.datetime` and `numpy.datetime64` objects as plotting arguments. Dates and times require special formatting, which can often benefit from manual intervention. In order to help, dates have special Locators and Formatters, defined in the `matplotlib.dates` module.

A simple example is as follows. Note how we have to rotate the tick labels so that they don't over-run each other.

```
import datetime

fig, ax = plt.subplots(figsize=(5, 3), tight_layout=True)
base = datetime.datetime(2017, 1, 1, 0, 0, 1)
time = [base + datetime.timedelta(days=x) for x in range(len(y1))]

ax.plot(time, y1)
ax.tick_params(axis='x', rotation=70)
plt.show()
```

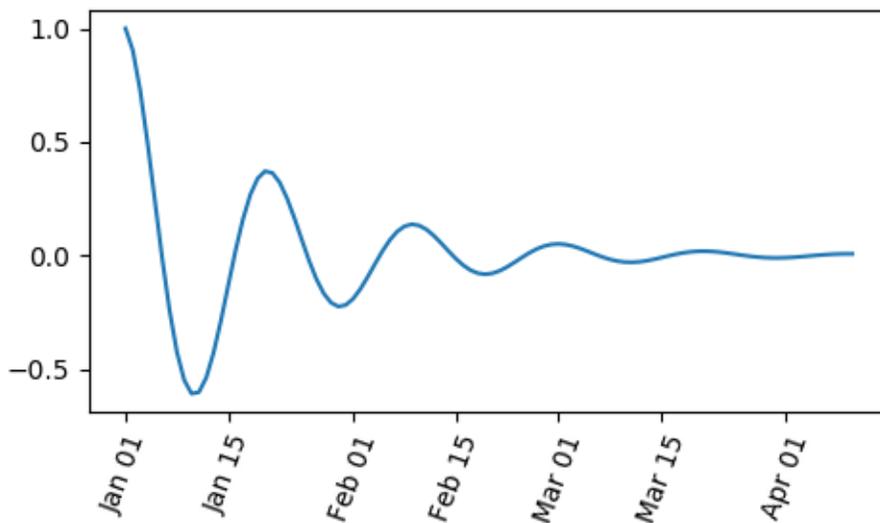


We can pass a format to `matplotlib.dates.DateFormatter`. Also note that the 29th and the next month are very close together. We can fix this by using the `dates.DayLocator` class, which allows us to specify a list of days of the month to use. Similar formatters are listed in the `matplotlib.dates` module.

```
import matplotlib.dates as mdates

locator = mdates.DayLocator(bymonthday=[1, 15])
formatter = mdates.DateFormatter('%b %d')

fig, ax = plt.subplots(figsize=(5, 3), tight_layout=True)
ax.xaxis.set_major_locator(locator)
ax.xaxis.set_major_formatter(formatter)
ax.plot(time, y1)
ax.tick_params(axis='x', rotation=70)
plt.show()
```



## Legends and Annotations

- Legends: *Legend guide*
- Annotations: *Annotations*

**Total running time of the script:** ( 0 minutes 1.356 seconds)

**Note:** Click *here* to download the full example code

## 2.5.2 Text properties and layout

Controlling properties of text and its layout with Matplotlib.

The `matplotlib.text.Text` instances have a variety of properties which can be configured via keyword arguments to the text commands (e.g., `title()`, `xlabel()` and `text()`).

Property	Value Type
alpha	float
backgroundcolor	any matplotlib <i>color</i>
bbox	<i>Rectangle</i> prop dict plus key 'pad' which is a pad in points
clip_box	a matplotlib.transform.Bbox instance
clip_on	bool
clip_path	a <i>Path</i> instance and a <i>Transform</i> instance, a <i>Patch</i>
color	any matplotlib <i>color</i>
family	[ 'serif'   'sans-serif'   'cursive'   'fantasy'   'monospace' ]
fontproperties	a <i>FontProperties</i> instance
horizontalalignment or ha	[ 'center'   'right'   'left' ]
label	any string
linespacing	float
multialignment	[ 'left'   'right'   'center' ]
name or fontname	string e.g., [ 'Sans'   'Courier'   'Helvetica' ...]
picker	[None float boolean callable]
position	(x, y)
rotation	[ angle in degrees   'vertical'   'horizontal' ]
size or fontsize	[ size in points   relative size, e.g., 'smaller', 'x-large' ]
style or fontstyle	[ 'normal'   'italic'   'oblique' ]
text	string or anything printable with '%s' conversion
transform	a <i>Transform</i> instance
variant	[ 'normal'   'small-caps' ]
verticalalignment or va	[ 'center'   'top'   'bottom'   'baseline' ]
visible	bool
weight or fontweight	[ 'normal'   'bold'   'heavy'   'light'   'ultrabold'   'ultralight' ]
x	float
y	float
zorder	any number

You can lay out text with the alignment arguments `horizontalalignment`, `verticalalignment`, and `multialignment`. `horizontalalignment` controls whether the x positional argument for the text indicates the left, center or right side of the text bounding box. `verticalalignment` controls

whether the y positional argument for the text indicates the bottom, center or top side of the text bounding box. `multialignment`, for newline separated strings only, controls whether the different lines are left, center or right justified. Here is an example which uses the `text()` command to show the various alignment possibilities. The use of `transform=ax.transAxes` throughout the code indicates that the coordinates are given relative to the axes bounding box, with 0,0 being the lower left of the axes and 1,1 the upper right.

```
import matplotlib.pyplot as plt
import matplotlib.patches as patches

# build a rectangle in axes coords
left, width = .25, .5
bottom, height = .25, .5
right = left + width
top = bottom + height

fig = plt.figure()
ax = fig.add_axes([0, 0, 1, 1])

# axes coordinates are 0,0 is bottom left and 1,1 is upper right
p = patches.Rectangle(
    (left, bottom), width, height,
    fill=False, transform=ax.transAxes, clip_on=False
)

ax.add_patch(p)

ax.text(left, bottom, 'left top',
        horizontalalignment='left',
        verticalalignment='top',
        transform=ax.transAxes)

ax.text(left, bottom, 'left bottom',
        horizontalalignment='left',
        verticalalignment='bottom',
        transform=ax.transAxes)

ax.text(right, top, 'right bottom',
        horizontalalignment='right',
        verticalalignment='bottom',
        transform=ax.transAxes)

ax.text(right, top, 'right top',
        horizontalalignment='right',
        verticalalignment='top',
        transform=ax.transAxes)

ax.text(right, bottom, 'center top',
        horizontalalignment='center',
        verticalalignment='top',
        transform=ax.transAxes)

ax.text(left, 0.5*(bottom+top), 'right center',
```

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```
        horizontalalignment='right',
        verticalalignment='center',
        rotation='vertical',
        transform=ax.transAxes)

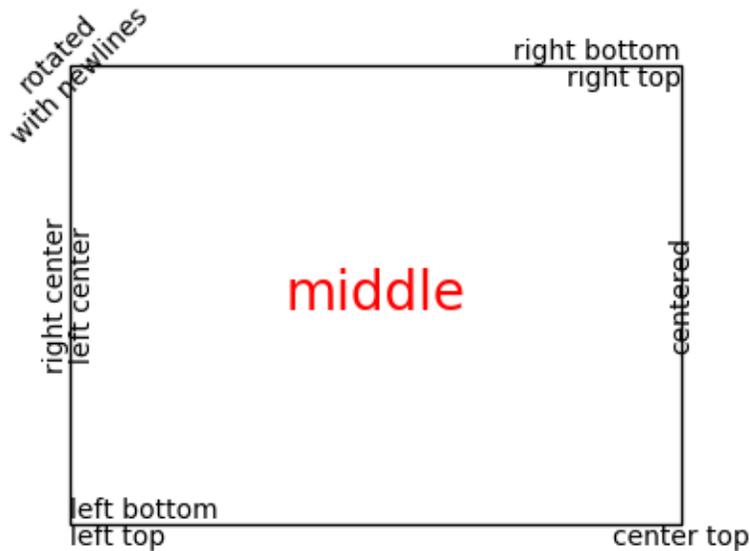
ax.text(left, 0.5*(bottom+top), 'left center',
        horizontalalignment='left',
        verticalalignment='center',
        rotation='vertical',
        transform=ax.transAxes)

ax.text(0.5*(left+right), 0.5*(bottom+top), 'middle',
        horizontalalignment='center',
        verticalalignment='center',
        fontsize=20, color='red',
        transform=ax.transAxes)

ax.text(right, 0.5*(bottom+top), 'centered',
        horizontalalignment='center',
        verticalalignment='center',
        rotation='vertical',
        transform=ax.transAxes)

ax.text(left, top, 'rotated\nwith newlines',
        horizontalalignment='center',
        verticalalignment='center',
        rotation=45,
        transform=ax.transAxes)

ax.set_axis_off()
plt.show()
```



### 2.5.3 Default Font

The base default font is controlled by a set of rcParams. To set the font for mathematical expressions, use the rcParams beginning with `mathtext` (see *mathtext*).

rcParam	usage
'font.family'	List of either names of font or {'cursive', 'fantasy', 'monospace', 'sans', 'sans serif', 'sans-serif', 'serif'}.
'font.style'	The default style, ex 'normal', 'italic'.
'font.variant'	Default variant, ex 'normal', 'small-caps' (untested)
'font.stretch'	Default stretch, ex 'normal', 'condensed' (incomplete)
'font.weight'	Default weight. Either string or integer
'font.size'	Default font size in points. Relative font sizes ('large', 'x-small') are computed against this size.

The mapping between the family aliases ({'cursive', 'fantasy', 'monospace', 'sans', 'sans serif', 'sans-serif', 'serif'}) and actual font names is controlled by the following rcParams:

family alias	rcParam with mappings
'serif'	'font.serif'
'monospace'	'font.monospace'
'fantasy'	'font.fantasy'
'cursive'	'font.cursive'
{'sans', 'sans serif', 'sans-serif'}	'font.sans-serif'

which are lists of font names.

### Text with non-latin glyphs

As of v2.0 the *default font* contains glyphs for many western alphabets, but still does not cover all of the glyphs that may be required by mpl users. For example, DejaVu has no coverage of Chinese, Korean, or Japanese.

To set the default font to be one that supports the code points you need, prepend the font name to 'font.family' or the desired alias lists

```
matplotlib.rcParams['font.sans-serif'] = ['Source Han Sans TW', 'sans-serif']
```

or set it in your .matplotlibrc file:

```
font.sans-serif: Source Han Sans TW, Arial, sans-serif
```

To control the font used on per-artist basis use the 'name', 'fontname' or 'fontproperties' kwargs documented *above*.

On linux, `fc-list` can be a useful tool to discover the font name; for example

```
$ fc-list :lang=zh family
Noto to Sans Mono CJK TC,Noto Sans Mono CJK TC Bold
Noto Sans CJK TC,Noto Sans CJK TC Medium
Noto Sans CJK TC,Noto Sans CJK TC DemiLight
Noto Sans CJK KR,Noto Sans CJK KR Black
Noto Sans CJK TC,Noto Sans CJK TC Black
Noto Sans Mono CJK TC,Noto Sans Mono CJK TC Regular
Noto Sans CJK SC,Noto Sans CJK SC Light
```

lists all of the fonts that support Chinese.

---

**Note:** Click [here](#) to download the full example code

---

## 2.5.4 Annotations

Annotating text with Matplotlib.

### Table of Contents

- *Annotations*

- *Basic annotation*
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  - *Using Complex Coordinates with Annotations*
  - *Using ConnectionPatch*
    - \* *Advanced Topics*
  - *Zoom effect between Axes*
  - *Define Custom BoxStyle*

### 2.5.5 Basic annotation

The uses of the basic `text()` will place text at an arbitrary position on the Axes. A common use case of text is to annotate some feature of the plot, and the `annotate()` method provides helper functionality to make annotations easy. In an annotation, there are two points to consider: the location being annotated represented by the argument `xy` and the location of the text `xytext`. Both of these arguments are `(x,y)` tuples.

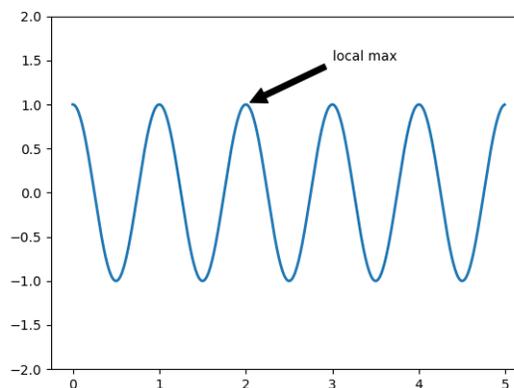


Fig. 23: Annotation Basic

In this example, both the `xy` (arrow tip) and `xytext` locations (text location) are in data coordinates. There are a variety of other coordinate systems one can choose - you can specify the coordinate system of `xy` and `xytext` with one of the following strings for `xycoords` and `textcoords` (default is 'data')

argument	coordinate system
'figure points'	points from the lower left corner of the figure
'figure pixels'	pixels from the lower left corner of the figure
'figure fraction'	0,0 is lower left of figure and 1,1 is upper right
'axes points'	points from lower left corner of axes
'axes pixels'	pixels from lower left corner of axes
'axes fraction'	0,0 is lower left of axes and 1,1 is upper right
'data'	use the axes data coordinate system

For example to place the text coordinates in fractional axes coordinates, one could do:

```
ax.annotate('local max', xy=(3, 1), xycoords='data',
            xytext=(0.8, 0.95), textcoords='axes fraction',
            arrowprops=dict(facecolor='black', shrink=0.05),
            horizontalalignment='right', verticalalignment='top',
            )
```

For physical coordinate systems (points or pixels) the origin is the bottom-left of the figure or axes.

Optionally, you can enable drawing of an arrow from the text to the annotated point by giving a dictionary of arrow properties in the optional keyword argument `arrowprops`.

arrowprops key	description
width	the width of the arrow in points
frac	the fraction of the arrow length occupied by the head
headwidth	the width of the base of the arrow head in points
shrink	move the tip and base some percent away from the annotated point and text
**kwargs	any key for <code>matplotlib.patches.Polygon</code> , e.g., <code>facecolor</code>

In the example below, the `xy` point is in native coordinates (`xycoords` defaults to 'data'). For a polar axes, this is in (theta, radius) space. The text in this example is placed in the fractional figure coordinate system. `matplotlib.text.Text` keyword args like `horizontalalignment`, `verticalalignment` and `fontsize` are passed from `annotate` to the `Text` instance.

For more on all the wild and wonderful things you can do with annotations, including fancy arrows, see *Advanced Annotation* and [/gallery/text\\_labels\\_and\\_annotations/annotation\\_demo](/gallery/text_labels_and_annotations/annotation_demo).

Do not proceed unless you have already read *Basic annotation*, `text()` and `annotate()`!

## 2.5.6 Advanced Annotation

### Annotating with Text with Box

Let's start with a simple example.

The `text()` function in the `pyplot` module (or `text` method of the `Axes` class) takes `bbox` keyword argument, and when given, a box around the text is drawn.

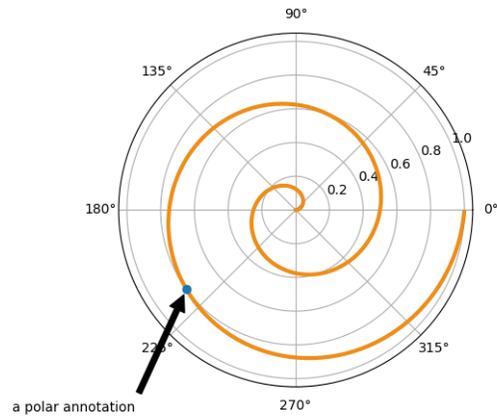


Fig. 24: Annotation Polar

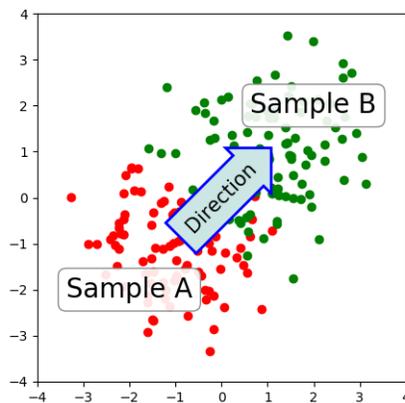


Fig. 25: Annotate Text Arrow

```

bbox_props = dict(boxstyle="rarrow,pad=0.3", fc="cyan", ec="b", lw=2)
t = ax.text(0, 0, "Direction", ha="center", va="center", rotation=45,
           size=15,
           bbox=bbox_props)

```

The patch object associated with the text can be accessed by:

```
bb = t.get_bbox_patch()
```

The return value is an instance of `FancyBboxPatch` and the patch properties like facecolor, edgewidth, etc. can be accessed and modified as usual. To change the shape of the box, use the `set_boxstyle` method.

```
bb.set_boxstyle("rarrow", pad=0.6)
```

The arguments are the name of the box style with its attributes as keyword arguments. Currently, following box styles are implemented.

Class	Name	Attrs
Circle	circle	pad=0.3
DArrow	darrow	pad=0.3
LArrow	larrow	pad=0.3
RArrow	rarrow	pad=0.3
Round	round	pad=0.3,rounding_size=None
Round4	round4	pad=0.3,rounding_size=None
Roundtooth	roundtooth	pad=0.3,tooth_size=None
Sawtooth	sawtooth	pad=0.3,tooth_size=None
Square	square	pad=0.3

Note that the attribute arguments can be specified within the style name with separating comma (this form can be used as "boxstyle" value of `bbox` argument when initializing the text instance)

```
bb.set_boxstyle("rarrow,pad=0.6")
```

### Annotating with Arrow

The `annotate()` function in the `pyplot` module (or `annotate` method of the `Axes` class) is used to draw an arrow connecting two points on the plot.

```

ax.annotate("Annotation",
           xy=(x1, y1), xycoords='data',
           xytext=(x2, y2), textcoords='offset points',
           )

```

This annotates a point at `xy` in the given coordinate (`xycoords`) with the text at `xytext` given in `textcoords`. Often, the annotated point is specified in the `data` coordinate and the annotating text in `offset points`. See `annotate()` for available coordinate systems.

An arrow connecting two points (`xy` & `xytext`) can be optionally drawn by specifying the `arrowprops` argument. To draw only an arrow, use empty string as the first argument.

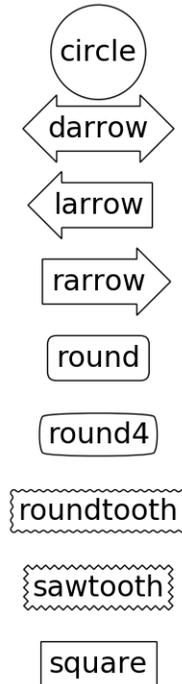


Fig. 26: Fancybox Demo

```
ax.annotate("",
            xy=(0.2, 0.2), xycoords='data',
            xytext=(0.8, 0.8), textcoords='data',
            arrowprops=dict(arrowstyle="->",
                            connectionstyle="arc3"),
            )
```

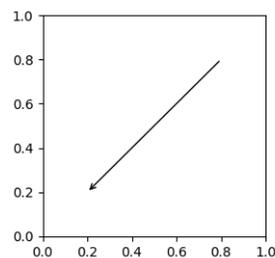


Fig. 27: Annotate Simple01

The arrow drawing takes a few steps.

1. a connecting path between two points are created. This is controlled by `connectionstyle` key value.
2. If patch object is given (*patchA* & *patchB*), the path is clipped to avoid the patch.
3. The path is further shrunk by given amount of pixels (*shrinkA* & *shrinkB*)
4. The path is transmuted to arrow patch, which is controlled by the `arrowstyle` key value.

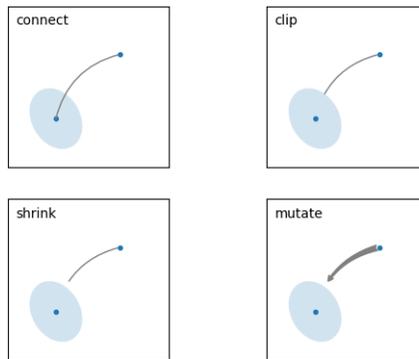


Fig. 28: Annotate Explain

The creation of the connecting path between two points is controlled by `connectionstyle` key and the following styles are available.

Name	Attrs
<code>angle</code>	<code>angleA=90,angleB=0,rad=0.0</code>
<code>angle3</code>	<code>angleA=90,angleB=0</code>
<code>arc</code>	<code>angleA=0,angleB=0,armA=None,armB=None,rad=0.0</code>
<code>arc3</code>	<code>rad=0.0</code>
<code>bar</code>	<code>armA=0.0,armB=0.0,fraction=0.3,angle=None</code>

Note that "3" in `angle3` and `arc3` is meant to indicate that the resulting path is a quadratic spline segment (three control points). As will be discussed below, some arrow style options can only be used when the connecting path is a quadratic spline.

The behavior of each connection style is (limitedly) demonstrated in the example below. (Warning : The behavior of the `bar` style is currently not well defined, it may be changed in the future).

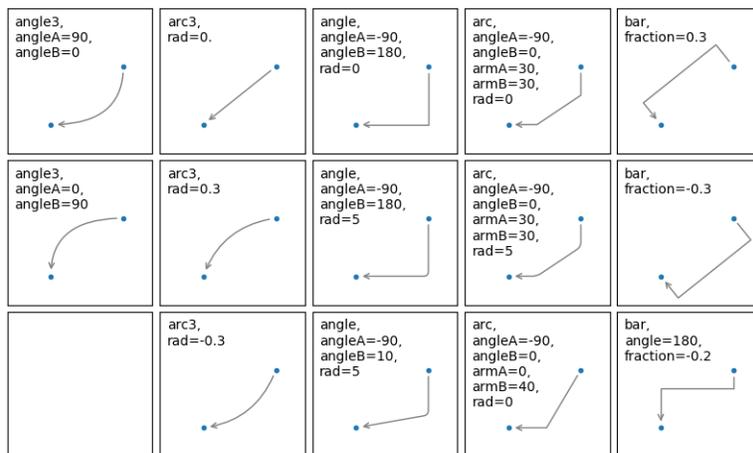


Fig. 29: Connectionstyle Demo

The connecting path (after clipping and shrinking) is then mutated to an arrow patch, accord-

ing to the given arrowstyle.

Name	Attrs
-	None
->	head_length=0.4,head_width=0.2
-[	widthB=1.0,lengthB=0.2,angleB=None
-	widthA=1.0,widthB=1.0
- >	head_length=0.4,head_width=0.2
<-	head_length=0.4,head_width=0.2
<->	head_length=0.4,head_width=0.2
< -	head_length=0.4,head_width=0.2
< - >	head_length=0.4,head_width=0.2
fancy	head_length=0.4,head_width=0.4,tail_width=0.4
simple	head_length=0.5,head_width=0.5,tail_width=0.2
wedge	tail_width=0.3,shrink_factor=0.5

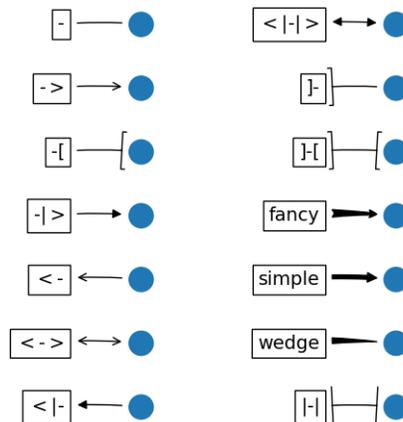


Fig. 30: Fancyarrow Demo

Some arrowstyles only work with connection styles that generate a quadratic-spline segment. They are fancy, simple, and wedge. For these arrow styles, you must use the "angle3" or "arc3" connection style.

If the annotation string is given, the patchA is set to the bbox patch of the text by default.

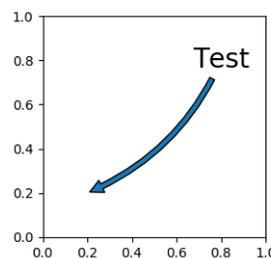


Fig. 31: Annotate Simple02

As in the text command, a box around the text can be drawn using the `bbbox` argument.

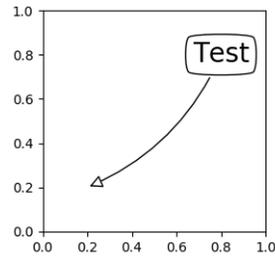


Fig. 32: Annotate Simple03

By default, the starting point is set to the center of the text extent. This can be adjusted with `relpos` key value. The values are normalized to the extent of the text. For example, (0,0) means lower-left corner and (1,1) means top-right.

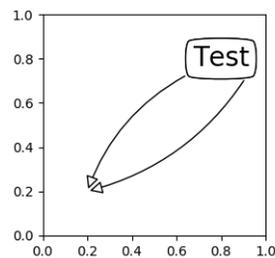


Fig. 33: Annotate Simple04

### Placing Artist at the anchored location of the Axes

There are classes of artists that can be placed at an anchored location in the Axes. A common example is the legend. This type of artist can be created by using the `OffsetBox` class. A few predefined classes are available in `mpl_toolkits.axes_grid1.anchored_artists` others in `matplotlib.offsetbox`

```
from matplotlib.offsetbox import AnchoredText
at = AnchoredText("Figure 1a",
                  prop=dict(size=15), frameon=True,
                  loc='upper left',
                  )
at.patch.set_boxstyle("round,pad=0.,rounding_size=0.2")
ax.add_artist(at)
```

The `loc` keyword has same meaning as in the legend command.

A simple application is when the size of the artist (or collection of artists) is known in pixel size during the time of creation. For example, If you want to draw a circle with fixed size of 20 pixel x 20 pixel (radius = 10 pixel), you can utilize `AnchoredDrawingArea`. The instance is created with a size of the drawing area (in pixels), and arbitrary artists can added to the drawing area. Note that the extents of the artists that are added to the drawing area are not related to the placement of the drawing area itself. Only the initial size matters.

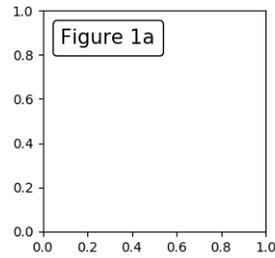


Fig. 34: Anchored Box01

```

from mpl_toolkits.axes_grid1.anchored_artists import AnchoredDrawingArea

ada = AnchoredDrawingArea(20, 20, 0, 0,
                          loc='upper right', pad=0., frameon=False)
p1 = Circle((10, 10), 10)
ada.drawing_area.add_artist(p1)
p2 = Circle((30, 10), 5, fc="r")
ada.drawing_area.add_artist(p2)

```

The artists that are added to the drawing area should not have a transform set (it will be overridden) and the dimensions of those artists are interpreted as a pixel coordinate, i.e., the radius of the circles in above example are 10 pixels and 5 pixels, respectively.

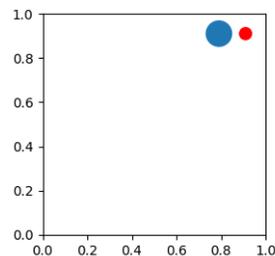


Fig. 35: Anchored Box02

Sometimes, you want your artists to scale with the data coordinate (or coordinates other than canvas pixels). You can use `AnchoredAuxTransformBox` class. This is similar to `AnchoredDrawingArea` except that the extent of the artist is determined during the drawing time respecting the specified transform.

```

from mpl_toolkits.axes_grid1.anchored_artists import AnchoredAuxTransformBox

box = AnchoredAuxTransformBox(ax.transData, loc='upper left')
el = Ellipse((0,0), width=0.1, height=0.4, angle=30) # in data coordinates!
box.drawing_area.add_artist(el)

```

The ellipse in the above example will have width and height corresponding to 0.1 and 0.4 in data coordinates and will be automatically scaled when the view limits of the axes change.

As in the legend, the `bbox_to_anchor` argument can be set. Using the `HParser` and `VParser`, you can have an arrangement(?) of artist as in the legend (as a matter of fact, this is how the legend is created).

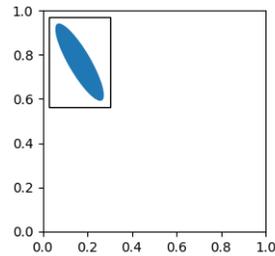


Fig. 36: Anchored Box03

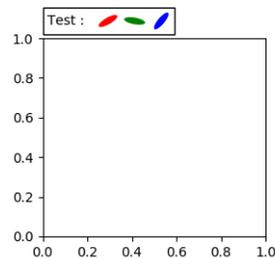


Fig. 37: Anchored Box04

Note that unlike the legend, the `bbox_transform` is set to `IdentityTransform` by default.

### Using Complex Coordinates with Annotations

The Annotation in matplotlib supports several types of coordinates as described in *Basic annotation*. For an advanced user who wants more control, it supports a few other options.

1. *Transform* instance. For example,

```
ax.annotate("Test", xy=(0.5, 0.5), xycoords=ax.transAxes)
```

is identical to

```
ax.annotate("Test", xy=(0.5, 0.5), xycoords="axes fraction")
```

With this, you can annotate a point in other axes.

```
ax1, ax2 = subplot(121), subplot(122)
ax2.annotate("Test", xy=(0.5, 0.5), xycoords=ax1.transData,
             xytext=(0.5, 0.5), textcoords=ax2.transData,
             arrowprops=dict(arrowstyle="->"))
```

2. *Artist* instance. The `xy` value (or `xytext`) is interpreted as a fractional coordinate of the `bbox` (return value of `get_window_extent`) of the artist.

```
an1 = ax.annotate("Test 1", xy=(0.5, 0.5), xycoords="data",
                 va="center", ha="center",
                 bbox=dict(boxstyle="round", fc="w"))
an2 = ax.annotate("Test 2", xy=(1, 0.5), xycoords=an1, # (1,0.5) of the an1's bbox
```

(continues on next page)

(continued from previous page)

```
xytext=(30,0), textcoords="offset points",
va="center", ha="left",
bbox=dict(boxstyle="round", fc="w"),
arrowprops=dict(arrowstyle="->"))
```

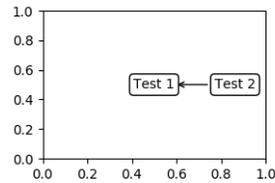


Fig. 38: Annotation with Simple Coordinates

Note that it is your responsibility that the extent of the coordinate artist (*an1* in above example) is determined before *an2* gets drawn. In most cases, it means that *an2* needs to be drawn later than *an1*.

3. A callable object that returns an instance of either *BboxBase* or *Transform*. If a transform is returned, it is the same as 1 and if a *bbox* is returned, it is the same as 2. The callable object should take a single argument of the renderer instance. For example, the following two commands give identical results

```
an2 = ax.annotate("Test 2", xy=(1, 0.5), xycoords=an1,
                 xytext=(30,0), textcoords="offset points")
an2 = ax.annotate("Test 2", xy=(1, 0.5), xycoords=an1.get_window_extent,
                 xytext=(30,0), textcoords="offset points")
```

4. A tuple of two coordinate specifications. The first item is for the x-coordinate and the second is for the y-coordinate. For example,

```
annotate("Test", xy=(0.5, 1), xycoords=("data", "axes fraction"))
```

0.5 is in data coordinates, and 1 is in normalized axes coordinates. You may use an artist or transform as with a tuple. For example,

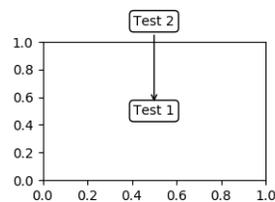


Fig. 39: Annotation with Simple Coordinates 2

5. Sometimes, you want your annotation with some "offset points", not from the annotated point but from some other point. *OffsetFrom* is a helper class for such cases.

You may take a look at this example [/gallery/text\\_labels\\_and\\_annotations/annotation\\_demo](/gallery/text_labels_and_annotations/annotation_demo).

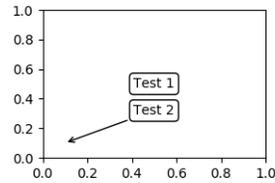


Fig. 40: Annotation with Simple Coordinates 3

### Using ConnectionPatch

The ConnectionPatch is like an annotation without text. While the annotate function is recommended in most situations, the ConnectionPatch is useful when you want to connect points in different axes.

```
from matplotlib.patches import ConnectionPatch
xy = (0.2, 0.2)
con = ConnectionPatch(xyA=xy, xyB=xy, coordsA="data", coordsB="data",
                    axesA=ax1, axesB=ax2)
ax2.add_artist(con)
```

The above code connects point `xy` in the data coordinates of `ax1` to point `xy` in the data coordinates of `ax2`. Here is a simple example.

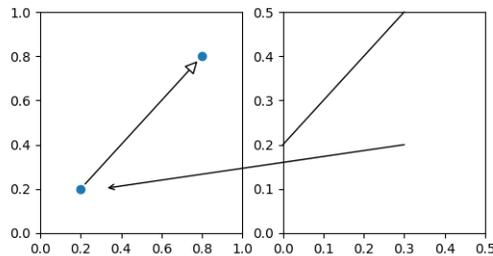


Fig. 41: Connect Simple01

While the ConnectionPatch instance can be added to any axes, you may want to add it to the axes that is latest in drawing order to prevent overlap by other axes.

### Advanced Topics

#### Zoom effect between Axes

`mpl_toolkits.axes_grid1.inset_locator` defines some patch classes useful for interconnecting two axes. Understanding the code requires some knowledge of how mpl's transform works. But, utilizing it will be straight forward.

#### Define Custom BoxStyle

You can use a custom box style. The value for the `boxstyle` can be a callable object in the following forms.:

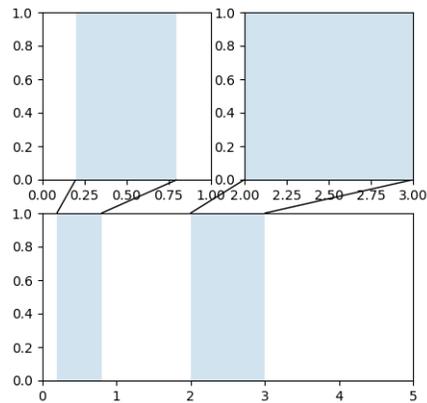


Fig. 42: Axes Zoom Effect

```
def __call__(self, x0, y0, width, height, mutation_size,
             aspect_ratio=1.):
    """
    Given the location and size of the box, return the path of
    the box around it.

    - *x0*, *y0*, *width*, *height* : location and size of the box
    - *mutation_size* : a reference scale for the mutation.
    - *aspect_ratio* : aspect-ratio for the mutation.
    """
    path = ...
    return path
```

Here is a complete example.

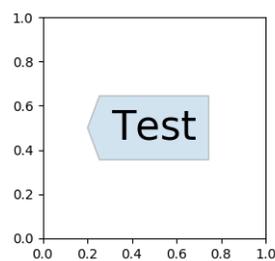


Fig. 43: Custom Boxstyle01

However, it is recommended that you derive from the `matplotlib.patches.BoxStyle._Base` as demonstrated below.

Similarly, you can define a custom `ConnectionStyle` and a custom `ArrowStyle`. See the source code of `lib/matplotlib/patches.py` and check how each style class is defined.

---

**Note:** Click [here](#) to download the full example code

---

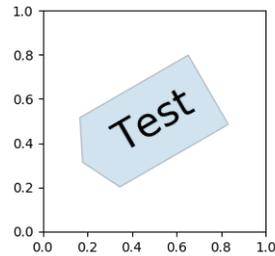


Fig. 44: Custom Boxstyle02

## 2.5.7 Writing mathematical expressions

An introduction to writing mathematical expressions in Matplotlib.

You can use a subset TeX markup in any matplotlib text string by placing it inside a pair of dollar signs (\$).

Note that you do not need to have TeX installed, since Matplotlib ships its own TeX expression parser, layout engine, and fonts. The layout engine is a fairly direct adaptation of the layout algorithms in Donald Knuth's TeX, so the quality is quite good (matplotlib also provides a `usetex` option for those who do want to call out to TeX to generate their text (see *Text rendering With LaTeX*).

Any text element can use math text. You should use raw strings (precede the quotes with an 'r'), and surround the math text with dollar signs (\$), as in TeX. Regular text and `mathtext` can be interleaved within the same string. `Mathtext` can use DejaVu Sans (default), DejaVu Serif, the Computer Modern fonts (from (La)TeX), **STIX** fonts (with are designed to blend well with Times), or a Unicode font that you provide. The `mathtext` font can be selected with the customization variable `mathtext.fontset` (see *Customizing Matplotlib with style sheets and rcParams*)

Here is a simple example:

```
# plain text
plt.title('alpha > beta')
```

produces "alpha > beta".

Whereas this:

```
# math text
plt.title(r'$\alpha > \beta$')
```

produces " $\alpha > \beta$ ".

---

**Note:** `Mathtext` should be placed between a pair of dollar signs (\$). To make it easy to display monetary values, e.g., "\$100.00", if a single dollar sign is present in the entire string, it will be displayed verbatim as a dollar sign. This is a small change from regular TeX, where the dollar sign in non-math text would have to be escaped (`\$`).

---

**Note:** While the syntax inside the pair of dollar signs (\$) aims to be TeX-like, the text outside does not. In particular, characters such as:



```
r'\left(\frac{5 - \frac{1}{x}}{4}\right)'
```

$$\left(\frac{5 - \frac{1}{x}}{4}\right)$$

## Radicals

Radicals can be produced with the `\sqrt[]{}{}` command. For example:

```
r'\sqrt{2}'
```

$$\sqrt{2}$$

Any base can (optionally) be provided inside square brackets. Note that the base must be a simple expression, and can not contain layout commands such as fractions or sub/superscripts:

```
r'\sqrt[3]{x}'
```

$$\sqrt[3]{x}$$

## Fonts

The default font is *italics* for mathematical symbols.

---

**Note:** This default can be changed using the `mathtext.default rcParam`. This is useful, for example, to use the same font as regular non-math text for math text, by setting it to `regular`.

---

To change fonts, e.g., to write "sin" in a Roman font, enclose the text in a font command:

```
r'$s(t) = \mathcal{A}\mathrm{sin}(2 \omega t)$'
```

$$s(t) = \mathcal{A}\sin(2\omega t)$$

More conveniently, many commonly used function names that are typeset in a Roman font have shortcuts. So the expression above could be written as follows:

```
r'$s(t) = \mathcal{A}\sin(2 \omega t)$'
```

$$s(t) = \mathcal{A}\sin(2\omega t)$$

Here "s" and "t" are variable in italics font (default), "sin" is in Roman font, and the amplitude "A" is in calligraphy font. Note in the example above the calligraphy A is squished into the sin. You can use a spacing command to add a little whitespace between them:

```
r'$s(t) = \mathcal{A}\ \sin(2 \omega t)$'
```

$$s(t) = \mathcal{A} \sin(2\omega t)$$

The choices available with all fonts are:

Command	Result
<code>\mathrm{Roman}</code>	Roman
<code>\mathit{Italic}</code>	<i>Italic</i>
<code>\mathtt{Typewriter}</code>	Typewriter
<code>\mathcal{CALLIGRAPHY}</code>	<i>CALLIGRAPHY</i>

When using the **STIX** fonts, you also have the choice of:

Command	Result
<code>\mathbb{blackboard}</code>	$\langle \mathbb{1} \rangle$
<code>\mathrm{\mathbb{blackboard}}</code>	$\langle \mathbb{1} \rangle$
<code>\mathfrak{Fraktur}</code>	$\mathfrak{t}$
<code>\mathsf{sansserif}</code>	sansserif
<code>\mathrm{\mathsf{sansserif}}</code>	sansserif

There are also three global “font sets” to choose from, which are selected using the `mathtext.fontset` parameter in `matplotlibrc`.

cm: **Computer Modern (TeX)**

$$\mathcal{R} \prod_{i=\alpha_{i+1}}^{\infty} a_i \sin(2\pi f x_i)$$

stix: **STIX** (designed to blend well with Times)

$$\mathcal{R} \prod_{i=\alpha_{i+1}}^{\infty} a_i \sin(2\pi f x_i)$$

stixsans: **STIX sans-serif**

$$\mathcal{R} \prod_{i=\alpha_{i+1}}^{\infty} a_i \sin(2\pi f x_i)$$

Additionally, you can use `\mathdefault{...}` or its alias `\mathregular{...}` to use the font used for regular text outside of `mathtext`. There are a number of limitations to this approach, most notably that far fewer symbols will be available, but it can be useful to make math expressions blend well with other text in the plot.

### Custom fonts

`mathtext` also provides a way to use custom fonts for math. This method is fairly tricky to use, and should be considered an experimental feature for patient users only. By setting the rcParam `mathtext.fontset` to `custom`, you can then set the following parameters, which control which font file to use for a particular set of math characters.

Parameter	Corresponds to
<code>mathtext.it</code>	<code>\mathit{}</code> or default italic
<code>mathtext.rm</code>	<code>\mathrm{}</code> Roman (upright)
<code>mathtext.tt</code>	<code>\mathtt{}</code> Typewriter (monospace)
<code>mathtext.bf</code>	<code>\mathbf{}</code> bold italic
<code>mathtext.cal</code>	<code>\mathcal{}</code> calligraphic
<code>mathtext.sf</code>	<code>\mathsf{}</code> sans-serif

Each parameter should be set to a fontconfig font descriptor (as defined in the yet-to-be-written font chapter).

The fonts used should have a Unicode mapping in order to find any non-Latin characters, such as Greek. If you want to use a math symbol that is not contained in your custom fonts, you can set the rcParam `mathtext.fallback_to_cm` to `True` which will cause the `mathtext` system to use characters from the default Computer Modern fonts whenever a particular character can not be found in the custom font.

Note that the math glyphs specified in Unicode have evolved over time, and many fonts may not have glyphs in the correct place for `mathtext`.

### Accents

An accent command may precede any symbol to add an accent above it. There are long and short forms for some of them.

Command	Result
<code>\acute a</code> or <code>\'a</code>	$\acute{a}$
<code>\bar a</code>	$\bar{a}$
<code>\breve a</code>	$\breve{a}$
<code>\ddot a</code> or <code>\''a</code>	$\ddot{a}$
<code>\dot a</code> or <code>\.a</code>	$\dot{a}$
<code>\grave a</code> or <code>\`a</code>	$\grave{a}$
<code>\hat a</code> or <code>\^a</code>	$\hat{a}$
<code>\tilde a</code> or <code>\~a</code>	$\tilde{a}$
<code>\vec a</code>	$\vec{a}$
<code>\overline{abc}</code>	$\overline{abc}$

In addition, there are two special accents that automatically adjust to the width of the symbols below:

Command	Result
<code>\widehat{xyz}</code>	$\widehat{xyz}$
<code>\widetilde{xyz}</code>	$\widetilde{xyz}$

Care should be taken when putting accents on lower-case *i*'s and *j*'s. Note that in the following `\imath` is used to avoid the extra dot over the *i*:

```
r"$\hat i \ \ \hat \imath"
```

$\hat{i}$   $\hat{\imath}$

## Symbols

You can also use a large number of the TeX symbols, as in `\infty`, `\leftarrow`, `\sum`, `\int`.

### Lower-case Greek

$\alpha$ <code>\alpha</code>	$\beta$ <code>\beta</code>	$\chi$ <code>\chi</code>	$\delta$ <code>\delta</code>	$\digamma$ <code>\digamma</code>	$\epsilon$ <code>\epsilon</code>
$\eta$ <code>\eta</code>	$\gamma$ <code>\gamma</code>	$\iota$ <code>\iota</code>	$\kappa$ <code>\kappa</code>	$\lambda$ <code>\lambda</code>	$\mu$ <code>\mu</code>
$\nu$ <code>\nu</code>	$\omega$ <code>\omega</code>	$\phi$ <code>\phi</code>	$\pi$ <code>\pi</code>	$\psi$ <code>\psi</code>	$\rho$ <code>\rho</code>
$\sigma$ <code>\sigma</code>	$\tau$ <code>\tau</code>	$\theta$ <code>\theta</code>	$\upsilon$ <code>\upsilon</code>	$\varepsilon$ <code>\varepsilon</code>	$\varkappa$ <code>\varkappa</code>
$\phi$ <code>\varphi</code>	$\varpi$ <code>\varpi</code>	$\varrho$ <code>\varrho</code>	$\varsigma$ <code>\varsigma</code>	$\vartheta$ <code>\vartheta</code>	$\xi$ <code>\xi</code>
$\zeta$ <code>\zeta</code>					

### Upper-case Greek

$\Delta$ <code>\Delta</code>	$\Gamma$ <code>\Gamma</code>	$\Lambda$ <code>\Lambda</code>	$\Omega$ <code>\Omega</code>	$\Phi$ <code>\Phi</code>	$\Pi$ <code>\Pi</code>	$\Psi$ <code>\Psi</code>	$\Sigma$ <code>\Sigma</code>
$\Theta$ <code>\Theta</code>	$\Upsilon$ <code>\Upsilon</code>	$\Xi$ <code>\Xi</code>	$\Upsilon$ <code>\mho</code>	$\nabla$ <code>\nabla</code>			
	$\Upsilon$ <code>\Upsilon</code>						

### Hebrew

$\aleph$ <code>\aleph</code>	$\beth$ <code>\beth</code>	$\daleth$ <code>\daleth</code>	$\gimel$ <code>\gimel</code>		
------------------------------	----------------------------	--------------------------------	------------------------------	--	--

### Delimiters

<code>//</code>	<code>[ [</code>	$\Downarrow$ <code>\Downarrow</code>	$\Uparrow$ <code>\Uparrow</code>	$\Vert$ <code>\Vert</code>	<code>\backslash</code>
$\downarrow$ <code>\downarrow</code>	$\langle$ <code>\langle</code>	$\lceil$ <code>\lceil</code>	$\lfloor$ <code>\lfloor</code>	$\llcorner$ <code>\llcorner</code>	$\lrcorner$ <code>\lrcorner</code>
$\rangle$ <code>\rangle</code>	$\rceil$ <code>\rceil</code>	$\rfloor$ <code>\rfloor</code>	$\ulcorner$ <code>\ulcorner</code>	$\uparrow$ <code>\uparrow</code>	$\urcorner$ <code>\urcorner</code>
$\vert$ <code>\vert</code>	<code>{ \{</code>	$\backslash$	<code>} \}</code>	<code>] ]</code>	<code> </code>

### Big symbols

$\bigcap$ <code>\bigcap</code>	$\bigcup$ <code>\bigcup</code>	$\bigodot$ <code>\bigodot</code>	$\bigoplus$ <code>\bigoplus</code>	$\bigotimes$ <code>\bigotimes</code>	$\biguplus$ <code>\biguplus</code>
$\bigvee$ <code>\bigvee</code>	$\bigwedge$ <code>\bigwedge</code>	$\coprod$ <code>\coprod</code>	$\int$ <code>\int</code>	$\oint$ <code>\oint</code>	$\prod$ <code>\prod</code>
$\sum$ <code>\sum</code>					

### Standard function names

Pr \Pr	arccos \arccos	arcsin \arcsin	arctan \arctan	arg \arg	cos \cos
cosh \cosh	cot \cot	coth \coth	csc \csc	deg \deg	det \det
dim \dim	exp \exp	gcd \gcd	hom \hom	inf \inf	ker \ker
lg \lg	lim \lim	liminf \liminf	limsup \limsup	ln \ln	log \log
max \max	min \min	sec \sec	sin \sin	sinh \sinh	sup \sup
tan \tan	tanh \tanh				

### Binary operation and relation symbols

$\sqcup$ \Bumpeq	$\cap$ \Cap	$\cup$ \Cup	$\doteq$ \Doteq
$\Join$ \Join	$\subset$ \Subset	$\supset$ \Supset	$\Vdash$ \VDash
$\Vdash$ \Vdash	$\approx$ \approx	$\approx$ \approxeq	$*$ \ast
$\asymp$ \asymp	$\backepsilon$ \backepsilon	$\backsimeq$ \backsimeq	$\backsim$ \backsimeq
$\bar{\wedge}$ \barwedge	$\because$ \because	$\between$ \between	$\bigcirc$ \bigcirc
$\bigtriangledown$ \bigtriangledown	$\bigtriangleup$ \bigtriangleup	$\blacktriangleleft$ \blacktriangleleft	$\blacktriangleright$ \blacktriangleright
$\bot$ \bot	$\bowtie$ \bowtie	$\boxdot$ \boxdot	$\boxminus$ \boxminus
$\boxplus$ \boxplus	$\boxtimes$ \boxtimes	$\bullet$ \bullet	$\bumpeq$ \bumpeq
$\cap$ \cap	$\cdot$ \cdot	$\circ$ \circ	$\circeq$ \circeq
$\coloneqq$ \coloneqq	$\cong$ \cong	$\cup$ \cup	$\curlyeqprec$ \curlyeqprec
$\curlyeqsucc$ \curlyeqsucc	$\curlyvee$ \curlyvee	$\curlywedge$ \curlywedge	$\dagger$ \dagger
$\dashv$ \dashv	$\ddagger$ \ddagger	$\diamond$ \diamond	$\div$ \div
$\divideontimes$ \divideontimes	$\doteq$ \doteq	$\doteqdot$ \doteqdot	$\dotplus$ \dotplus
$\doublebarwedge$ \doublebarwedge	$\eqcirc$ \eqcirc	$\equiv$ \equiv	$\eqsim$ \eqsim
$\eqslantgtr$ \eqslantgtr	$\eqslantless$ \eqslantless	$\equiv$ \equiv	$\fallingdotseq$ \fallingdotseq
$\frown$ \frown	$\geq$ \geq	$\geqq$ \geqq	$\geqslant$ \geqslant
$\gg$ \gg	$\ggg$ \ggg	$\gtrapprox$ \gtrapprox	$\gtrless$ \gtrless
$\gnsim$ \gnsim	$\gtrapprox$ \gtrapprox	$\gtrdot$ \gtrdot	$\gtreqless$ \gtreqless
$\gtreqless$ \gtreqless	$\gtrless$ \gtrless	$\gtrsim$ \gtrsim	$\in$ \in
$\intercal$ \intercal	$\leftthreetimes$ \leftthreetimes	$\leq$ \leq	$\leqq$ \leqq
$\leqslant$ \leqslant	$\lessapprox$ \lessapprox	$\lessdot$ \lessdot	$\lesseqgtr$ \lesseqgtr
$\lesseqqgtr$ \lesseqqgtr	$\lessgtr$ \lessgtr	$\lesssim$ \lesssim	$\ll$ \ll
$\lll$ \lll	$\lnapprox$ \lnapprox	$\lneqq$ \lneqq	$\lnsim$ \lnsim
$\ltimes$ \ltimes	$\mid$ \mid	$\models$ \models	$\mp$ \mp
$\nVDash$ \nVDash	$\nVDash$ \nVDash	$\napprox$ \napprox	$\ncong$ \ncong
$\neq$ \neq	$\neq$ \neq	$\neq$ \neq	$\nequiv$ \nequiv
$\ngeq$ \ngeq	$\ngtr$ \ngtr	$\ni$ \ni	$\nleq$ \nleq
$\nless$ \nless	$\nmid$ \nmid	$\notin$ \notin	$\nparallel$ \nparallel
$\nprec$ \nprec	$\nsim$ \nsim	$\nsubset$ \nsubset	$\nsubseteq$ \nsubseteq
$\nsucc$ \nsucc	$\nsupset$ \nsupset	$\nsupseteq$ \nsupseteq	$\ntriangleleft$ \ntriangleleft
$\ntrianglelefteq$ \ntrianglelefteq	$\ntriangleright$ \ntriangleright	$\ntrianglerighteq$ \ntrianglerighteq	$\nVdash$ \nVdash
$\nvDash$ \nvDash	$\odot$ \odot	$\ominus$ \ominus	$\oplus$ \oplus
$\oslash$ \oslash	$\otimes$ \otimes	$\parallel$ \parallel	$\perp$ \perp
$\pitchfork$ \pitchfork	$\pm$ \pm	$\prec$ \prec	$\precapprox$ \precapprox
$\preccurlyeq$ \preccurlyeq	$\preceq$ \preceq	$\precnapprox$ \precnapprox	$\precnsim$ \precnsim
$\precsim$ \precsim	$\propto$ \propto	$\rightthreetimes$ \rightthreetimes	$\risingdotseq$ \risingdotseq
$\rtimes$ \rtimes	$\sim$ \sim	$\simeq$ \simeq	$/$ \slash

Continued on next page

Table 2 – continued from previous page

$\sqcap$ \smile	$\sqcap$ \sqcap	$\sqcup$ \sqcup	$\sqsubset$ \sqsubset
$\sqsubset$ \sqsubset	$\sqsubseteq$ \sqsubseteq	$\sqsupset$ \sqsupset	$\sqsupseteq$ \sqsupseteq
$\sqsupseteq$ \sqsupseteq	$\star$ \star	$\subset$ \subset	$\subseteq$ \subseteq
$\subseteq$ \subseteq	$\subsetneq$ \subsetneq	$\subsetneqq$ \subsetneqq	\succ
$\simeq$ \simeq	$\succcurlyeq$ \succcurlyeq	$\succeq$ \succeq	$\succapprox$ \succapprox
$\sim$ \sim	$\succsim$ \succsim	$\supset$ \supset	$\supseteq$ \supseteq
$\supseteq$ \supseteq	$\supsetneq$ \supsetneq	$\supsetneqq$ \supsetneqq	\therefore
$\times$ \times	$\top$ \top	$\triangleleft$ \triangleleft	$\trianglelefteq$ \trianglelefteq
$\triangleleft$ \triangleleft	$\triangleright$ \triangleright	$\trianglerighteq$ \trianglerighteq	$\uplus$ \uplus
$\vDash$ \vDash	$\varpropto$ \varpropto	$\vartriangleleft$ \vartriangleleft	$\vartriangleright$ \vartriangleright
$\vdash$ \vdash	$\vee$ \vee	$\veebar$ \veebar	$\wedge$ \wedge
$\wr$ \wr			

### Arrow symbols

$\Downarrow$ \Downarrow	$\Leftarrow$ \Leftarrow	$\Leftrightarrow$ \Leftrightarrow	$\Lleftarrow$ \Lleftarrow
$\Lleftarrow$ \Lleftarrow	$\Lrightrightarrows$ \Lrightrightarrows	$\Longrightarrow$ \Longrightarrow	$\Lsh$ \Lsh
$\Nearrow$ \Nearrow	$\Nwarrow$ \Nwarrow	$\Rightarrow$ \Rightarrow	$\Rrightarrow$ \Rrightarrow
$\Rsh$ \Rsh	$\Searrow$ \Searrow	$\Swarrow$ \Swarrow	$\Uparrow$ \Uparrow
$\Updownarrow$ \Updownarrow	$\circlearrowleft$ \circlearrowleft	$\circlearrowright$ \circlearrowright	$\curvearrowleft$ \curvearrowleft
$\curvearrowright$ \curvearrowright	$\dashleftarrow$ \dashleftarrow	$\dashrightarrow$ \dashrightarrow	$\downarrow$ \downarrow
$\Downarrow$ \Downarrow	$\downharpoonleft$ \downharpoonleft	$\downharpoonright$ \downharpoonright	$\hookleftarrow$ \hookleftarrow
$\hookrightarrow$ \hookrightarrow	$\leadsto$ \leadsto	$\leftarrow$ \leftarrow	$\leftarrowtail$ \leftarrowtail
$\leftharpoondown$ \leftharpoondown	$\leftharpoonup$ \leftharpoonup	$\leftleftarrows$ \leftleftarrows	$\leftrightarrow$ \leftrightarrow
$\leftrightsquigarrow$ \leftrightsquigarrow	$\leftrightharpoons$ \leftrightharpoons	$\leftrightsquigarrow$ \leftrightsquigarrow	$\leftsquigarrow$ \leftsquigarrow
$\longleftarrow$ \longleftarrow	$\longleftrightarrow$ \longleftrightarrow	$\longmapsto$ \longmapsto	$\longrightarrow$ \longrightarrow
$\looparrowleft$ \looparrowleft	$\looparrowright$ \looparrowright	$\mapsto$ \mapsto	$\multimap$ \multimap
$\nLeftarrow$ \nLeftarrow	$\nLeftrightarrow$ \nLeftrightarrow	$\nrightarrow$ \nrightarrow	$\nearrow$ \nearrow
$\nleftarrow$ \nleftarrow	$\nlefttrightarrow$ \nlefttrightarrow	$\rightarrow$ \rightarrow	$\nwarrow$ \nwarrow
$\rightarrow$ \rightarrow	$\rightarrowtail$ \rightarrowtail	$\rightharpoondown$ \rightharpoondown	$\rightharpoonup$ \rightharpoonup
$\rightrightarrows$ \rightrightarrows	$\rightleftarrows$ \rightleftarrows	$\rightleftharpoons$ \rightleftharpoons	$\rightleftharpoons$ \rightleftharpoons
$\rightrightarrows$ \rightrightarrows	$\rightrightarrows$ \rightrightarrows	$\rightsquigarrow$ \rightsquigarrow	$\searrow$ \searrow
$\swarrow$ \swarrow	$\rightarrow$ \to	$\twoheadleftarrow$ \twoheadleftarrow	$\twoheadrightarrow$ \twoheadrightarrow
$\uparrow$ \uparrow	$\updownarrow$ \updownarrow	$\updownarrow$ \updownarrow	$\upharpoonleft$ \upharpoonleft
$\upharpoonright$ \upharpoonright	$\upuparrows$ \upuparrows		

### Miscellaneous symbols

$\$ \backslash \$$	$\text{\AA} \backslash AA$	$\text{\Finv} \backslash Finv$	$\text{\Game} \backslash Game$
$\text{\Im} \backslash \text{Im}$	$\text{\P} \backslash P$	$\text{\Re} \backslash Re$	$\text{\S} \backslash S$
$\angle \backslash angle$	$\text{\backprime} \backslash \text{backprime}$	$\text{\bigstar} \backslash \text{bigstar}$	$\blacksquare \backslash \text{blacksquare}$
$\blacktriangle \backslash \text{blacktriangle}$	$\blacktriangledown \backslash \text{blacktriangledown}$	$\text{\cdots} \backslash \text{cdots}$	$\checkmark \backslash \text{checkmark}$
$\text{\circledR} \backslash \text{circledR}$	$\text{\circledS} \backslash \text{circledS}$	$\clubsuit \backslash \text{clubsuit}$	$\text{\complement} \backslash \text{complement}$
$\text{\copyright} \backslash \text{copyright}$	$\text{\ddots} \backslash \text{ddots}$	$\diamondsuit \backslash \text{diamondsuit}$	$\text{\ell} \backslash \text{ell}$
$\text{\emptyset} \backslash \text{emptyset}$	$\text{\eth} \backslash \text{eth}$	$\exists \backslash \text{exists}$	$\flat \backslash \text{flat}$
$\forall \backslash \text{forall}$	$\hbar \backslash \text{hbar}$	$\heartsuit \backslash \text{heartsuit}$	$\hslash \backslash \text{hslash}$
$\iiint \backslash \text{iiint}$	$\iint \backslash \text{iint}$	$\imath \backslash \text{imath}$	$\infty \backslash \text{infty}$
$\jmath \backslash \text{jmath}$	$\dots \backslash \text{ldots}$	$\measuredangle \backslash \text{measuredangle}$	$\natural \backslash \text{natural}$
$\neg \backslash \text{neg}$	$\nexists \backslash \text{nexists}$	$\oiint \backslash \text{oiint}$	$\partial \backslash \text{partial}$
$\prime \backslash \text{prime}$	$\sharp \backslash \text{sharp}$	$\spadesuit \backslash \text{spadesuit}$	$\sphericalangle \backslash \text{sphericalangle}$
$\text{\ss} \backslash \text{ss}$	$\triangledown \backslash \text{triangledown}$	$\varnothing \backslash \text{varnothing}$	$\vartriangle \backslash \text{vartriangle}$
$\text{\vdots} \backslash \text{vdots}$	$\wp \backslash \text{wp}$	$\yen \backslash \text{yen}$	

If a particular symbol does not have a name (as is true of many of the more obscure symbols in the STIX fonts), Unicode characters can also be used:

```
ur'$\u23ce$'
```

#### Example

Here is an example illustrating many of these features in context.

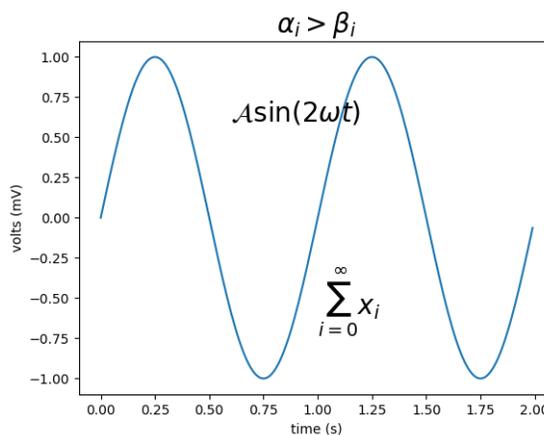


Fig. 45: Pyplot Mathtext

**Note:** Click [here](#) to download the full example code

## 2.5.8 Typesetting With XeLaTeX/LuaLaTeX

How to typeset text with the pgf backend in Matplotlib.

Using the `pgf` backend, matplotlib can export figures as `pgf` drawing commands that can be processed with `pdflatex`, `xelatex` or `lualatex`. XeLaTeX and LuaLaTeX have full unicode support and can use any font that is installed in the operating system, making use of advanced typographic features of OpenType, AAT and Graphite. `Pgf` pictures created by `plt.savefig('figure.pgf')` can be embedded as raw commands in LaTeX documents. Figures can also be directly compiled and saved to PDF with `plt.savefig('figure.pdf')` by either switching to the backend

```
matplotlib.use('pgf')
```

or registering it for handling pdf output

```
from matplotlib.backends.backend_pgf import FigureCanvasPgf
matplotlib.backend_bases.register_backend('pdf', FigureCanvasPgf)
```

The second method allows you to keep using regular interactive backends and to save `xelatex`, `lualatex` or `pdflatex` compiled PDF files from the graphical user interface.

Matplotlib's `pgf` support requires a recent LaTeX installation that includes the TikZ/PGF packages (such as [TeXLive](#)), preferably with XeLaTeX or LuaLaTeX installed. If either `pdftocairo` or `ghostscript` is present on your system, figures can optionally be saved to PNG images as well. The executables for all applications must be located on your `PATH`.

Rc parameters that control the behavior of the `pgf` backend:

Parameter	Documentation
<code>pgf.preamble</code>	Lines to be included in the LaTeX preamble
<code>pgf.rcfonts</code>	Setup fonts from rc params using the <code>fontspec</code> package
<code>pgf.texsystem</code>	Either "xelatex" (default), "lualatex" or "pdflatex"

**Note:** TeX defines a set of special characters, such as:

```
# $ % & ~ _ ^ \ { }
```

Generally, these characters must be escaped correctly. For convenience, some characters (`_`, `^`, `%`) are automatically escaped outside of math environments.

## Multi-Page PDF Files

The `pgf` backend also supports multipage pdf files using `PdfPages`

```
from matplotlib.backends.backend_pgf import PdfPages
import matplotlib.pyplot as plt

with PdfPages('multipage.pdf', metadata={'author': 'Me'}) as pdf:

    fig1, ax1 = plt.subplots()
    ax1.plot([1, 5, 3])
    pdf.savefig(fig1)

    fig2, ax2 = plt.subplots()
```

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```
ax2.plot([1, 5, 3])
pdf.savefig(fig2)
```

## Font specification

The fonts used for obtaining the size of text elements or when compiling figures to PDF are usually defined in the matplotlib rc parameters. You can also use the LaTeX default Computer Modern fonts by clearing the lists for `font.serif`, `font.sans-serif` or `font.monospace`. Please note that the glyph coverage of these fonts is very limited. If you want to keep the Computer Modern font face but require extended unicode support, consider installing the [Computer Modern Unicode](#) fonts *CMU Serif*, *CMU Sans Serif*, etc.

When saving to `.pgf`, the font configuration matplotlib used for the layout of the figure is included in the header of the text file.

```
"""
=====
Pgf Fonts
=====

"""

import matplotlib.pyplot as plt
plt.rcParams.update({
    "font.family": "serif",
    "font.serif": [], # use latex default serif font
    "font.sans-serif": ["DejaVu Sans"], # use a specific sans-serif font
})

plt.figure(figsize=(4.5, 2.5))
plt.plot(range(5))
plt.text(0.5, 3., "serif")
plt.text(0.5, 2., "monospace", family="monospace")
plt.text(2.5, 2., "sans-serif", family="sans-serif")
plt.text(2.5, 1., "comic sans", family="Comic Sans MS")
plt.xlabel("μ is not  $\mu$ ")
plt.tight_layout(.5)
```

## Custom preamble

Full customization is possible by adding your own commands to the preamble. Use the `pgf.preamble` parameter if you want to configure the math fonts, using `unicode-math` for example, or for loading additional packages. Also, if you want to do the font configuration yourself instead of using the fonts specified in the rc parameters, make sure to disable `pgf.rcfonts`.

```
"""
=====
Pgf Preamble
=====
```

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```
"""
import matplotlib as mpl
mpl.use("pgf")
```

### Choosing the TeX system

The TeX system to be used by matplotlib is chosen by the `pgf.texsystem` parameter. Possible values are 'xelatex' (default), 'lualatex' and 'pdflatex'. Please note that when selecting `pdflatex` the fonts and unicode handling must be configured in the preamble.

```
"""
=====
Pgf TeXsystem
=====

"""

import matplotlib.pyplot as plt
plt.rcParams.update({
    "pgf.texsystem": "pdflatex",
    "pgf.preamble": [
        r"\usepackage[utf8x]{inputenc}",
        r"\usepackage[T1]{fontenc}",
        r"\usepackage{cmbright}",
    ]
})

plt.figure(figsize=(4.5, 2.5))
plt.plot(range(5))
plt.text(0.5, 3., "serif", family="serif")
plt.text(0.5, 2., "monospace", family="monospace")
plt.text(2.5, 2., "sans-serif", family="sans-serif")
plt.xlabel(r" $\mu$  is not  $\mu$ ")
plt.tight_layout(.5)
```

### Troubleshooting

- Please note that the TeX packages found in some Linux distributions and MiKTeX installations are dramatically outdated. Make sure to update your package catalog and upgrade or install a recent TeX distribution.
- On Windows, the `PATH` environment variable may need to be modified to include the directories containing the `latex`, `dvipng` and `ghostscript` executables. See *Environment Variables* and *Setting environment variables in windows* for details.
- A limitation on Windows causes the backend to keep file handles that have been opened by your application open. As a result, it may not be possible to delete the corresponding files until the application closes (see [#1324](#)).

- Sometimes the font rendering in figures that are saved to png images is very bad. This happens when the `pdftocairo` tool is not available and `ghostscript` is used for the pdf to png conversion.
- Make sure what you are trying to do is possible in a LaTeX document, that your LaTeX syntax is valid and that you are using raw strings if necessary to avoid unintended escape sequences.
- The `pgf.preamble.rc` setting provides lots of flexibility, and lots of ways to cause problems. When experiencing problems, try to minimize or disable the custom preamble.
- Configuring an `unicode-math` environment can be a bit tricky. The TeXLive distribution for example provides a set of math fonts which are usually not installed system-wide. XeTeX, unlike LuaLatex, cannot find these fonts by their name, which is why you might have to specify `\setmathfont{xits-math.otf}` instead of `\setmathfont{XITS Math}` or alternatively make the fonts available to your OS. See this [tex.stackexchange.com](https://tex.stackexchange.com) question for more details.
- If the font configuration used by matplotlib differs from the font setting in your LaTeX document, the alignment of text elements in imported figures may be off. Check the header of your `.pgf` file if you are unsure about the fonts matplotlib used for the layout.
- Vector images and hence `.pgf` files can become bloated if there are a lot of objects in the graph. This can be the case for image processing or very big scatter graphs. In an extreme case this can cause TeX to run out of memory: "TeX capacity exceeded, sorry" You can configure latex to increase the amount of memory available to generate the `.pdf` image as discussed on [tex.stackexchange.com](https://tex.stackexchange.com). Another way would be to "rasterize" parts of the graph causing problems using either the `rasterized=True` keyword, or `.set_rasterized(True)` as per this example.
- If you still need help, please see *Getting help*

---

**Note:** Click [here](#) to download the full example code

---

## 2.5.9 Text rendering With LaTeX

Rendering text with LaTeX in Matplotlib.

Matplotlib has the option to use LaTeX to manage all text layout. This option is available with the following backends:

- Agg
- PS
- PDF

The LaTeX option is activated by setting `text.usetex : True` in your rc settings. Text handling with matplotlib's LaTeX support is slower than matplotlib's very capable *mathtext*, but is more flexible, since different LaTeX packages (font packages, math packages, etc.) can be used. The results can be striking, especially when you take care to use the same fonts in your figures as in the main document.

Matplotlib's LaTeX support requires a working LaTeX installation, [dvipng](#) (which may be included with your LaTeX installation), and [Ghostscript](#) (GPL Ghostscript 9.0 or later is required). The executables for these external dependencies must all be located on your `PATH`.

There are a couple of options to mention, which can be changed using *rc settings*. Here is an example `matplotlibrc` file:

```
font.family      : serif
font.serif       : Times, Palatino, New Century Schoolbook, Bookman, Computer Modern,
↳Roman
font.sans-serif  : Helvetica, Avant Garde, Computer Modern Sans serif
font.cursive     : Zapf Chancery
font.monospace   : Courier, Computer Modern Typewriter

text.usetex     : true
```

The first valid font in each family is the one that will be loaded. If the fonts are not specified, the Computer Modern fonts are used by default. All of the other fonts are Adobe fonts. Times and Palatino each have their own accompanying math fonts, while the other Adobe serif fonts make use of the Computer Modern math fonts. See the [PSNFSS](#) documentation for more details.

To use LaTeX and select Helvetica as the default font, without editing `matplotlibrc` use:

```
from matplotlib import rc
rc('font',**{'family':'sans-serif','sans-serif':['Helvetica']})
## for Palatino and other serif fonts use:
#rc('font',**{'family':'serif','serif':['Palatino']})
rc('text', usetex=True)
```

Here is the standard example, `tex_demo.py`:

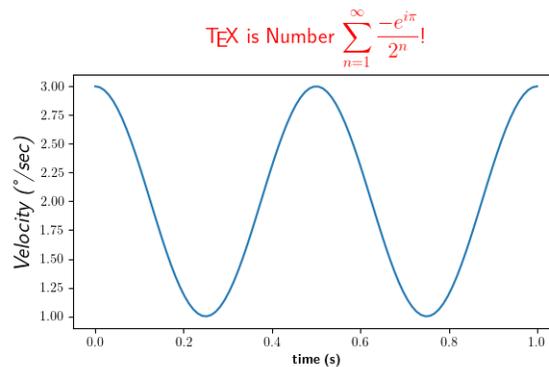


Fig. 46: TeX Demo

Note that display math mode ( $e=mc^2$ ) is not supported, but adding the command `\displaystyle`, as in `tex_demo.py`, will produce the same results.

**Note:** Certain characters require special escaping in TeX, such as:

```
# $ % & ~ _ ^ \ { } \ ( \ ) \ [ \ ]
```

Therefore, these characters will behave differently depending on the `rcParam text.usetex` flag.

### usetex with unicode

It is also possible to use unicode strings with the LaTeX text manager, here is an example taken from `tex_demo.py`. The axis labels include Unicode text:

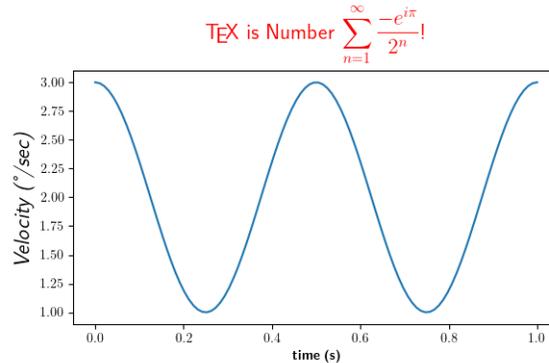


Fig. 47: TeX Unicode Demo

### Postscript options

In order to produce encapsulated postscript files that can be embedded in a new LaTeX document, the default behavior of matplotlib is to distill the output, which removes some postscript operators used by LaTeX that are illegal in an eps file. This step produces results which may be unacceptable to some users, because the text is coarsely rasterized and converted to bitmaps, which are not scalable like standard postscript, and the text is not searchable. One workaround is to set `ps.distiller.res` to a higher value (perhaps 6000) in your rc settings, which will produce larger files but may look better and scale reasonably. A better workaround, which requires [Poppler](#) or [Xpdf](#), can be activated by changing the `ps.usedistiller` rc setting to `xpdf`. This alternative produces postscript without rasterizing text, so it scales properly, can be edited in Adobe Illustrator, and searched text in pdf documents.

### Possible hangups

- On Windows, the `PATH` environment variable may need to be modified to include the directories containing the latex, dvi2png and ghostscript executables. See *Environment Variables* and *Setting environment variables in windows* for details.
- Using MiKTeX with Computer Modern fonts, if you get odd \*Agg and PNG results, go to MiKTeX/Options and update your format files
- On Ubuntu and Gentoo, the base texlive install does not ship with the `type1cm` package. You may need to install some of the extra packages to get all the goodies that come bundled with other latex distributions.
- Some progress has been made so matplotlib uses the dvi files directly for text layout. This allows latex to be used for text layout with the pdf and svg backends, as well as the \*Agg and PS backends. In the future, a latex installation may be the only external dependency.

## Troubleshooting

- Try deleting your `.matplotlib/tex.cache` directory. If you don't know where to find `.matplotlib`, see *matplotlib configuration and cache directory locations*.
- Make sure LaTeX, `dvipng` and `ghostscript` are each working and on your *PATH*.
- Make sure what you are trying to do is possible in a LaTeX document, that your LaTeX syntax is valid and that you are using raw strings if necessary to avoid unintended escape sequences.
- Most problems reported on the mailing list have been cleared up by upgrading [Ghostscript](#). If possible, please try upgrading to the latest release before reporting problems to the list.
- The `text.latex.preamble rc` setting is not officially supported. This option provides lots of flexibility, and lots of ways to cause problems. Please disable this option before reporting problems to the mailing list.
- If you still need help, please see *Getting help*

## 2.6 Toolkits

These tutorials cover toolkits designed to extend the functionality of Matplotlib in order to accomplish specific goals.

---

**Note:** Click [here](#) to download the full example code

---

### 2.6.1 Overview of `axes_grid1` toolkit

Controlling the layout of plots with the `axes_grid` toolkit.

#### What is `axes_grid1` toolkit?

`axes_grid1` is a collection of helper classes to ease displaying (multiple) images with matplotlib. In matplotlib, the axes location (and size) is specified in the normalized figure coordinates, which may not be ideal for displaying images that needs to have a given aspect ratio. For example, it helps if you have a colorbar whose height always matches that of the image. *ImageGrid*, *RGB Axes* and *AxesDivider* are helper classes that deals with adjusting the location of (multiple) Axes. They provides a framework to adjust the position of multiple axes at the drawing time. *ParasiteAxes* provides `twinx`(or `twiny`)-like features so that you can plot different data (e.g., different y-scale) in a same Axes. *AnchoredArtists* includes custom artists which are placed at some anchored position, like the legend.

#### `axes_grid1`

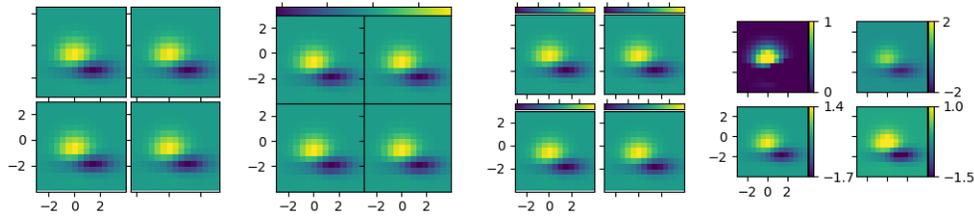


Fig. 48: Demo Axes Grid

### ImageGrid

A class that creates a grid of Axes. In matplotlib, the axes location (and size) is specified in the normalized figure coordinates. This may not be ideal for images that needs to be displayed with a given aspect ratio. For example, displaying images of a same size with some fixed padding between them cannot be easily done in matplotlib. ImageGrid is used in such case.

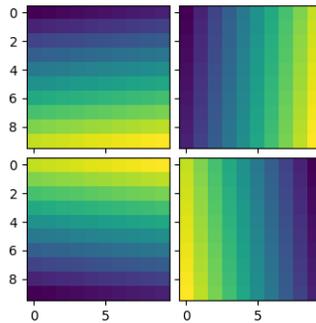


Fig. 49: Simple Axesgrid

- The position of each axes is determined at the drawing time (see *AxesDivider*), so that the size of the entire grid fits in the given rectangle (like the aspect of axes). Note that in this example, the paddings between axes are fixed even if you changes the figure size.
- axes in the same column has a same axes width (in figure coordinate), and similarly, axes in the same row has a same height. The widths (height) of the axes in the same row (column) are scaled according to their view limits (xlim or ylim).

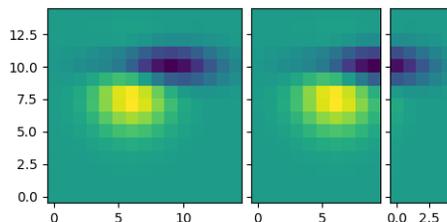


Fig. 50: Simple Axes Grid

- axis are shared among axes in a same column. Similarly, yaxis are shared among axes in a same row. Therefore, changing axis properties (view limits, tick location, etc. either by plot commands or using your mouse in interactive backends) of one axes will affect all other shared axes.

When initialized, ImageGrid creates given number (*ngrids* or *ncols \* nrows* if *ngrids* is None) of Axes instances. A sequence-like interface is provided to access the individual Axes instances (e.g., `grid[0]` is the first Axes in the grid. See below for the order of axes).

ImageGrid takes following arguments,

Name	De- fault	Description
<code>fig</code>		
<code>rect</code>		
<code>nrows_ncols</code>		number of rows and cols. e.g., (2,2)
<code>ngrids</code>	None	number of grids. <code>nrows x ncols</code> if None
<code>direction</code>	"row"	increasing direction of axes number. [row column]
<code>axes_pad</code>	0.02	pad between axes in inches
<code>add_all</code>	True	Add axes to figures if True
<code>share_all</code>	False	xaxis & yaxis of all axes are shared if True
<code>aspect</code>	True	aspect of axes
<code>label_mode</code>	"L"	location of tick labels that will be displayed. "1" (only the lower left axes), "L" (left most and bottom most axes), or "all".
<code>cbar_mode</code>	None	[None single each]
<code>cbar_location</code>	"right"	[right top]
<code>cbar_pad</code>	None	pad between image axes and colorbar axes
<code>cbar_size</code>	"5%"	size of the colorbar
<code>axes_class</code>	None	

**rect** specifies the location of the grid. You can either specify coordinates of the rectangle to be used (e.g., (0.1, 0.1, 0.8, 0.8) as in the Axes), or the subplot-like position (e.g., "121").

**direction** means the increasing direction of the axes number.

**aspect** By default (False), widths and heights of axes in the grid are scaled independently. If True, they are scaled according to their data limits (similar to aspect parameter in mpl).

**share\_all** if True, xaxis and yaxis of all axes are shared.

**direction** direction of increasing axes number. For "row",

<code>grid[0]</code>	<code>grid[1]</code>
<code>grid[2]</code>	<code>grid[3]</code>

For "column",

<code>grid[0]</code>	<code>grid[2]</code>
<code>grid[1]</code>	<code>grid[3]</code>

You can also create a colorbar (or colorbars). You can have colorbar for each axes (`cbar_mode="each"`), or you can have a single colorbar for the grid (`cbar_mode="single"`).

The colorbar can be placed on your right, or top. The axes for each colorbar is stored as a `cbar_axes` attribute.

The examples below show what you can do with ImageGrid.

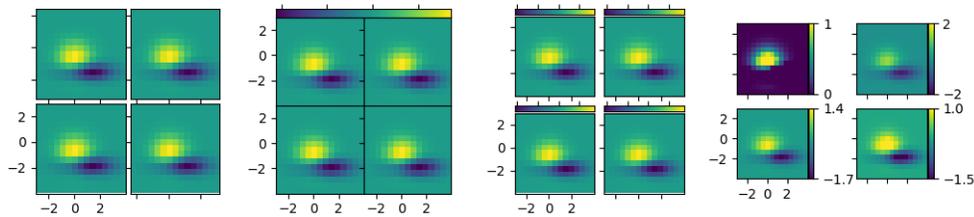


Fig. 51: Demo Axes Grid

### AxesDivider Class

Behind the scene, the ImageGrid class and the RGBAxes class utilize the AxesDivider class, whose role is to calculate the location of the axes at drawing time. While a more about the AxesDivider is (will be) explained in (yet to be written) AxesDividerGuide, direct use of the AxesDivider class will not be necessary for most users. The axes\_divider module provides a helper function `make_axes_locatable`, which can be useful. It takes a existing axes instance and create a divider for it.

```
ax = subplot(1,1,1)
divider = make_axes_locatable(ax)
```

`make_axes_locatable` returns an instance of the AxesLocator class, derived from the Locator. It provides `append_axes` method that creates a new axes on the given side of ("top", "right", "bottom" and "left") of the original axes.

colorbar whose height (or width) in sync with the master axes

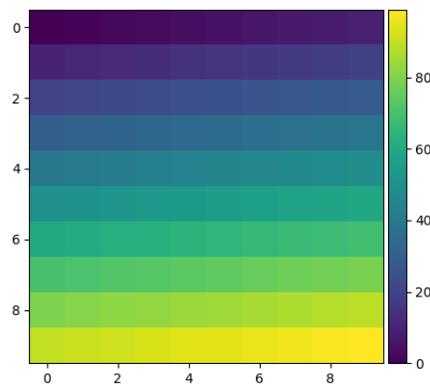


Fig. 52: Simple Colorbar

**scatter\_hist.py with AxesDivider**

The "scatter\_hist.py" example in mpl can be rewritten using `make_axes_locatable`.

```
axScatter = subplot(111)
axScatter.scatter(x, y)
axScatter.set_aspect(1.)

# create new axes on the right and on the top of the current axes.
divider = make_axes_locatable(axScatter)
axHistx = divider.append_axes("top", size=1.2, pad=0.1, sharex=axScatter)
axHisty = divider.append_axes("right", size=1.2, pad=0.1, sharey=axScatter)

# the scatter plot:
# histograms
bins = np.arange(-lim, lim + binwidth, binwidth)
axHistx.hist(x, bins=bins)
axHisty.hist(y, bins=bins, orientation='horizontal')
```

See the full source code below.

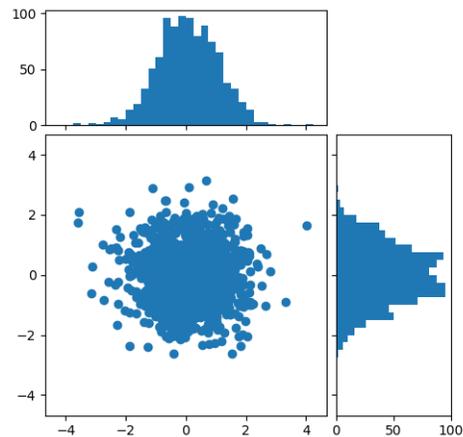


Fig. 53: Scatter Hist

The `scatter_hist` using the `AxesDivider` has some advantage over the original `scatter_hist.py` in `mpl`. For example, you can set the aspect ratio of the scatter plot, even with the x-axis or y-axis is shared accordingly.

**ParasiteAxes**

The `ParasiteAxes` is an axes whose location is identical to its host axes. The location is adjusted in the drawing time, thus it works even if the host change its location (e.g., images).

In most cases, you first create a host axes, which provides a few method that can be used to create parasite axes. They are `twinx`, `twiny` (which are similar to `twinx` and `twiny` in the `matplotlib`) and `twin`. `twin` takes an arbitrary transformation that maps between the data coordinates of the host axes and the parasite axes. `draw` method of the parasite axes are

never called. Instead, `host axes` collects artists in parasite axes and draw them as if they belong to the host axes, i.e., artists in parasite axes are merged to those of the host axes and then drawn according to their zorder. The host and parasite axes modifies some of the axes behavior. For example, color cycle for plot lines are shared between host and parasites. Also, the legend command in host, creates a legend that includes lines in the parasite axes. To create a host axes, you may use `host_subplot` or `host_axes` command.

### Example 1. `twinx`

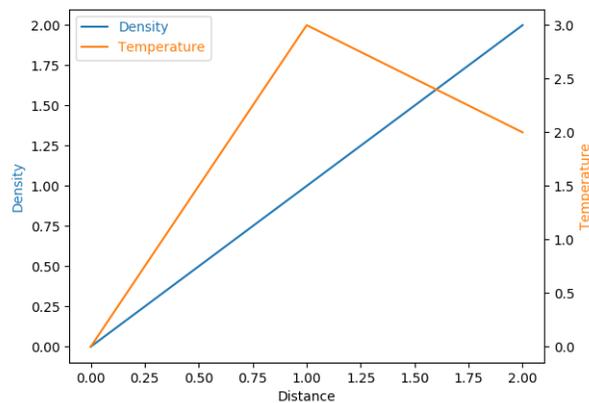


Fig. 54: Parasite Simple

### Example 2. `twin`

`twin` without a transform argument assumes that the parasite axes has the same data transform as the host. This can be useful when you want the top(or right)-axis to have different tick-locations, tick-labels, or tick-formatter for bottom(or left)-axis.

```
ax2 = ax.twin() # now, ax2 is responsible for "top" axis and "right" axis
ax2.set_xticks([0., .5*np.pi, np.pi, 1.5*np.pi, 2*np.pi])
ax2.set_xticklabels(["0", r"$\frac{1}{2}\pi$",
                    r"$\pi$", r"$\frac{3}{2}\pi$", r"$2\pi$"])
```

A more sophisticated example using `twin`. Note that if you change the x-limit in the host axes, the x-limit of the parasite axes will change accordingly.

### AnchoredArtists

It's a collection of artists whose location is anchored to the (axes) `bbox`, like the legend. It is derived from `OffsetBox` in `mpl`, and artist need to be drawn in the canvas coordinate. But, there is a limited support for an arbitrary transform. For example, the ellipse in the example below will have width and height in the data coordinate.

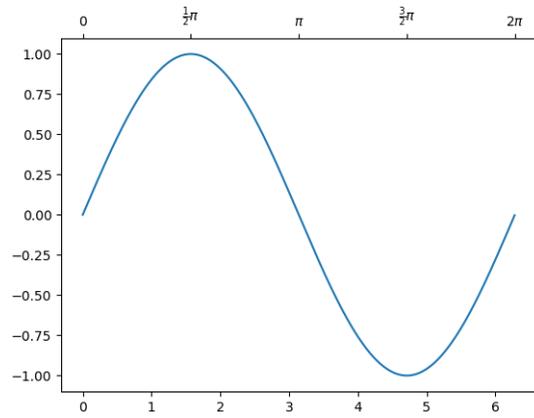


Fig. 55: Simple Axisline4

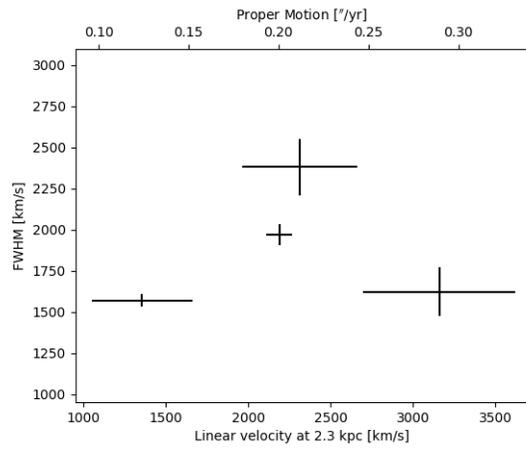


Fig. 56: Parasite Simple2

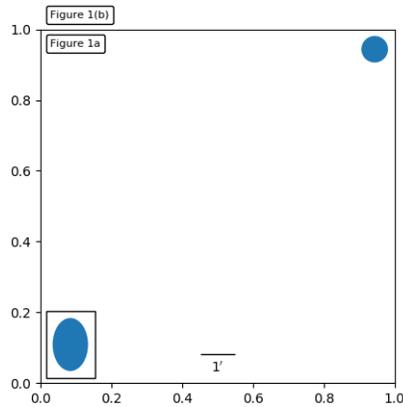


Fig. 57: Simple Anchored Artists

## InsetLocator

`mpl_toolkits.axes_grid1.inset_locator` provides helper classes and functions to place your (inset) axes at the anchored position of the parent axes, similarly to `AnchoredArtist`.

Using `mpl_toolkits.axes_grid1.inset_locator.inset_axes()`, you can have inset axes whose size is either fixed, or a fixed proportion of the parent axes. For example,:

```
inset_axes = inset_axes(parent_axes,
                        width="30%", # width = 30% of parent_bbox
                        height=1., # height : 1 inch
                        loc='lower left')
```

creates an inset axes whose width is 30% of the parent axes and whose height is fixed at 1 inch.

You may create your inset whose size is determined so that the data scale of the inset axes to be that of the parent axes multiplied by some factor. For example,

```
inset_axes = zoomed_inset_axes(ax,
                              0.5, # zoom = 0.5
                              loc='upper right')
```

creates an inset axes whose data scale is half of the parent axes. Here is complete examples.

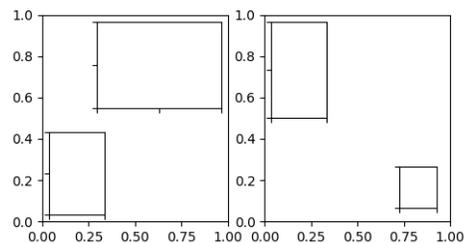


Fig. 58: Inset Locator Demo

For example, `zoomed_inset_axes()` can be used when you want the inset represents the zoom-up of the small portion in the parent axes. And `mpl_toolkits/axes_grid/inset_locator` provides a helper function `mark_inset()` to mark the location of the area represented by the inset axes.

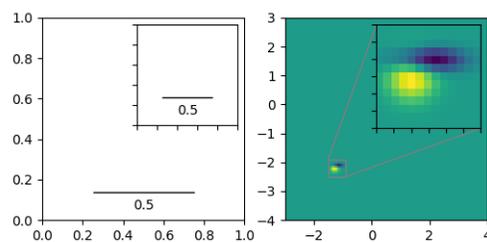


Fig. 59: Inset Locator Demo2

## RGB Axes

RGBAxes is a helper class to conveniently show RGB composite images. Like ImageGrid, the location of axes are adjusted so that the area occupied by them fits in a given rectangle. Also, the xaxis and yaxis of each axes are shared.

```
from mpl_toolkits.axes_grid1.axes_rgb import RGBAxes

fig = plt.figure()
ax = RGBAxes(fig, [0.1, 0.1, 0.8, 0.8])

r, g, b = get_rgb() # r,g,b are 2-d images
ax.imshow_rgb(r, g, b,
              origin="lower", interpolation="nearest")
```

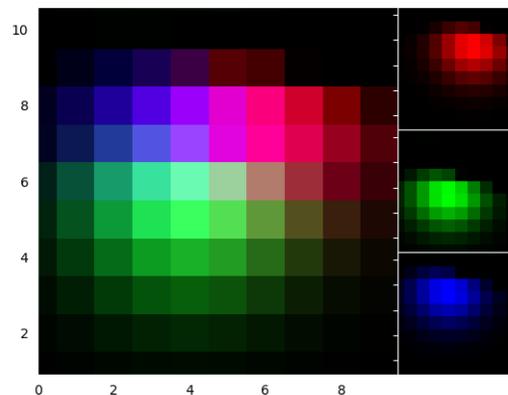


Fig. 60: Simple Rgb

## AxesDivider

The `axes_divider` module provides helper classes to adjust the axes positions of a set of images at drawing time.

- `axes_size` provides a class of units that are used to determine the size of each axes. For example, you can specify a fixed size.
- `Divider` is the class that calculates the axes position. It divides the given rectangular area into several areas. The divider is initialized by setting the lists of horizontal and vertical sizes on which the division will be based. Then use `new_locator()`, which returns a callable object that can be used to set the `axes_locator` of the axes.

First, initialize the divider by specifying its grids, i.e., horizontal and vertical.

for example,:

```
rect = [0.2, 0.2, 0.6, 0.6]
horiz=[h0, h1, h2, h3]
vert=[v0, v1, v2]
divider = Divider(fig, rect, horiz, vert)
```

where, `rect` is a bounds of the box that will be divided and `h0,..h3`, `v0,..v2` need to be an instance of classes in the `axes_size`. They have `get_size` method that returns a tuple of two floats. The first float is the relative size, and the second float is the absolute size. Consider a following grid.

v0			
v1			
h0,v2	h1	h2	h3

- `v0 => 0, 2`
- `v1 => 2, 0`
- `v2 => 3, 0`

The height of the bottom row is always 2 (`axes_divider` internally assumes that the unit is inches). The first and the second rows have a height ratio of 2:3. For example, if the total height of the grid is 6, then the first and second row will each occupy  $2/(2+3)$  and  $3/(2+3)$  of (6-1) inches. The widths of the horizontal columns will be similarly determined. When the aspect ratio is set, the total height (or width) will be adjusted accordingly.

The `mpl_toolkits.axes_grid1.axes_size` contains several classes that can be used to set the horizontal and vertical configurations. For example, for vertical configuration one could use:

```
from mpl_toolkits.axes_grid1.axes_size import Fixed, Scaled
vert = [Fixed(2), Scaled(2), Scaled(3)]
```

After you set up the divider object, then you create a locator instance that will be given to the axes object.:

```
locator = divider.new_locator(nx=0, ny=1)
ax.set_axes_locator(locator)
```

The return value of the `new_locator` method is an instance of the `AxesLocator` class. It is a callable object that returns the location and size of the cell at the first column and the second row. You may create a locator that spans over multiple cells.:

```
locator = divider.new_locator(nx=0, nx=2, ny=1)
```

The above locator, when called, will return the position and size of the cells spanning the first and second column and the first row. In this example, it will return `[0:2, 1]`.

See the example,

You can adjust the size of each axes according to its x or y data limits (`AxesX` and `AxesY`).

---

**Note:** Click [here](#) to download the full example code

---

## 2.6.2 Overview of axisartist toolkit

The axisartist toolkit tutorial.

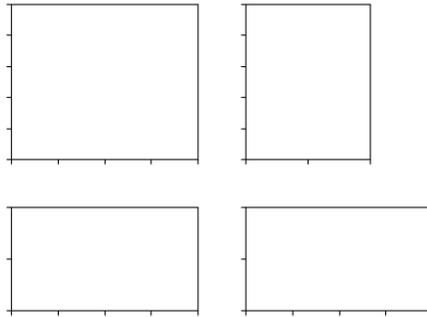


Fig. 61: Simple Axes Divider2

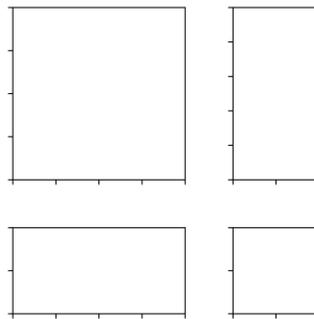


Fig. 62: Simple Axes Divider3

**Warning:** *axisartist* uses a custom Axes class (derived from the mpl's original Axes class). As a side effect, some commands (mostly tick-related) do not work.

The *axisartist* contains a custom Axes class that is meant to support curvilinear grids (e.g., the world coordinate system in astronomy). Unlike mpl's original Axes class which uses `Axes.xaxis` and `Axes.yaxis` to draw ticks, ticklines, etc., *axisartist* uses a special artist (`AxisArtist`) that can handle ticks, ticklines, etc. for curved coordinate systems.

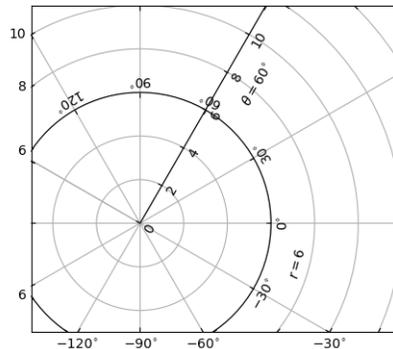


Fig. 63: Demo Floating Axis

Since it uses special artists, some Matplotlib commands that work on `Axes.xaxis` and `Axes.yaxis` may not work.

### **axisartist**

The *axisartist* module provides a custom (and very experimental) Axes class, where each axis (left, right, top, and bottom) have a separate associated artist which is responsible for drawing the axis-line, ticks, ticklabels, and labels. You can also create your own axis, which can pass through a fixed position in the axes coordinate, or a fixed position in the data coordinate (i.e., the axis floats around when `viewlimit` changes).

The axes class, by default, has its `xaxis` and `yaxis` invisible, and has 4 additional artists which are responsible for drawing the 4 axis spines in "left", "right", "bottom", and "top". They are accessed as `ax.axis["left"]`, `ax.axis["right"]`, and so on, i.e., `ax.axis` is a dictionary that contains artists (note that `ax.axis` is still a callable method and it behaves as an original `Axes.axis` method in Matplotlib).

To create an axes,

```
import mpl_toolkits.axisartist as AA
fig = plt.figure()
ax = AA.Axes(fig, [0.1, 0.1, 0.8, 0.8])
fig.add_axes(ax)
```

or to create a subplot

```
ax = AA.Subplot(fig, 111)
fig.add_subplot(ax)
```

For example, you can hide the right and top spines using:

```
ax.axis["right"].set_visible(False)
ax.axis["top"].set_visible(False)
```

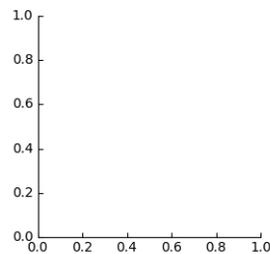


Fig. 64: Simple Axisline3

It is also possible to add a horizontal axis. For example, you may have an horizontal axis at  $y=0$  (in data coordinate).

```
ax.axis["y=0"] = ax.new_floating_axis(nth_coord=0, value=0)
```

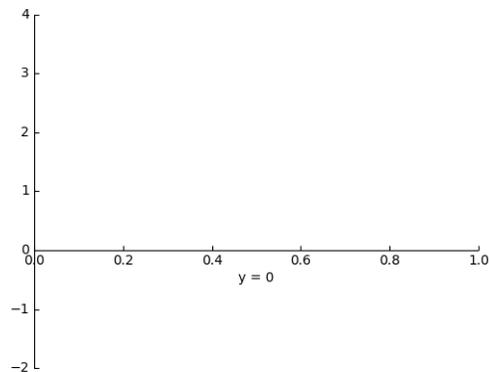


Fig. 65: Simple Axisartist1

Or a fixed axis with some offset

```
# make new (right-side) yaxis, but with some offset
ax.axis["right2"] = ax.new_fixed_axis(loc="right",
                                     offset=(20, 0))
```

### axisartist with ParasiteAxes

Most commands in the `axes_grid1` toolkit can take an `axes_class` keyword argument, and the commands create an axes of the given class. For example, to create a host subplot with

axisartist.Axes,

```
import mpl_toolkits.axisartist as AA
from mpl_toolkits.axes_grid1 import host_subplot

host = host_subplot(111, axes_class=AA.Axes)
```

Here is an example that uses ParasiteAxes.

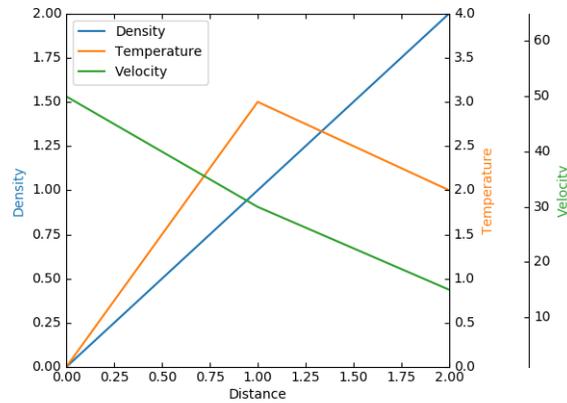


Fig. 66: Demo Parasite Axes2

### Curvilinear Grid

The motivation behind the AxisArtist module is to support a curvilinear grid and ticks.

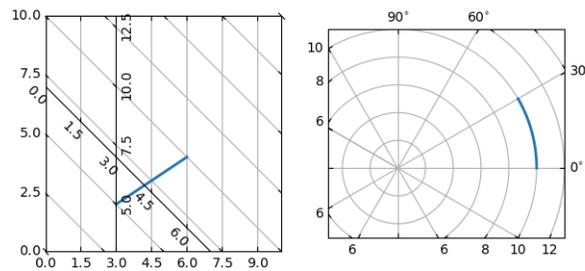


Fig. 67: Demo Curvilinear Grid

### Floating Axes

AxisArtist also supports a Floating Axes whose outer axes are defined as floating axis.

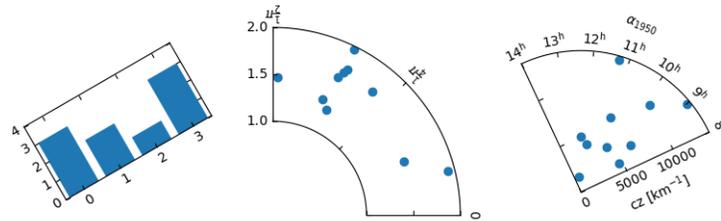


Fig. 68: Demo Floating Axes

### axisartist namespace

The *axisartist* namespace includes a derived Axes implementation. The biggest difference is that the artists responsible to draw axis line, ticks, ticklabel and axis labels are separated out from the mpl's Axis class, which are much more than artists in the original mpl. This change was strongly motivated to support curvilinear grid. Here are a few things that `mpl_toolkits.axisartist.Axes` is different from original Axes from mpl.

- Axis elements (axis line(spine), ticks, ticklabel and axis labels) are drawn by a `AxisArtist` instance. Unlike `Axis`, left, right, top and bottom axis are drawn by separate artists. And each of them may have different tick location and different tick labels.
- gridlines are drawn by a `Gridlines` instance. The change was motivated that in curvilinear coordinate, a gridline may not cross axis-lines (i.e., no associated ticks). In the original `Axis` class, gridlines are tied to ticks.
- ticklines can be rotated if necessary (i.e, along the gridlines)

In summary, all these changes was to support

- a curvilinear grid.
- a floating axis

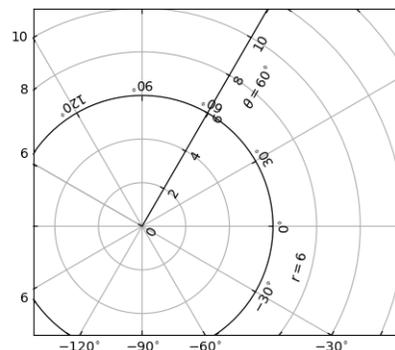


Fig. 69: Demo Floating Axis

`mpl_toolkits.axisartist.Axes` class defines a `axis` attribute, which is a dictionary of `AxisArtist` instances. By default, the dictionary has 4 `AxisArtist` instances, responsible for drawing of left, right, bottom and top axis.

`axis` and `yaxis` attributes are still available, however they are set to not visible. As separate artists are used for rendering axis, some axis-related method in `mpl` may have no effect. In addition to `AxisArtist` instances, the `mpl_toolkits.axisartist.Axes` will have `gridlines` attribute (`Gridlines`), which obviously draws grid lines.

In both `AxisArtist` and `Gridlines`, the calculation of tick and grid location is delegated to an instance of `GridHelper` class. `mpl_toolkits.axisartist.Axes` class uses `GridHelperRectilinear` as a grid helper. The `GridHelperRectilinear` class is a wrapper around the `xaxis` and `yaxis` of `mpl`'s original `Axes`, and it was meant to work as the way how `mpl`'s original axes works. For example, tick location changes using `set_ticks` method and etc. should work as expected. But change in artist properties (e.g., color) will not work in general, although some effort has been made so that some often-change attributes (color, etc.) are respected.

### AxisArtist

`AxisArtist` can be considered as a container artist with following attributes which will draw ticks, labels, etc.

- `line`
- `major_ticks`, `major_ticklabels`
- `minor_ticks`, `minor_ticklabels`
- `offsetText`
- `label`

### line

Derived from `Line2d` class. Responsible for drawing a spinal(?) line.

### major\_ticks, minor\_ticks

Derived from `Line2d` class. Note that ticks are markers.

### major\_ticklabels, minor\_ticklabels

Derived from `Text`. Note that it is not a list of `Text` artist, but a single artist (similar to a collection).

### axislabel

Derived from `Text`.

## Default AxisArtists

By default, following for axis artists are defined.:

```
ax.axis["left"], ax.axis["bottom"], ax.axis["right"], ax.axis["top"]
```

The ticklabels and axislabel of the top and the right axis are set to not visible.

For example, if you want to change the color attributes of major\_ticklabels of the bottom x-axis

```
ax.axis["bottom"].major_ticklabels.set_color("b")
```

Similarly, to make ticklabels invisible

```
ax.axis["bottom"].major_ticklabels.set_visible(False)
```

AxisArtist provides a helper method to control the visibility of ticks, ticklabels, and label. To make ticklabel invisible,

```
ax.axis["bottom"].toggle(ticklabels=False)
```

To make all of ticks, ticklabels, and (axis) label invisible

```
ax.axis["bottom"].toggle(all=False)
```

To turn all off but ticks on

```
ax.axis["bottom"].toggle(all=False, ticks=True)
```

To turn all on but (axis) label off

```
ax.axis["bottom"].toggle(all=True, label=False)
```

ax.axis's `__getitem__` method can take multiple axis names. For example, to turn ticklabels of "top" and "right" axis on,

```
ax.axis["top", "right"].toggle(ticklabels=True)
```

Note that 'ax.axis["top", "right"]' returns a simple proxy object that translate above code to something like below.

```
for n in ["top", "right"]:
    ax.axis[n].toggle(ticklabels=True)
```

So, any return values in the for loop are ignored. And you should not use it anything more than a simple method.

Like the list indexing ":" means all items, i.e.,

```
ax.axis[:].major_ticks.set_color("r")
```

changes tick color in all axis.

## HowTo

1. Changing tick locations and label.

Same as the original mpl's axes.:

```
ax.set_xticks([1,2,3])
```

2. Changing axis properties like color, etc.

Change the properties of appropriate artists. For example, to change the color of the ticklabels:

```
ax.axis["left"].major_ticklabels.set_color("r")
```

3. To change the attributes of multiple axis:

```
ax.axis["left","bottom"].major_ticklabels.set_color("r")
```

or to change the attributes of all axis:

```
ax.axis[:].major_ticklabels.set_color("r")
```

4. **To change the tick size (length), you need to use** `axis.major_ticks.set_ticksize` method. To change the direction of the ticks (ticks are in opposite direction of ticklabels by default), use `axis.major_ticks.set_tick_out` method.

To change the pad between ticks and ticklabels, use `axis.major_ticklabels.set_pad` method.

To change the pad between ticklabels and axis label, `axis.label.set_pad` method.

### Rotation and Alignment of TickLabels

This is also quite different from the original mpl and can be confusing. When you want to rotate the ticklabels, first consider using "set\_axis\_direction" method.

```
ax1.axis["left"].major_ticklabels.set_axis_direction("top")
ax1.axis["right"].label.set_axis_direction("left")
```

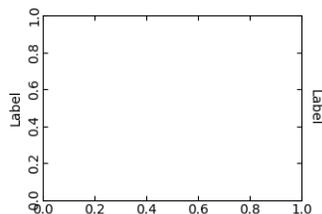


Fig. 70: Simple Axis Direction01

The parameter for `set_axis_direction` is one of ["left", "right", "bottom", "top"].

You must understand some underlying concept of directions.

1. There is a reference direction which is defined as the direction of the axis line with increasing coordinate. For example, the reference direction of the left x-axis is from bottom to top.

The direction, text angle, and alignments of the ticks, ticklabels and axis-label is determined with respect to the reference direction



Fig. 71: Axis Direction Demo - Step 01

2. *ticklabel\_direction* is either the right-hand side (+) of the reference direction or the left-hand side (-).

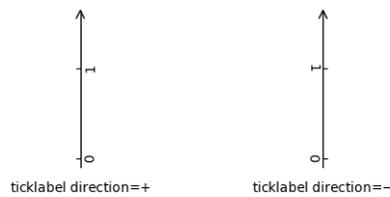


Fig. 72: Axis Direction Demo - Step 02

3. same for the *label\_direction*

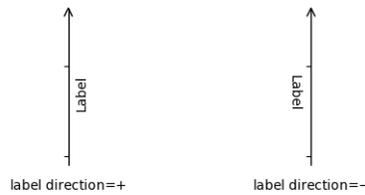


Fig. 73: Axis Direction Demo - Step 03

4. ticks are by default drawn toward the opposite direction of the ticklabels.
5. text rotation of ticklabels and label is determined in reference to the *ticklabel\_direction* or *label\_direction*, respectively. The rotation of ticklabels and label is anchored.

On the other hand, there is a concept of "axis\_direction". This is a default setting of above properties for each, "bottom", "left", "top", and "right" axis.

?	?	left	bottom	right	top
axislabel	direction	'-'	'+'	'+'	'-'
axislabel	rotation	180	0	0	180
axislabel	va	center	top	center	bottom
axislabel	ha	right	center	right	center
ticklabel	direction	'-'	'+'	'+'	'-'
ticklabels	rotation	90	0	-90	180
ticklabel	ha	right	center	right	center
ticklabel	va	center	baseline	center	baseline

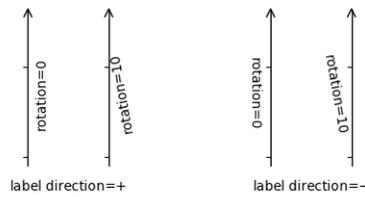


Fig. 74: Axis Direction Demo - Step 04

And, 'set\_axis\_direction("top")' means to adjust the text rotation etc, for settings suitable for "top" axis. The concept of axis direction can be more clear with curved axis.

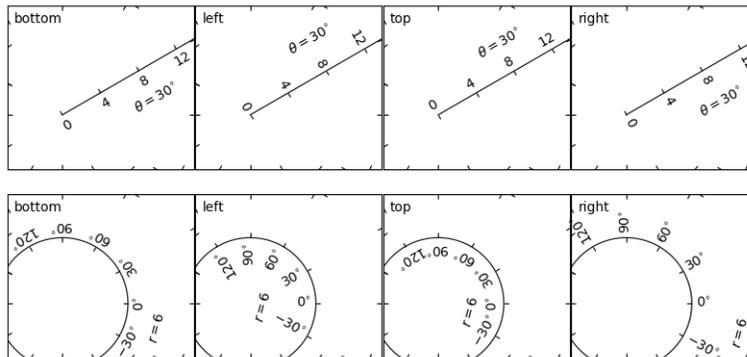


Fig. 75: Demo Axis Direction

The axis\_direction can be adjusted in the AxisArtist level, or in the level of its child artists, i.e., ticks, ticklabels, and axis-label.

```
ax1.axis["left"].set_axis_direction("top")
```

changes axis\_direction of all the associated artist with the "left" axis, while

```
ax1.axis["left"].major_ticklabels.set_axis_direction("top")
```

changes the axis\_direction of only the major\_ticklabels. Note that set\_axis\_direction in the AxisArtist level changes the ticklabel\_direction and label\_direction, while changing the axis\_direction of ticks, ticklabels, and axis-label does not affect them.

If you want to make ticks outward and ticklabels inside the axes, use invert\_ticklabel\_direction method.

```
ax.axis[:].invert_ticklabel_direction()
```

A related method is "set\_tick\_out". It makes ticks outward (as a matter of fact, it makes ticks toward the opposite direction of the default direction).

```
ax.axis[:].major_ticks.set_tick_out(True)
```

So, in summary,

- **AxisArtist's methods**

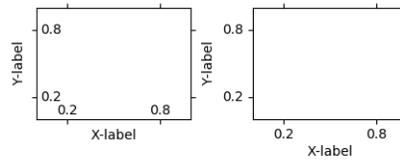


Fig. 76: Simple Axis Direction03

- `set_axis_direction` : "left", "right", "bottom", or "top"
- `set_ticklabel_direction` : "+" or "-"
- `set_axislabel_direction` : "+" or "-"
- `invert_ticklabel_direction`
- **Ticks' methods (major\_ticks and minor\_ticks)**
  - `set_tick_out` : True or False
  - `set_ticksize` : size in points
- **TickLabels' methods (major\_ticklabels and minor\_ticklabels)**
  - `set_axis_direction` : "left", "right", "bottom", or "top"
  - `set_rotation` : angle with respect to the reference direction
  - `set_ha` and `set_va` : see below
- **AxisLabels' methods (label)**
  - `set_axis_direction` : "left", "right", "bottom", or "top"
  - `set_rotation` : angle with respect to the reference direction
  - `set_ha` and `set_va`

### Adjusting ticklabels alignment

Alignment of TickLabels are treated specially. See below

### Adjusting pad

To change the pad between ticks and ticklabels

```
ax.axis["left"].major_ticklabels.set_pad(10)
```

Or ticklabels and axis-label

```
ax.axis["left"].label.set_pad(10)
```

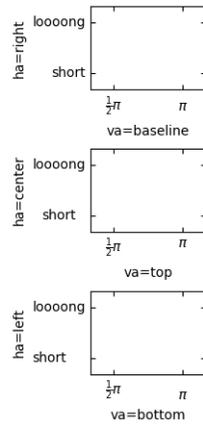


Fig. 77: Demo Ticklabel Alignment

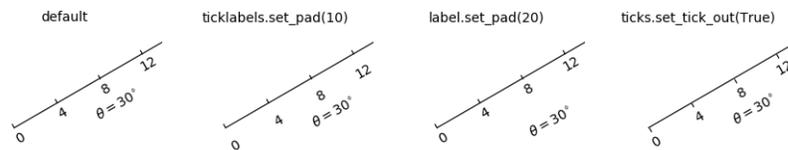


Fig. 78: Simple Axis Pad

## GridHelper

To actually define a curvilinear coordinate, you have to use your own grid helper. A generalised version of grid helper class is supplied and this class should suffice in most of cases. A user may provide two functions which defines a transformation (and its inverse pair) from the curved coordinate to (rectilinear) image coordinate. Note that while ticks and grids are drawn for curved coordinate, the data transform of the axes itself (`ax.transData`) is still rectilinear (image) coordinate.

```
from mpl_toolkits.axisartist.grid_helper_curvilinear \
    import GridHelperCurveLinear
from mpl_toolkits.axisartist import Subplot

# from curved coordinate to rectilinear coordinate.
def tr(x, y):
    x, y = np.asarray(x), np.asarray(y)
    return x, y-x

# from rectilinear coordinate to curved coordinate.
def inv_tr(x,y):
    x, y = np.asarray(x), np.asarray(y)
    return x, y+x

grid_helper = GridHelperCurveLinear((tr, inv_tr))

ax1 = Subplot(fig, 1, 1, 1, grid_helper=grid_helper)

fig.add_subplot(ax1)
```

You may use matplotlib's Transform instance instead (but a inverse transformation must be defined). Often, coordinate range in a curved coordinate system may have a limited range, or may have cycles. In those cases, a more customized version of grid helper is required.

```
import mpl_toolkits.axisartist.angle_helper as angle_helper

# PolarAxes.PolarTransform takes radian. However, we want our coordinate
# system in degree
tr = Affine2D().scale(np.pi/180., 1.) + PolarAxes.PolarTransform()

# extreme finder : find a range of coordinate.
# 20, 20 : number of sampling points along x, y direction
# The first coordinate (longitude, but theta in polar)
# has a cycle of 360 degree.
# The second coordinate (latitude, but radius in polar) has a minimum of 0
extreme_finder = angle_helper.ExtremeFinderCycle(20, 20,
                                                lon_cycle = 360,
                                                lat_cycle = None,
                                                lon_minmax = None,
                                                lat_minmax = (0, np.inf),
                                                )

# Find a grid values appropriate for the coordinate (degree,
# minute, second). The argument is a approximate number of grids.
```

(continues on next page)

(continued from previous page)

```

grid_locator1 = angle_helper.LocatorDMS(12)

# And also uses an appropriate formatter. Note that, the
# acceptable Locator and Formatter class is a bit different than
# that of mpl's, and you cannot directly use mpl's Locator and
# Formatter here (but may be possible in the future).
tick_formatter1 = angle_helper.FormatterDMS()

grid_helper = GridHelperCurveLinear(tr,
                                   extreme_finder=extreme_finder,
                                   grid_locator1=grid_locator1,
                                   tick_formatter1=tick_formatter1
                                   )

```

Again, the *transData* of the axes is still a rectilinear coordinate (image coordinate). You may manually do conversion between two coordinates, or you may use Parasite Axes for convenience.:

```

ax1 = SubplotHost(fig, 1, 2, 2, grid_helper=grid_helper)

# A parasite axes with given transform
ax2 = ParasiteAxesAuxTrans(ax1, tr, "equal")
# note that ax2.transData == tr + ax1.transData
# Anything you draw in ax2 will match the ticks and grids of ax1.
ax1.parasites.append(ax2)

```

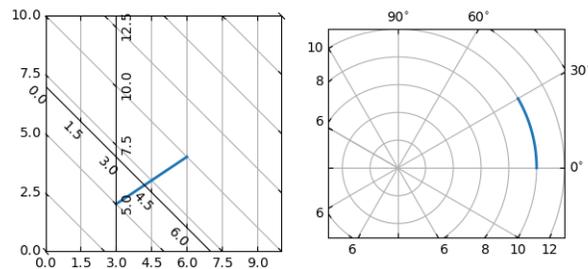


Fig. 79: Demo Curvilinear Grid

### FloatingAxis

A floating axis is an axis one of whose data coordinate is fixed, i.e. its location is not fixed in Axes coordinate but changes as axes data limits changes. A floating axis can be created using *new\_floating\_axis* method. However, it is your responsibility that the resulting AxisArtist is properly added to the axes. A recommended way is to add it as an item of Axes's axis attribute.:

```
# floating axis whose first (index starts from 0) coordinate
# (theta) is fixed at 60

ax1.axis["lat"] = axis = ax1.new_floating_axis(0, 60)
axis.label.set_text(r"$\theta = 60^{\circ}$")
axis.label.set_visible(True)
```

See the first example of this page.

### Current Limitations and TODO's

The code need more refinement. Here is a incomplete list of issues and TODO's

- No easy way to support a user customized tick location (for curvilinear grid). A new Locator class needs to be created.
- FloatingAxis may have coordinate limits, e.g., a floating axis of  $x = 0$ , but  $y$  only spans from 0 to 1.
- The location of axislabel of FloatingAxis needs to be optionally given as a coordinate value. ex, a floating axis of  $x=0$  with label at  $y=1$

---

**Note:** Click [here](#) to download the full example code

---

## 2.6.3 The mplot3d Toolkit

Generating 3D plots using the mplot3d toolkit.

### Contents

- *The mplot3d Toolkit*
  - *Getting started*
    - \* *Line plots*
    - \* *Scatter plots*
    - \* *Wireframe plots*
    - \* *Surface plots*
    - \* *Tri-Surface plots*
    - \* *Contour plots*
    - \* *Filled contour plots*
    - \* *Polygon plots*
    - \* *Bar plots*
    - \* *Quiver*
    - \* *2D plots in 3D*

- \* *Text*
- \* *Subplotting*

## Getting started

An `Axes3D` object is created just like any other axes using the `projection='3d'` keyword. Create a new `matplotlib.figure.Figure` and add a new axes to it of type `Axes3D`:

```
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D
fig = plt.figure()
ax = fig.add_subplot(111, projection='3d')
```

New in version 1.0.0: This approach is the preferred method of creating a 3D axes.

---

**Note:** Prior to version 1.0.0, the method of creating a 3D axes was different. For those using older versions of matplotlib, change `ax = fig.add_subplot(111, projection='3d')` to `ax = Axes3D(fig)`.

---

See the *mplot3d* FAQ for more information about the *mplot3d* toolkit.

## Line plots

`Axes3D.plot(self, xs, ys, *args, zdir='z', **kwargs)`  
Plot 2D or 3D data.

### Parameters

- xs** [1D array-like] x coordinates of vertices.
- ys** [1D array-like] y coordinates of vertices.
- zs** [scalar or 1D array-like] z coordinates of vertices; either one for all points or one for each point.
- zdir** [{'x', 'y', 'z'}] When plotting 2D data, the direction to use as z ('x', 'y' or 'z'); defaults to 'z'.
- \*\*kwargs** Other arguments are forwarded to `matplotlib.axes.Axes.plot`.

## Scatter plots

`Axes3D.scatter(self, xs, ys, zs=0, zdir='z', s=20, c=None, depthshade=True, *args, **kwargs)`  
Create a scatter plot.

### Parameters

- xs, ys** [array-like] The data positions.
- zs** [float or array-like, optional, default: 0] The z-positions. Either an array of the same length as `xs` and `ys` or a single value to place all points in the same plane.

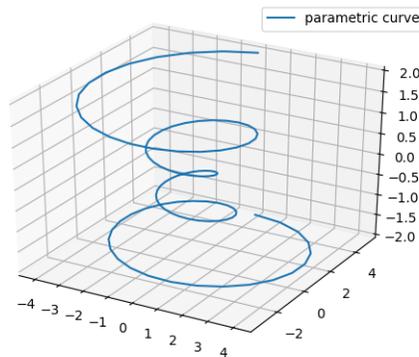


Fig. 80: Lines3d

**zdir** [`{'x', 'y', 'z', '-x', '-y', '-z'}`, optional, default: `'z'`] The axis direction for the `zs`. This is useful when plotting 2D data on a 3D Axes. The data must be passed as `xs`, `ys`. Setting `zdir` to `'y'` then plots the data to the x-z-plane.

See also `/gallery/mplot3d/2dcollections3d`.

**s** [scalar or array-like, optional, default: 20] The marker size in `points**2`. Either an array of the same length as `xs` and `ys` or a single value to make all markers the same size.

**c** [color, sequence, or sequence of color, optional] The marker color. Possible values:

- A single color format string.
- A sequence of color specifications of length `n`.
- A sequence of `n` numbers to be mapped to colors using `cmap` and `norm`.
- A 2-D array in which the rows are RGB or RGBA.

For more details see the `c` argument of `scatter`.

**depthshade** [bool, optional, default: True] Whether to shade the scatter markers to give the appearance of depth.

**\*\*kwargs** All other arguments are passed on to `scatter`.

### Returns

**paths** [`PathCollection`]

### Wireframe plots

`Axes3D.plot_wireframe(self, X, Y, Z, *args, **kwargs)`  
Plot a 3D wireframe.

---

**Note:** The `rcount` and `ccount` kwargs, which both default to 50, determine the maximum number of samples used in each direction. If the input data is larger, it will be

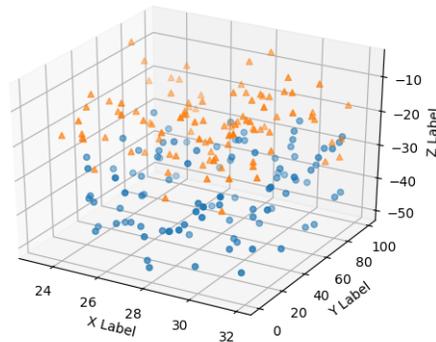


Fig. 81: Scatter3d

downsampled (by slicing) to these numbers of points.

### Parameters

**X, Y, Z** [2d arrays] Data values.

**rcount, ccount** [int] Maximum number of samples used in each direction. If the input data is larger, it will be downsampled (by slicing) to these numbers of points. Setting a count to zero causes the data to be not sampled in the corresponding direction, producing a 3D line plot rather than a wireframe plot. Defaults to 50.

New in version 2.0.

**rstride, cstride** [int] Downsampling stride in each direction. These arguments are mutually exclusive with *rcount* and *ccount*. If only one of *rstride* or *cstride* is set, the other defaults to 1. Setting a stride to zero causes the data to be not sampled in the corresponding direction, producing a 3D line plot rather than a wireframe plot.

'classic' mode uses a default of *rstride* = *cstride* = 1 instead of the new default of *rcount* = *ccount* = 50.

**\*\*kwargs** Other arguments are forwarded to *Line3DCollection*.

### Surface plots

```
Axes3D.plot_surface(self, X, Y, Z, *args, norm=None, vmin=None, vmax=None, light-
                    source=None, **kwargs)
```

Create a surface plot.

By default it will be colored in shades of a solid color, but it also supports color mapping by supplying the *cmap* argument.

**Note:** The *rcount* and *ccount* kwargs, which both default to 50, determine the maximum number of samples used in each direction. If the input data is larger, it will be

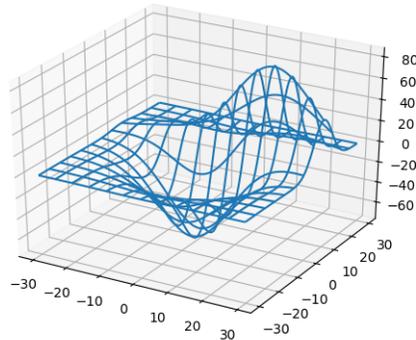


Fig. 82: Wire3d

downsampled (by slicing) to these numbers of points.

### Parameters

**X, Y, Z** [2d arrays] Data values.

**rcount, ccount** [int] Maximum number of samples used in each direction. If the input data is larger, it will be downsampled (by slicing) to these numbers of points. Defaults to 50.

New in version 2.0.

**rstride, cstride** [int] Downsampling stride in each direction. These arguments are mutually exclusive with *rcount* and *ccount*. If only one of *rstride* or *cstride* is set, the other defaults to 10.

'classic' mode uses a default of *rstride* = *cstride* = 10 instead of the new default of *rcount* = *ccount* = 50.

**color** [color-like] Color of the surface patches.

**cmap** [Colormap] Colormap of the surface patches.

**facecolors** [array-like of colors.] Colors of each individual patch.

**norm** [Normalize] Normalization for the colormap.

**vmin, vmax** [float] Bounds for the normalization.

**shade** [bool] Whether to shade the facecolors. Defaults to True. Shading is always disabled when *cmap* is specified.

**lightsource** [*LightSource*] The lightsource to use when *shade* is True.

**\*\*kwargs** Other arguments are forwarded to *Poly3DCollection*.

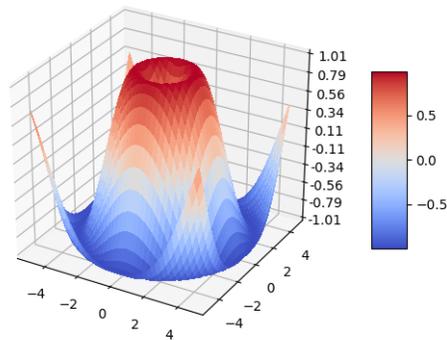


Fig. 83: Surface3d  
Surface3d 2  
Surface3d 3

### Tri-Surface plots

`Axes3D.plot_trisurf(self, *args, color=None, norm=None, vmin=None, vmax=None, lightsources=None, **kwargs)`

Plot a triangulated surface.

The (optional) triangulation can be specified in one of two ways; either:

```
plot_trisurf(triangulation, ...)
```

where *triangulation* is a *Triangulation* object, or:

```
plot_trisurf(X, Y, ...)
plot_trisurf(X, Y, triangles, ...)
plot_trisurf(X, Y, triangles=triangles, ...)
```

in which case a *Triangulation* object will be created. See *Triangulation* for a explanation of these possibilities.

The remaining arguments are:

```
plot_trisurf(..., Z)
```

where *Z* is the array of values to contour, one per point in the triangulation.

#### Parameters

**X, Y, Z** [array-like] Data values as 1D arrays.

**color** Color of the surface patches.

**cmap** A colormap for the surface patches.

**norm** [Normalize] An instance of *Normalize* to map values to colors.

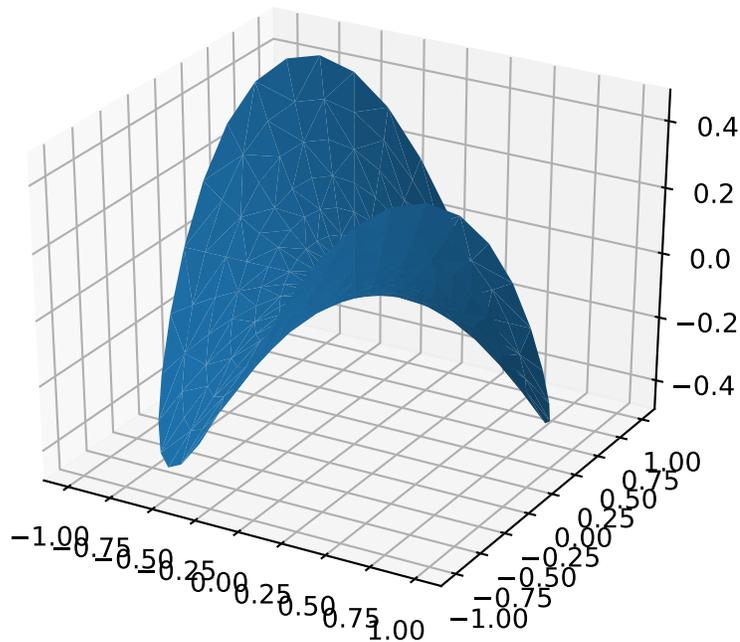
**vmin, vmax** [scalar, optional, default: None] Minimum and maximum value to map.

**shade** [bool] Whether to shade the facecolors. Defaults to True. Shading is always disabled when *cmap* is specified.

**lightsource** [*LightSource*] The lightsource to use when *shade* is True.

**\*\*kwargs** All other arguments are passed on to *Poly3DCollection*

## Examples



New in version 1.2.0: This plotting function was added for the v1.2.0 release.

## Contour plots

```
Axes3D.contour(self, X, Y, Z, *args, extend3d=False, stride=5, zdir='z', offset=None,
               **kwargs)
```

Create a 3D contour plot.

### Parameters

**X, Y, Z** [array-likes] Input data.

**extend3d** [bool] Whether to extend contour in 3D; defaults to False.

**stride** [int] Step size for extending contour.

**zdir** [{'x', 'y', 'z'}] The direction to use; defaults to 'z'.

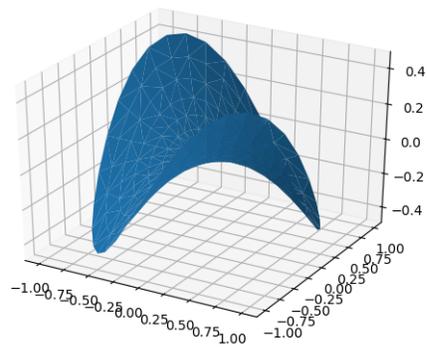
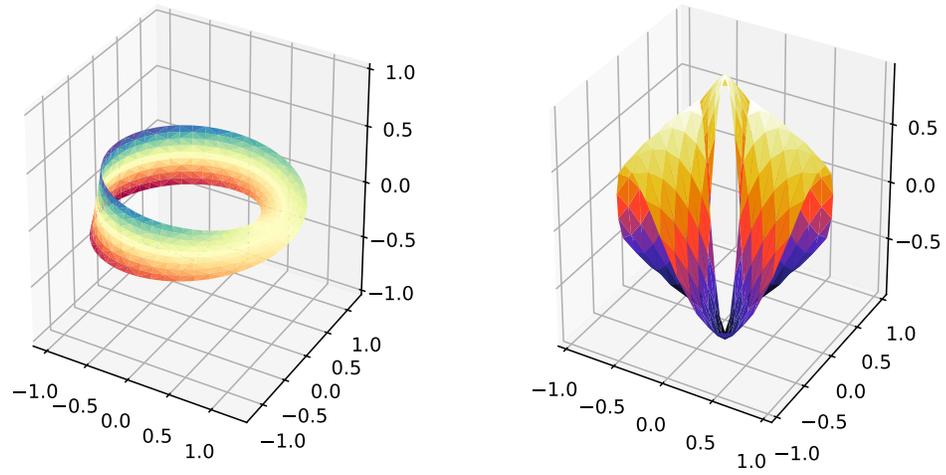


Fig. 84: Trisurf3d

**offset** [scalar] If specified, plot a projection of the contour lines at this position in a plane normal to `zdir`

**\*args, \*\*kwargs** Other arguments are forwarded to `matplotlib.axes.Axes.contour`.

### Returns

`matplotlib.contour.QuadContourSet`

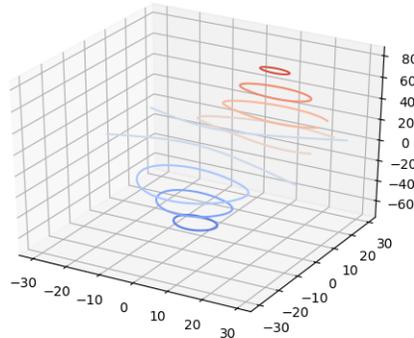


Fig. 85: Contour3d  
Contour3d 2  
Contour3d 3

### Filled contour plots

`Axes3D.contourf(self, X, Y, Z, *args, zdir='z', offset=None, **kwargs)`  
Create a 3D filled contour plot.

#### Parameters

**X, Y, Z** [array-likes] Input data.

**zdir** [{'x', 'y', 'z'}] The direction to use; defaults to 'z'.

**offset** [scalar] If specified, plot a projection of the contour lines at this position in a plane normal to `zdir`

**\*args, \*\*kwargs** Other arguments are forwarded to `matplotlib.axes.Axes.contourf`.

### Returns

`matplotlib.contour.QuadContourSet`

### Notes

New in version 1.1.0: The `zdir` and `offset` parameters.

New in version 1.1.0: The feature demoed in the second `contourf3d` example was enabled as a result of a bugfix for version 1.1.0.

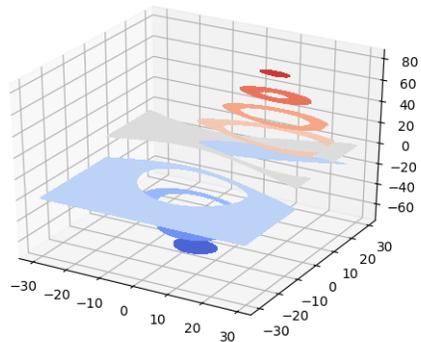


Fig. 86: Contourf3d  
Contourf3d 2

### Polygon plots

`Axes3D.add_collection3d(self, col, zs=0, zdir='z')`  
Add a 3D collection object to the plot.

2D collection types are converted to a 3D version by modifying the object and adding z coordinate information.

#### Supported are:

- PolyCollection
- LineCollection
- PatchCollection

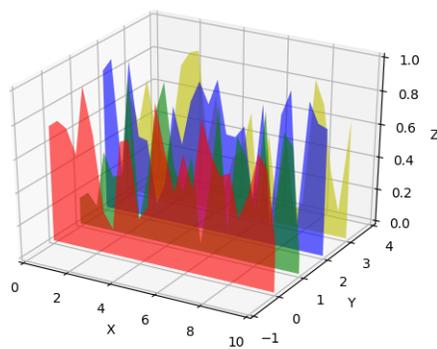


Fig. 87: Polys3d

## Bar plots

`Axes3D.bar(self, left, height, zs=0, zdir='z', *args, **kwargs)`  
 Add 2D bar(s).

### Parameters

**left** [1D array-like] The x coordinates of the left sides of the bars.

**height** [1D array-like] The height of the bars.

**zs** [scalar or 1D array-like] Z coordinate of bars; if a single value is specified, it will be used for all bars.

**zdir** [{'x', 'y', 'z'}] When plotting 2D data, the direction to use as z ('x', 'y' or 'z'); defaults to 'z'.

**\*\*kwargs** Other arguments are forwarded to `matplotlib.axes.Axes.bar`.

### Returns

`mpl_toolkits.mplot3d.art3d.Patch3DCollection`

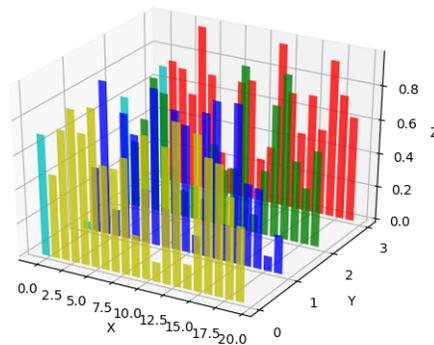


Fig. 88: Bars3d

## Quiver

`Axes3D.quiver(X, Y, Z, U, V, W, /, length=1, arrow_length_ratio=.3, pivot='tail', normalize=False, **kwargs)`  
 Plot a 3D field of arrows.

The arguments could be array-like or scalars, so long as they they can be broadcast together. The arguments can also be masked arrays. If an element in any of argument is masked, then that corresponding quiver element will not be plotted.

### Parameters

**X, Y, Z** [array-like] The x, y and z coordinates of the arrow locations (default is tail of arrow; see `pivot` kwarg)

**U, V, W** [array-like] The x, y and z components of the arrow vectors

**length** [float] The length of each quiver, default to 1.0, the unit is the same with the axes

**arrow\_length\_ratio** [float] The ratio of the arrow head with respect to the quiver, default to 0.3

**pivot** [{'tail', 'middle', 'tip'}] The part of the arrow that is at the grid point; the arrow rotates about this point, hence the name *pivot*. Default is 'tail'

**normalize** [bool] When True, all of the arrows will be the same length. This defaults to False, where the arrows will be different lengths depending on the values of u,v,w.

**\*\*kwargs** Any additional keyword arguments are delegated to *LineCollection*

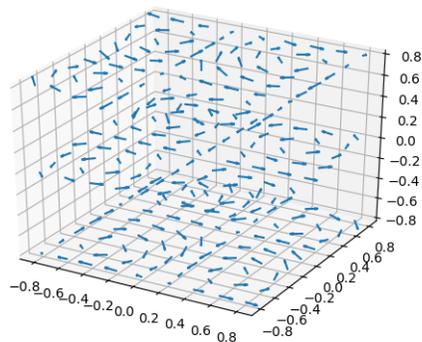


Fig. 89: Quiver3d

2D plots in 3D

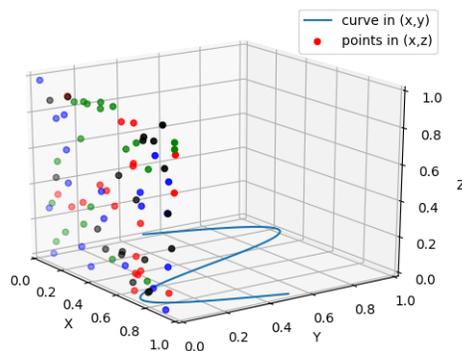


Fig. 90: 2dcollections3d

## Text

`Axes3D.text(self, x, y, z, s, zdir=None, **kwargs)`

Add text to the plot. `kwargs` will be passed on to `Axes.text`, except for the `zdir` keyword, which sets the direction to be used as the z direction.

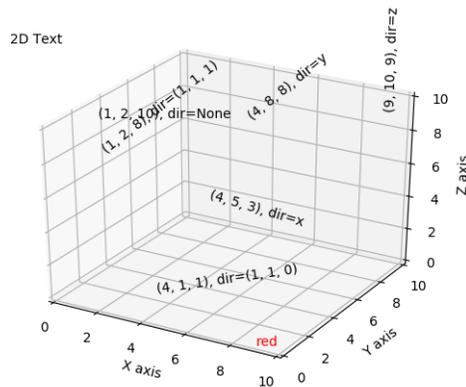


Fig. 91: Text3d

## Subplotting

Having multiple 3D plots in a single figure is the same as it is for 2D plots. Also, you can have both 2D and 3D plots in the same figure.

New in version 1.0.0: Subplotting 3D plots was added in v1.0.0. Earlier version can not do this.

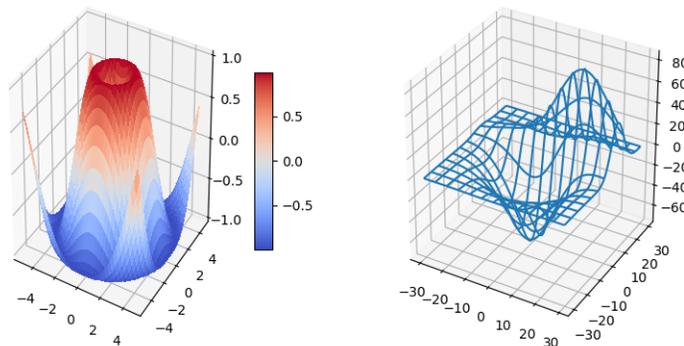


Fig. 92: Subplot3d  
Mixed Subplots



## INTERACTIVE PLOTS

### 3.1 Interactive navigation



All figure windows come with a navigation toolbar, which can be used to navigate through the data set. Here is a description of each of the buttons at the bottom of the toolbar



**The Home, Forward and Back buttons** These are akin to a web browser's home, forward and back controls. Forward and Back are used to navigate back and forth between previously defined views. They have no meaning unless you have already navigated somewhere else using the pan and zoom buttons. This is analogous to trying to click Back on your web browser before visiting a new page or Forward before you have gone back to a page - nothing happens. Home always takes you to the first, default view of your data. Again, all of these buttons should feel very familiar to any user of a web browser.

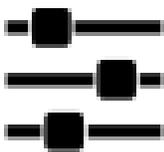


**The Pan/Zoom button** This button has two modes: pan and zoom. Click the toolbar button to activate panning and zooming, then put your mouse somewhere over an axes. Press the left mouse button and hold it to pan the figure, dragging it to a new position. When you release it, the data under the point where you pressed will be moved to the point where you released. If you press 'x' or 'y' while panning the motion will be constrained to the x or y axis, respectively. Press the right mouse button to zoom, dragging it to a new position. The x axis will be zoomed in proportionately to the rightward movement and zoomed out proportionately to the leftward movement. The same is true for the y axis and up/down motions. The point under your mouse when you begin the zoom remains stationary, allowing you to zoom in or out around that point as much as you wish. You can use the modifier keys 'x', 'y' or 'CONTROL' to constrain the zoom to the x axis, the y axis, or aspect ratio preserve, respectively.

With polar plots, the pan and zoom functionality behaves differently. The radius axis labels can be dragged using the left mouse button. The radius scale can be zoomed in and out using the right mouse button.



**The Zoom-to-rectangle button** Click this toolbar button to activate this mode. Put your mouse somewhere over an axes and press a mouse button. Define a rectangular region by dragging the mouse while holding the button to a new location. When using the left mouse button, the axes view limits will be zoomed to the defined region. When using the right mouse button, the axes view limits will be zoomed out, placing the original axes in the defined region.



**The Subplot-configuration button** Use this tool to configure the appearance of the subplot: you can stretch or compress the left, right, top, or bottom side of the subplot, or the space between the rows or space between the columns.



**The Save button** Click this button to launch a file save dialog. You can save files with the

following extensions: png, ps, eps, svg and pdf.

### 3.1.1 Navigation Keyboard Shortcuts

The following table holds all the default keys, which can be overwritten by use of your matplotlibrc (`#keymap.*`).

Command	Keyboard Shortcut(s)
Home/Reset	<b>h</b> or <b>r</b> or <b>home</b>
Back	<b>c</b> or <b>left arrow</b> or <b>backspace</b>
Forward	<b>v</b> or <b>right arrow</b>
Pan/Zoom	<b>p</b>
Zoom-to-rect	<b>o</b>
Save	<b>ctrl + s</b>
Toggle fullscreen	<b>f</b> or <b>ctrl + f</b>
Close plot	<b>ctrl + w</b>
Close all plots	<b>shift + w</b>
Constrain pan/zoom to x axis	hold <b>x</b> when panning/zooming with mouse
Constrain pan/zoom to y axis	hold <b>y</b> when panning/zooming with mouse
Preserve aspect ratio	hold <b>CONTROL</b> when panning/zooming with mouse
Toggle major grids	<b>g</b> when mouse is over an axes
Toggle minor grids	<b>G</b> when mouse is over an axes
Toggle x axis scale (log/linear)	<b>L</b> or <b>k</b> when mouse is over an axes
Toggle y axis scale (log/linear)	<b>I</b> when mouse is over an axes

If you are using `matplotlib.pyplot` the toolbar will be created automatically for every figure. If you are writing your own user interface code, you can add the toolbar as a widget. The exact syntax depends on your UI, but we have examples for every supported UI in the `matplotlib/examples/user_interfaces` directory. Here is some example code for GTK+ 3:

```
import gi
gi.require_version('Gtk', '3.0')
from gi.repository import Gtk

from matplotlib.figure import Figure
from matplotlib.backends.backend_gtk3agg import FigureCanvas
from matplotlib.backends.backend_gtk3 import (
    NavigationToolbar2GTK3 as NavigationToolbar)

win = Gtk.Window()
win.connect("destroy", lambda x: Gtk.main_quit())
win.set_default_size(400,300)
win.set_title("Embedding in GTK")

vbox = Gtk.VBox()
win.add(vbox)

fig = Figure(figsize=(5,4), dpi=100)
ax = fig.add_subplot(111)
ax.plot([1,2,3])
```

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```
canvas = FigureCanvas(fig) # a Gtk.DrawingArea
vbox.pack_start(canvas, True, True, 0)
toolbar = NavigationToolbar(canvas, win)
vbox.pack_start(toolbar, False, False, 0)

win.show_all()
Gtk.main()
```

## 3.2 Using matplotlib in a python shell

**Warning:** This page is significantly out of date

By default, matplotlib defers drawing until the end of the script because drawing can be an expensive operation, and you may not want to update the plot every time a single property is changed, only once after all the properties have changed.

But when working from the python shell, you usually do want to update the plot with every command, e.g., after changing the `xlabel()`, or the marker style of a line. While this is simple in concept, in practice it can be tricky, because matplotlib is a graphical user interface application under the hood, and there are some tricks to make the applications work right in a python shell.

### 3.2.1 IPython to the rescue

**Note:** The mode described here still exists for historical reasons, but it is highly advised not to use. It pollutes namespaces with functions that will shadow python built-in and can lead to hard to track bugs. To get IPython integration without imports the use of the `%matplotlib` magic is preferred. See [ipython documentation](#).

Fortunately, [ipython](#), an enhanced interactive python shell, has figured out all of these tricks, and is matplotlib aware, so when you start ipython in the *pylab* mode.

```
johnh@flag:~> ipython
Python 2.4.5 (#4, Apr 12 2008, 09:09:16)
IPython 0.9.0 -- An enhanced Interactive Python.

In [1]: %pylab

Welcome to pylab, a matplotlib-based Python environment.
For more information, type 'help(pylab)'.

In [2]: x = randn(10000)

In [3]: hist(x, 100)
```

it sets everything up for you so interactive plotting works as you would expect it to. Call `figure()` and a figure window pops up, call `plot()` and your data appears in the figure window.

Note in the example above that we did not import any matplotlib names because in pylab mode, ipython will import them automatically. ipython also turns on *interactive* mode for you, which causes every pyplot command to trigger a figure update, and also provides a matplotlib aware `run` command to run matplotlib scripts efficiently. ipython will turn off interactive mode during a `run` command, and then restore the interactive state at the end of the run so you can continue tweaking the figure manually.

There has been a lot of recent work to embed ipython, with pylab support, into various GUI applications, so check on the ipython mailing [list](#) for the latest status.

### 3.2.2 Other python interpreters

If you can't use ipython, and still want to use matplotlib/pylab from an interactive python shell, e.g., the plain-ole standard python interactive interpreter, you are going to need to understand what a matplotlib backend is *What is a backend?*.

With the TkAgg backend, which uses the Tkinter user interface toolkit, you can use matplotlib from an arbitrary non-gui python shell. Just set your backend : TkAgg and interactive : True in your `matplotlibrc` file (see *Customizing Matplotlib with style sheets and rcParams*) and fire up python. Then:

```
>>> from pylab import *
>>> plot([1,2,3])
>>> xlabel('hi mom')
```

should work out of the box. This is also likely to work with recent versions of the qt4agg and gtk3agg backends, and with the macosx backend on the Macintosh. Note, in batch mode, i.e. when making figures from scripts, interactive mode can be slow since it redraws the figure with each command. So you may want to think carefully before making this the default behavior via the `matplotlibrc` file instead of using the functions listed in the next section.

Gui shells are at best problematic, because they have to run a mainloop, but interactive plotting also involves a mainloop. Ipython has sorted all this out for the primary matplotlib backends. There may be other shells and IDEs that also work with matplotlib in interactive mode, but one obvious candidate does not: the python IDLE IDE is a Tkinter gui app that does not support pylab interactive mode, regardless of backend.

### 3.2.3 Controlling interactive updating

The *interactive* property of the pyplot interface controls whether a figure canvas is drawn on every pyplot command. If *interactive* is *False*, then the figure state is updated on every plot command, but will only be drawn on explicit calls to `draw()`. When *interactive* is *True*, then every pyplot command triggers a draw.

The pyplot interface provides 4 commands that are useful for interactive control.

`isinteractive()` returns the interactive setting *True|False*

`ion()` turns interactive mode on

`ioff()` turns interactive mode off

`draw()` forces a figure redraw

When working with a big figure in which drawing is expensive, you may want to turn matplotlib's interactive setting off temporarily to avoid the performance hit:

```
>>> #create big-expensive-figure
>>> ioff()          # turn updates off
>>> title('now how much would you pay?')
>>> xticklabels(fontsize=20, color='green')
>>> draw()         # force a draw
>>> savefig('alldone', dpi=300)
>>> close()
>>> ion()          # turn updating back on
>>> plot(rand(20), mfc='g', mec='r', ms=40, mew=4, ls='--', lw=3)
```

## 3.3 Event handling and picking

Matplotlib works with a number of user interface toolkits (wxpython, tkinter, qt4, gtk, and macosx) and in order to support features like interactive panning and zooming of figures, it is helpful to the developers to have an API for interacting with the figure via key presses and mouse movements that is "GUI neutral" so we don't have to repeat a lot of code across the different user interfaces. Although the event handling API is GUI neutral, it is based on the GTK model, which was the first user interface matplotlib supported. The events that are triggered are also a bit richer vis-a-vis matplotlib than standard GUI events, including information like which `matplotlib.axes.Axes` the event occurred in. The events also understand the matplotlib coordinate system, and report event locations in both pixel and data coordinates.

### 3.3.1 Event connections

To receive events, you need to write a callback function and then connect your function to the event manager, which is part of the `FigureCanvasBase`. Here is a simple example that prints the location of the mouse click and which button was pressed:

```
fig, ax = plt.subplots()
ax.plot(np.random.rand(10))

def onclick(event):
    print('%s click: button=%d, x=%d, y=%d, xdata=%f, ydata=%f' %
          ('double' if event.dblclick else 'single', event.button,
            event.x, event.y, event.xdata, event.ydata))

cid = fig.canvas.mpl_connect('button_press_event', onclick)
```

The `FigureCanvas` method `mpl_connect()` returns a connection id which is simply an integer. When you want to disconnect the callback, just call:

```
fig.canvas.mpl_disconnect(cid)
```

**Note:** The canvas retains only weak references to instance methods used as callbacks. Therefore, you need to retain a reference to instances owning such methods. Otherwise the instance will be garbage-collected and the callback will vanish.

This does not affect free functions used as callbacks.

Here are the events that you can connect to, the class instances that are sent back to you when the event occurs, and the event descriptions:

Event name	Class and description
'button_press_event'	<i>MouseEvent</i> - mouse button is pressed
'button_release_event'	<i>MouseEvent</i> - mouse button is released
'draw_event'	<i>DrawEvent</i> - canvas draw (but before screen update)
'key_press_event'	<i>KeyEvent</i> - key is pressed
'key_release_event'	<i>KeyEvent</i> - key is released
'motion_notify_event'	<i>MouseEvent</i> - mouse motion
'pick_event'	<i>PickEvent</i> - an object in the canvas is selected
'resize_event'	<i>ResizeEvent</i> - figure canvas is resized
'scroll_event'	<i>MouseEvent</i> - mouse scroll wheel is rolled
'figure_enter_event'	<i>LocationEvent</i> - mouse enters a new figure
'figure_leave_event'	<i>LocationEvent</i> - mouse leaves a figure
'axes_enter_event'	<i>LocationEvent</i> - mouse enters a new axes
'axes_leave_event'	<i>LocationEvent</i> - mouse leaves an axes

### 3.3.2 Event attributes

All matplotlib events inherit from the base class `matplotlib.backend_bases.Event`, which store the attributes:

`name` the event name

`canvas` the `FigureCanvas` instance generating the event

`guiEvent` the GUI event that triggered the matplotlib event

The most common events that are the bread and butter of event handling are key press/release events and mouse press/release and movement events. The `KeyEvent` and `MouseEvent` classes that handle these events are both derived from the `LocationEvent`, which has the following attributes

`x` x position - pixels from left of canvas

`y` y position - pixels from bottom of canvas

`inaxes` the `Axes` instance if mouse is over axes

`xdata` x coord of mouse in data coords

`ydata` y coord of mouse in data coords

Let's look a simple example of a canvas, where a simple line segment is created every time a mouse is pressed:

```
from matplotlib import pyplot as plt

class LineBuilder:
    def __init__(self, line):
        self.line = line
        self.xs = list(line.get_xdata())
        self.ys = list(line.get_ydata())
```

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```

        self.cid = line.figure.canvas.mpl_connect('button_press_event', self)

    def __call__(self, event):
        print('click', event)
        if event.inaxes!=self.line.axes: return
        self.xs.append(event.xdata)
        self.ys.append(event.ydata)
        self.line.set_data(self.xs, self.ys)
        self.line.figure.canvas.draw()

fig = plt.figure()
ax = fig.add_subplot(111)
ax.set_title('click to build line segments')
line, = ax.plot([0], [0]) # empty line
linebuilder = LineBuilder(line)

plt.show()

```

The *MouseEvent* that we just used is a *LocationEvent*, so we have access to the data and pixel coordinates in `event.x` and `event.xdata`. In addition to the *LocationEvent* attributes, it has

`button` button pressed: None, 1, 2, 3, 'up', 'down' (up and down are used for scroll events)

`key` the key pressed: None, any character, 'shift', 'win', or 'control'

### Draggable rectangle exercise

Write draggable rectangle class that is initialized with a *Rectangle* instance but will move its `x,y` location when dragged. Hint: you will need to store the original `xy` location of the rectangle which is stored as `rect.xy` and connect to the press, motion and release mouse events. When the mouse is pressed, check to see if the click occurs over your rectangle (see `matplotlib.patches.Rectangle.contains()`) and if it does, store the rectangle `xy` and the location of the mouse click in data coords. In the motion event callback, compute the `deltax` and `deltay` of the mouse movement, and add those deltas to the origin of the rectangle you stored. The redraw the figure. On the button release event, just reset all the button press data you stored as `None`.

Here is the solution:

```

import numpy as np
import matplotlib.pyplot as plt

class DraggableRectangle:
    def __init__(self, rect):
        self.rect = rect
        self.press = None

    def connect(self):
        'connect to all the events we need'
        self.cidpress = self.rect.figure.canvas.mpl_connect(
            'button_press_event', self.on_press)

```

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```

self.cidrelease = self.rect.figure.canvas.mpl_connect(
    'button_release_event', self.on_release)
self.cidmotion = self.rect.figure.canvas.mpl_connect(
    'motion_notify_event', self.on_motion)

def on_press(self, event):
    'on button press we will see if the mouse is over us and store some data'
    if event.inaxes != self.rect.axes: return

    contains, attrd = self.rect.contains(event)
    if not contains: return
    print('event contains', self.rect.xy)
    x0, y0 = self.rect.xy
    self.press = x0, y0, event.xdata, event.ydata

def on_motion(self, event):
    'on motion we will move the rect if the mouse is over us'
    if self.press is None: return
    if event.inaxes != self.rect.axes: return
    x0, y0, xpress, ypress = self.press
    dx = event.xdata - xpress
    dy = event.ydata - ypress
    #print('x0=%f, xpress=%f, event.xdata=%f, dx=%f, x0+dx=%f' %
    #      (x0, xpress, event.xdata, dx, x0+dx))
    self.rect.set_x(x0+dx)
    self.rect.set_y(y0+dy)

    self.rect.figure.canvas.draw()

def on_release(self, event):
    'on release we reset the press data'
    self.press = None
    self.rect.figure.canvas.draw()

def disconnect(self):
    'disconnect all the stored connection ids'
    self.rect.figure.canvas.mpl_disconnect(self.cidpress)
    self.rect.figure.canvas.mpl_disconnect(self.cidrelease)
    self.rect.figure.canvas.mpl_disconnect(self.cidmotion)

fig = plt.figure()
ax = fig.add_subplot(111)
rects = ax.bar(range(10), 20*np.random.rand(10))
drs = []
for rect in rects:
    dr = DraggableRectangle(rect)
    dr.connect()
    drs.append(dr)

plt.show()

```

**Extra credit:** use the animation blit techniques discussed in the [animations recipe](#) to make

the animated drawing faster and smoother.

Extra credit solution:

```
# draggable rectangle with the animation blit techniques; see
# http://www.scipy.org/Cookbook/Matplotlib/Animations
import numpy as np
import matplotlib.pyplot as plt

class DraggableRectangle:
    lock = None # only one can be animated at a time
    def __init__(self, rect):
        self.rect = rect
        self.press = None
        self.background = None

    def connect(self):
        'connect to all the events we need'
        self.cidpress = self.rect.figure.canvas.mpl_connect(
            'button_press_event', self.on_press)
        self.cidrelease = self.rect.figure.canvas.mpl_connect(
            'button_release_event', self.on_release)
        self.cidmotion = self.rect.figure.canvas.mpl_connect(
            'motion_notify_event', self.on_motion)

    def on_press(self, event):
        'on button press we will see if the mouse is over us and store some data'
        if event.inaxes != self.rect.axes: return
        if DraggableRectangle.lock is not None: return
        contains, attrd = self.rect.contains(event)
        if not contains: return
        print('event contains', self.rect.xy)
        x0, y0 = self.rect.xy
        self.press = x0, y0, event.xdata, event.ydata
        DraggableRectangle.lock = self

        # draw everything but the selected rectangle and store the pixel buffer
        canvas = self.rect.figure.canvas
        axes = self.rect.axes
        self.rect.set_animated(True)
        canvas.draw()
        self.background = canvas.copy_from_bbox(self.rect.axes.bbox)

        # now redraw just the rectangle
        axes.draw_artist(self.rect)

        # and blit just the redrawn area
        canvas.blit(axes.bbox)

    def on_motion(self, event):
        'on motion we will move the rect if the mouse is over us'
        if DraggableRectangle.lock is not self:
            return
        if event.inaxes != self.rect.axes: return
```

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```

x0, y0, xpress, ypress = self.press
dx = event.xdata - xpress
dy = event.ydata - ypress
self.rect.set_x(x0+dx)
self.rect.set_y(y0+dy)

canvas = self.rect.figure.canvas
axes = self.rect.axes
# restore the background region
canvas.restore_region(self.background)

# redraw just the current rectangle
axes.draw_artist(self.rect)

# blit just the redrawn area
canvas.blit(axes.bbox)

def on_release(self, event):
    'on release we reset the press data'
    if DraggableRectangle.lock is not self:
        return

    self.press = None
    DraggableRectangle.lock = None

    # turn off the rect animation property and reset the background
    self.rect.set_animated(False)
    self.background = None

    # redraw the full figure
    self.rect.figure.canvas.draw()

def disconnect(self):
    'disconnect all the stored connection ids'
    self.rect.figure.canvas.mpl_disconnect(self.cidpress)
    self.rect.figure.canvas.mpl_disconnect(self.cidrelease)
    self.rect.figure.canvas.mpl_disconnect(self.cidmotion)

fig = plt.figure()
ax = fig.add_subplot(111)
rects = ax.bar(range(10), 20*np.random.rand(10))
drs = []
for rect in rects:
    dr = DraggableRectangle(rect)
    dr.connect()
    drs.append(dr)

plt.show()

```

### 3.3.3 Mouse enter and leave

If you want to be notified when the mouse enters or leaves a figure or axes, you can connect to the figure/axes enter/leave events. Here is a simple example that changes the colors of the axes and figure background that the mouse is over:

```
"""
Illustrate the figure and axes enter and leave events by changing the
frame colors on enter and leave
"""
import matplotlib.pyplot as plt

def enter_axes(event):
    print('enter_axes', event.inaxes)
    event.inaxes.patch.set_facecolor('yellow')
    event.canvas.draw()

def leave_axes(event):
    print('leave_axes', event.inaxes)
    event.inaxes.patch.set_facecolor('white')
    event.canvas.draw()

def enter_figure(event):
    print('enter_figure', event.canvas.figure)
    event.canvas.figure.patch.set_facecolor('red')
    event.canvas.draw()

def leave_figure(event):
    print('leave_figure', event.canvas.figure)
    event.canvas.figure.patch.set_facecolor('grey')
    event.canvas.draw()

fig1 = plt.figure()
fig1.suptitle('mouse hover over figure or axes to trigger events')
ax1 = fig1.add_subplot(211)
ax2 = fig1.add_subplot(212)

fig1.canvas.mpl_connect('figure_enter_event', enter_figure)
fig1.canvas.mpl_connect('figure_leave_event', leave_figure)
fig1.canvas.mpl_connect('axes_enter_event', enter_axes)
fig1.canvas.mpl_connect('axes_leave_event', leave_axes)

fig2 = plt.figure()
fig2.suptitle('mouse hover over figure or axes to trigger events')
ax1 = fig2.add_subplot(211)
ax2 = fig2.add_subplot(212)

fig2.canvas.mpl_connect('figure_enter_event', enter_figure)
fig2.canvas.mpl_connect('figure_leave_event', leave_figure)
fig2.canvas.mpl_connect('axes_enter_event', enter_axes)
fig2.canvas.mpl_connect('axes_leave_event', leave_axes)

plt.show()
```

### 3.3.4 Object picking

You can enable picking by setting the `picker` property of an *Artist* (e.g., a matplotlib *Line2D*, *Text*, *Patch*, *Polygon*, *AxesImage*, etc...)

There are a variety of meanings of the `picker` property:

**None** picking is disabled for this artist (default)

**boolean** if `True` then picking will be enabled and the artist will fire a pick event if the mouse event is over the artist

**float** if `picker` is a number it is interpreted as an epsilon tolerance in points and the artist will fire off an event if its data is within epsilon of the mouse event. For some artists like lines and patch collections, the artist may provide additional data to the pick event that is generated, e.g., the indices of the data within epsilon of the pick event.

**function** if `picker` is callable, it is a user supplied function which determines whether the artist is hit by the mouse event. The signature is `hit, props = picker(artist, mouseevent)` to determine the hit test. If the mouse event is over the artist, return `hit=True` and `props` is a dictionary of properties you want added to the *PickEvent* attributes

After you have enabled an artist for picking by setting the `picker` property, you need to connect to the figure canvas `pick_event` to get pick callbacks on mouse press events. e.g.:

```
def pick_handler(event):
    mouseevent = event.mouseevent
    artist = event.artist
    # now do something with this...
```

The *PickEvent* which is passed to your callback is always fired with two attributes:

**mouseevent** **the mouse event that generate the pick event.** The mouse event in turn has attributes like `x` and `y` (the coords in display space, e.g., pixels from left, bottom) and `xdata`, `ydata` (the coords in data space). Additionally, you can get information about which buttons were pressed, which keys were pressed, which *Axes* the mouse is over, etc. See `matplotlib.backend_bases.MouseEvent` for details.

**artist** the *Artist* that generated the pick event.

Additionally, certain artists like *Line2D* and *PatchCollection* may attach additional meta data like the indices into the data that meet the picker criteria (e.g., all the points in the line that are within the specified epsilon tolerance)

#### Simple picking example

In the example below, we set the line picker property to a scalar, so it represents a tolerance in points (72 points per inch). The `onpick` callback function will be called when the pick event it within the tolerance distance from the line, and has the indices of the data vertices that are within the pick distance tolerance. Our `onpick` callback function simply prints the data that are under the pick location. Different matplotlib Artists can attach different data to the *PickEvent*. For example, *Line2D* attaches the `ind` property, which are the indices into the line data under the pick point. See `pick()` for details on the *PickEvent* properties of the line. Here is the code:

```

import numpy as np
import matplotlib.pyplot as plt

fig = plt.figure()
ax = fig.add_subplot(111)
ax.set_title('click on points')

line, = ax.plot(np.random.rand(100), 'o', picker=5) # 5 points tolerance

def onpick(event):
    thisline = event.artist
    xdata = thisline.get_xdata()
    ydata = thisline.get_ydata()
    ind = event.ind
    points = tuple(zip(xdata[ind], ydata[ind]))
    print('onpick points:', points)

fig.canvas.mpl_connect('pick_event', onpick)

plt.show()

```

### Picking exercise

Create a data set of 100 arrays of 1000 Gaussian random numbers and compute the sample mean and standard deviation of each of them (hint: numpy arrays have a mean and std method) and make a xy marker plot of the 100 means vs the 100 standard deviations. Connect the line created by the plot command to the pick event, and plot the original time series of the data that generated the clicked on points. If more than one point is within the tolerance of the clicked on point, you can use multiple subplots to plot the multiple time series.

Exercise solution:

```

"""
compute the mean and stdddev of 100 data sets and plot mean vs stdddev.
When you click on one of the mu, sigma points, plot the raw data from
the dataset that generated the mean and stdddev
"""
import numpy as np
import matplotlib.pyplot as plt

X = np.random.rand(100, 1000)
xs = np.mean(X, axis=1)
ys = np.std(X, axis=1)

fig = plt.figure()
ax = fig.add_subplot(111)
ax.set_title('click on point to plot time series')
line, = ax.plot(xs, ys, 'o', picker=5) # 5 points tolerance

def onpick(event):

```

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```
if event.artist!=line: return True

N = len(event.ind)
if not N: return True

figi = plt.figure()
for subplotnum, dataind in enumerate(event.ind):
    ax = figi.add_subplot(N,1,subplotnum+1)
    ax.plot(X[dataind])
    ax.text(0.05, 0.9, 'mu=%1.3f\nsigma=%1.3f'%(xs[dataind], ys[dataind]),
            transform=ax.transAxes, va='top')
    ax.set_ylim(-0.5, 1.5)
figi.show()
return True

fig.canvas.mpl_connect('pick_event', onpick)

plt.show()
```



## WHATS NEW

### 4.1 What's new in Matplotlib 3.1

For a list of all of the issues and pull requests since the last revision, see the *GitHub Stats*.

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- `EngFormatter` now accepts `usetex`, `useMathText` as keyword only arguments
- \* *Animation and Interactivity*
  - Support for forward/backward mouse buttons
  - `progress_callback` argument to `save()`
  - Add `cache_frame_data` keyword-only argument into `animation.FuncAnimation`
  - Endless Looping GIFs with `PillowWriter`
  - Adjusted `matplotlib.widgets.Slider` to have vertical orientation
  - Improved formatting of image values under cursor when a colorbar is present
  - `MouseEvent` button attribute is now an `IntEnum`
- \* *Configuration, Install, and Development*
  - The `MATPLOTLIBRC` environment variable can now point to any "file" path
  - Allow LaTeX code `pgf.preamble` and `text.latex.preamble` in `MATPLOTLIBRC` file
  - New logging API

### 4.1.1 New Features

#### ConciseDateFormatter

The automatic date formatter used by default can be quite verbose. A new formatter can be accessed that tries to make the tick labels appropriately concise.

#### Secondary x/y Axis support

A new method provides the ability to add a second axis to an existing axes via `Axes.secondary_xaxis` and `Axes.secondary_yaxis`. See [/gallery/subplots\\_axes\\_and\\_figures/secondary\\_axis](/gallery/subplots_axes_and_figures/secondary_axis) for examples.

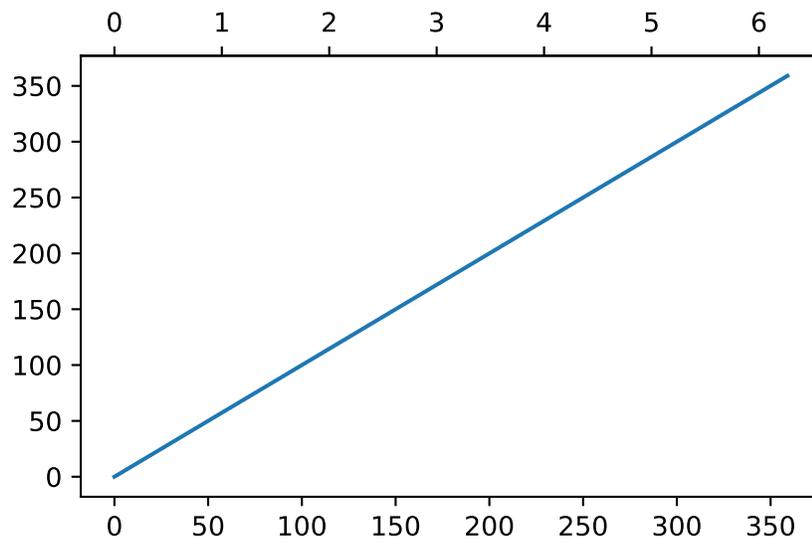
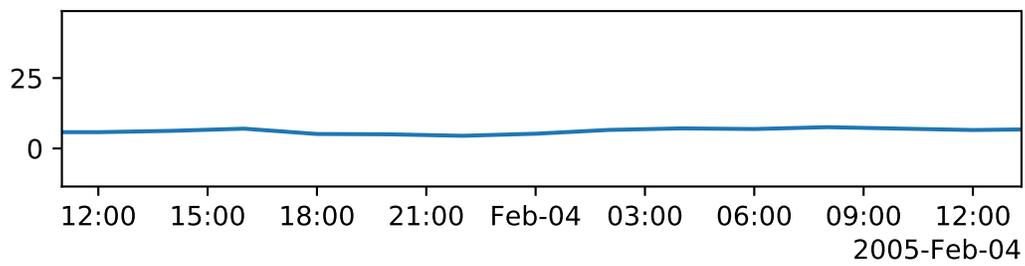
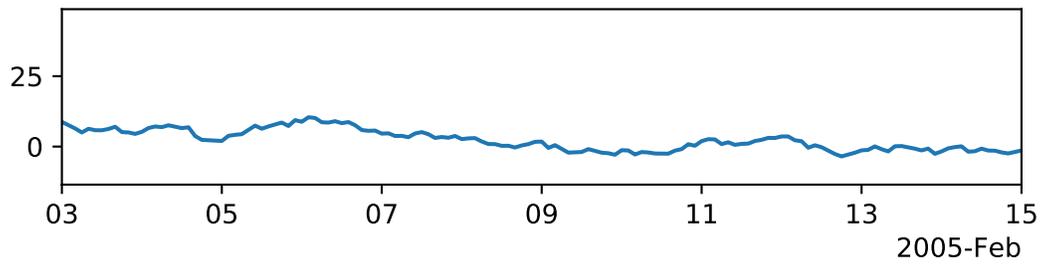
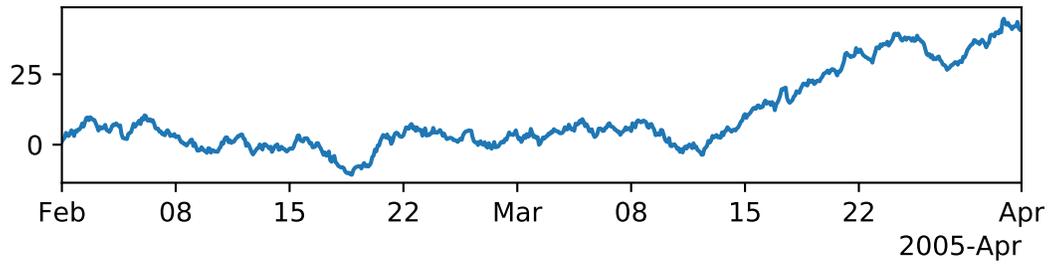
#### FuncScale for arbitrary axes scales

A new `FuncScale` class was added (and `FuncTransform`) to allow the user to have arbitrary scale transformations without having to write a new subclass of `ScaleBase`. This can be accessed by:

```
ax.set_yscale('function', functions=(forward, inverse))
```

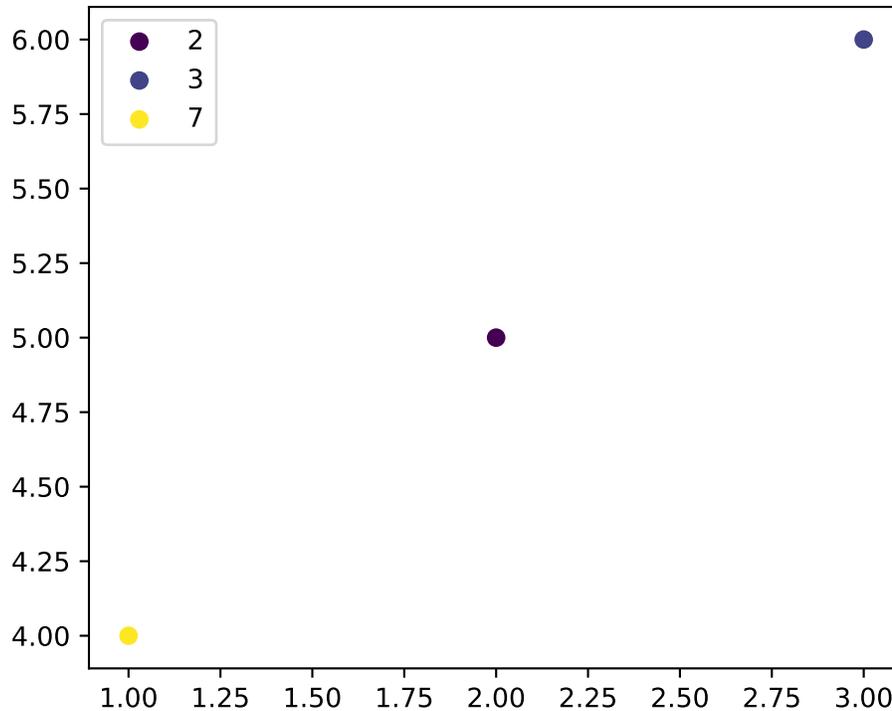
where `forward` and `inverse` are callables that return the scale transform and its inverse. See the last example in </gallery/scales/scales>.

Concise Date Formatter



### Legend for scatter

A new method for creating legends for scatter plots has been introduced. Previously, in order to obtain a legend for a `scatter()` plot, one could either plot several scatters, each with an individual label, or create proxy artists to show in the legend manually. Now, `PathCollection` provides a method `legend_elements()` to obtain the handles and labels for a scatter plot in an automated way. This makes creating a legend for a scatter plot as easy as



An example can be found in `automatedlegendcreation`.

### Matplotlib no longer requires framework app build on MacOSX backend

Previous versions of matplotlib required a Framework build of python to work. The app type was updated to no longer require this, so the MacOSX backend should work with non-framework python.

This also adds support for the MacOSX backend for PyPy3.

## 4.1.2 Figure, FigureCanvas, and Backends

### Figure.frameon is now a direct proxy for the Figure patch visibility state

Accessing `Figure.frameon` (including via `get_frameon` and `set_frameon` now directly forwards to the visibility of the underlying Rectangle artist (`Figure.patch.get_frameon`, `Figure.patch`).

`set_frameon)`.

#### ***pil\_kwargs* argument added to `savefig`**

Matplotlib uses Pillow to handle saving to the JPEG and TIFF formats. The `savefig()` function gained a `pil_kwargs` keyword argument, which can be used to forward arguments to Pillow's `pillow.Image.save()`.

The `pil_kwargs` argument can also be used when saving to PNG. In that case, Matplotlib also uses Pillow's `pillow.Image.save()` instead of going through its own builtin PNG support.

#### **Add `inaxes` method to `FigureCanvasBase`**

The `FigureCanvasBase` class has now an `inaxes` method to check whether a point is in an axes and returns the topmost axes, else `None`.

#### **cairo backend defaults to `pycairo` instead of `cairocffi`**

This leads to faster import/runtime performance in some cases. The backend will fall back to `cairocffi` in case `pycairo` isn't available.

### **4.1.3 Axes and Artists**

#### **`axes_grid1` and `axisartist` Axes no longer draw spines twice**

Previously, spines of `axes_grid1` and `axisartist` Axes would be drawn twice, leading to a "bold" appearance. This is no longer the case.

#### **Return type of `ArtistInspector.get_aliases` changed**

`ArtistInspector.get_aliases` previously returned the set of aliases as `{fullname: {alias1: None, alias2: None, ...}}`. The dict-to-None mapping was used to simulate a set in earlier versions of Python. It has now been replaced by a set, i.e. `{fullname: {alias1, alias2, ...}}`.

This value is also stored in `ArtistInspector.aliasd`, which has likewise changed.

#### **`ConnectionPatch` accepts arbitrary transforms**

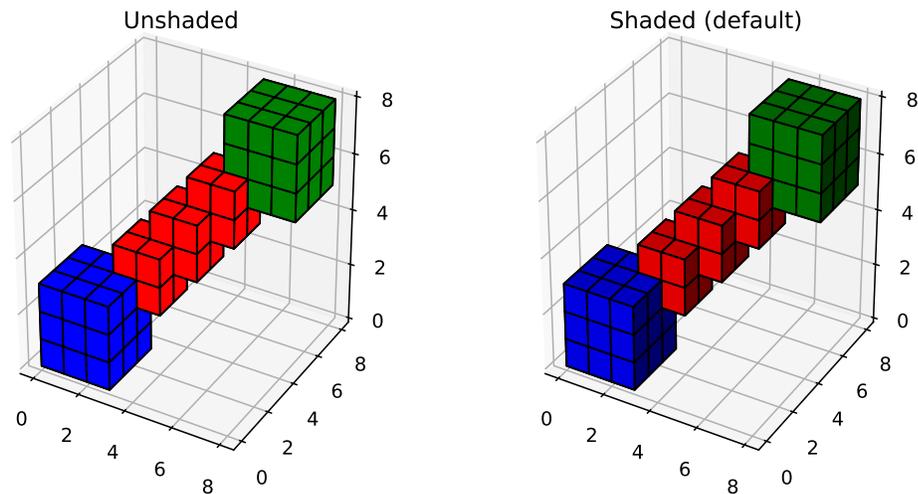
Alternatively to strings like "data" or "axes fraction" `ConnectionPatch` now accepts any `Transform` as input for the `coordsA` and `coordsB` argument. This allows to draw lines between points defined in different user defined coordinate systems. Also see the `Connect Simple01` example.

#### **`mplot3d` `Line3D` now allows `{set,get}_data_3d`**

Lines created with the 3d projection in `mplot3d` can now access the data using `get_data_3d()` which returns a tuple of array\_likes containing the (x, y, z) data. The equivalent `set_data_3d` can be used to modify the data of an existing `Line3D`.

**Axes3D.voxels now shades the resulting voxels**

The `voxels()` method now takes a *shade* parameter that defaults to `True`. This shades faces based on their orientation, behaving just like the matching parameters to `trisurf()` and `bar3d()`. The plot below shows how this affects the output.

**4.1.4 Axis and Ticks****Added `Axis.get_inverted` and `Axis.set_inverted`**

The `Axis.get_inverted` and `Axis.set_inverted` methods query and set whether the axis uses “inverted” orientation (i.e. increasing to the left for the x-axis and to the bottom for the y-axis).

They perform tasks similar to `Axes.xaxis_inverted`, `Axes.yaxis_inverted`, `Axes.invert_xaxis`, and `Axes.invert_yaxis`, with the specific difference that `Axes.set_inverted` makes it easier to set the invertedness of an axis regardless of whether it had previously been inverted before.

**Adjust default minor tick spacing**

Default minor tick spacing was changed from 0.625 to 0.5 for major ticks spaced 2.5 units apart.

**EngFormatter now accepts `usetex`, `useMathText` as keyword only arguments**

A public API has been added to `EngFormatter` to control how the numbers in the ticklabels will be rendered. By default, `useMathText` evaluates to `rcParams["axes.formatter.use_mathtext"]` and `usetex` evaluates to `rcParams["text.usetex"]`.

If either is `True` then the numbers will be encapsulated by \$ signs. When using TeX this implies that the numbers will be shown in TeX's math font. When using `mathtext`, the \$ signs around numbers will ensure unicode rendering (as implied by `mathtext`). This will make sure that the minus signs in the ticks are rendered as the unicode=minus (U+2212) when using `mathtext` (without relying on the `fix_minus` method).

## 4.1.5 Animation and Interactivity

### Support for forward/backward mouse buttons

Figure managers now support a `button_press` event for mouse buttons, similar to the `key_press` events. This allows binding actions to mouse buttons (see `MouseButton`). The first application of this mechanism is support of forward/backward mouse buttons in figures created with the Qt5 backend.

#### `progress_callback` argument to `save()`

The method `Animation.save` gained an optional `progress_callback` argument to notify the saving progress.

#### Add `cache_frame_data` keyword-only argument into `animation.FuncAnimation`

`matplotlib.animation.FuncAnimation` has been caching frame data by default; however, this caching is not ideal in certain cases e.g. When `FuncAnimation` needs to be only drawn(not saved) interactively and memory required by frame data is quite large. By adding `cache_frame_data` keyword-only argument, users can now disable this caching; thereby, this new argument provides a fix for issue [#8528](#).

### Endless Looping GIFs with PillowWriter

We acknowledge that most people want to watch a gif more than once. Saving an animation as a gif with PillowWriter now produces an endless looping gif.

#### Adjusted `matplotlib.widgets.Slider` to have vertical orientation

The `matplotlib.widgets.Slider` widget now takes an optional argument `orientation` which indicates the direction ('horizontal' or 'vertical') that the slider should take.

#### Improved formatting of image values under cursor when a colorbar is present

When a colorbar is present, its formatter is now used to format the image values under the mouse cursor in the status bar. For example, for an image displaying the values 10,000 and 10,001, the statusbar will now (using default settings) display the values as 10000 and 10001), whereas both values were previously displayed as `1e+04`.

### MouseEvent button attribute is now an IntEnum

The `button` attribute of `MouseEvent` instances can take the values `None`, `1` (left button), `2` (middle button), `3` (right button), `"up"` (scroll), and `"down"` (scroll). For better legibility, the `1`, `2`, and `3` values are now represented using the `IntEnum` class `matplotlib.backend_bases.MouseButton`, with the values `MouseButton.LEFT` (`== 1`), `MouseButton.MIDDLE` (`== 2`), and `MouseButton.RIGHT` (`== 3`).

## 4.1.6 Configuration, Install, and Development

### The MATPLOTLIBRC environment variable can now point to any "file" path

This includes device files; in particular, on Unix systems, one can set `MATPLOTLIBRC` to `/dev/null` to ignore the user's `matplotlibrc` file and fall back to Matplotlib's defaults.

As a reminder, if `MATPLOTLIBRC` points to a directory, Matplotlib will try to load the `matplotlibrc` file from `$MATPLOTLIBRC/matplotlibrc`.

### Allow LaTeX code `pgf.preamble` and `text.latex.preamble` in MATPLOTLIBRC file

Previously, the rc file keys `rcParams["pgf.preamble"]` and `rcParams["text.latex.preamble"]` were parsed using commas as separators. This would break valid LaTeX code, such as:

```
\usepackage[protrusion=true, expansion=false]{microtype}
```

The parsing has been modified to pass the complete line to the LaTeX system, keeping all commas. Passing a list of strings from within a Python script still works as it used to.

### New logging API

`matplotlib.set_loglevel` / `pyplot.set_loglevel` can be called to display more (or less) detailed logging output.

**HISTORY**

---

**Note:** The following introductory text was written in 2008 by John D. Hunter (1968-2012), the original author of Matplotlib.

---

Matplotlib is a library for making 2D plots of arrays in [Python](#). Although it has its origins in emulating the MATLAB graphics commands, it is independent of MATLAB, and can be used in a Pythonic, object oriented way. Although Matplotlib is written primarily in pure Python, it makes heavy use of [NumPy](#) and other extension code to provide good performance even for large arrays.

Matplotlib is designed with the philosophy that you should be able to create simple plots with just a few commands, or just one! If you want to see a histogram of your data, you shouldn't need to instantiate objects, call methods, set properties, and so on; it should just work.

For years, I used to use MATLAB exclusively for data analysis and visualization. MATLAB excels at making nice looking plots easy. When I began working with EEG data, I found that I needed to write applications to interact with my data, and developed an EEG analysis application in MATLAB. As the application grew in complexity, interacting with databases, http servers, manipulating complex data structures, I began to strain against the limitations of MATLAB as a programming language, and decided to start over in Python. Python more than makes up for all of MATLAB's deficiencies as a programming language, but I was having difficulty finding a 2D plotting package (for 3D [VTK](#) more than exceeds all of my needs).

When I went searching for a Python plotting package, I had several requirements:

- Plots should look great - publication quality. One important requirement for me is that the text looks good (antialiased, etc.)
- Postscript output for inclusion with TeX documents
- Embeddable in a graphical user interface for application development
- Code should be easy enough that I can understand it and extend it
- Making plots should be easy

Finding no package that suited me just right, I did what any self-respecting Python programmer would do: rolled up my sleeves and dived in. Not having any real experience with computer graphics, I decided to emulate MATLAB's plotting capabilities because that is something MATLAB does very well. This had the added advantage that many people have a lot of MATLAB experience, and thus they can quickly get up to steam plotting in python. From a developer's perspective, having a fixed user interface (the pylab interface) has been very useful, because the guts of the code base can be redesigned without affecting user code.

The Matplotlib code is conceptually divided into three parts: the *pylab interface* is the set of functions provided by `matplotlib.pylab` which allow the user to create plots with code quite similar to MATLAB figure generating code (*Pyplot tutorial*). The *Matplotlib frontend* or *Matplotlib API* is the set of classes that do the heavy lifting, creating and managing figures, text, lines, plots and so on (*Artist tutorial*). This is an abstract interface that knows nothing about output. The *backends* are device-dependent drawing devices, aka renderers, that transform the frontend representation to hardcopy or a display device (*What is a backend?*). Example backends: PS creates [PostScript®](#) hardcopy, SVG creates [Scalable Vector Graphics](#) hardcopy, Agg creates PNG output using the high quality [Anti-Grain Geometry](#) library that ships with Matplotlib, GTK embeds Matplotlib in a [Gtk+](#) application, GTKAgg uses the Anti-Grain renderer to create a figure and embed it in a [Gtk+](#) application, and so on for [PDF](#), [WxWidgets](#), [Tkinter](#), etc.

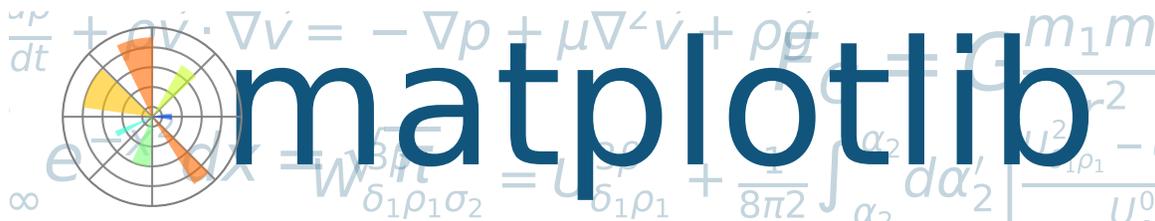
Matplotlib is used by many people in many different contexts. Some people want to automatically generate PostScript files to send to a printer or publishers. Others deploy Matplotlib on a web application server to generate PNG output for inclusion in dynamically-generated web pages. Some use Matplotlib interactively from the Python shell in Tkinter on Windows. My primary use is to embed Matplotlib in a [Gtk+](#) EEG application that runs on Windows, Linux and Macintosh OS X.

---

Matplotlib's original logo (2003 - 2008).



Matplotlib logo (2008 - 2015).



## GITHUB STATS

GitHub stats for 2019/05/18 - 2019/06/30 (tag: v3.1.0)

These lists are automatically generated, and may be incomplete or contain duplicates.

We closed 30 issues and merged 120 pull requests. The full list can be seen [on GitHub](#)

The following 30 authors contributed 323 commits.

- Adam Gomaa
- Antony Lee
- Ben Root
- Christer Jensen
- chuanzhu xu
- David Stansby
- Deng Tian
- djdt
- Dora Fraeman Caswell
- Elan Ernest
- Elliott Sales de Andrade
- Eric Firing
- Filipe Fernandes
- Ian Thomas
- ImportanceOfBeingErnest
- Jody Klymak
- Johannes H. Jensen
- Jonas Camillus Jeppesen
- LeiSurre
- Matt Adamson
- MeeseeksMachine
- Molly Rossow
- Nathan Goldbaum

- Nelle Varoquaux
- Paul Ivanov
- RoryIAngus
- Ryan May
- Thomas A Caswell
- Thomas Robitaille
- Tim Hoffmann

GitHub issues and pull requests:

Pull Requests (120):

- [PR #14636](#): Don't capture stderr in `_check_and_log_subprocess`.
- [PR #14655](#): Backport [PR #14649](#) on branch `v3.1.x` (Fix appveyor conda py37)
- [PR #14649](#): Fix appveyor conda py37
- [PR #14646](#): Backport [PR #14640](#) on branch `v3.1.x` (FIX: allow secondary axes to be non-linear)
- [PR #14640](#): FIX: allow secondary axes to be non-linear
- [PR #14643](#): Second attempt at fixing axis inversion (for `mpl3.1`).
- [PR #14623](#): Fix axis inversion with `loglocator` and `logitlocator`.
- [PR #14619](#): Backport [PR #14598](#) on branch `v3.1.x` (Fix inversion of shared axes.)
- [PR #14621](#): Backport [PR #14613](#) on branch `v3.1.x` (Cleanup `DateFormatter` docstring.)
- [PR #14622](#): Backport [PR #14611](#) on branch `v3.1.x` (Update some axis docstrings.)
- [PR #14611](#): Update some axis docstrings.
- [PR #14613](#): Cleanup `DateFormatter` docstring.
- [PR #14598](#): Fix inversion of shared axes.
- [PR #14610](#): Backport [PR #14579](#) on branch `v3.1.x` (Fix inversion of 3d axis.)
- [PR #14579](#): Fix inversion of 3d axis.
- [PR #14600](#): Backport [PR #14599](#) on branch `v3.1.x` (DOC: Add `numpngw` to third party packages.)
- [PR #14574](#): Backport [PR #14568](#) on branch `v3.1.x` (Don't assume tk canvas have a manager attached.)
- [PR #14568](#): Don't assume tk canvas have a manager attached.
- [PR #14571](#): Backport [PR #14566](#) on branch `v3.1.x` (Move setting of `AA_EnableHighDpiScaling` before creating `QApplication`.)
- [PR #14566](#): Move setting of `AA_EnableHighDpiScaling` before creating `QApplication`.
- [PR #14541](#): Backport [PR #14535](#) on branch `v3.1.x` (Invalidate `FT2Font` cache when `fork()`ing.)
- [PR #14535](#): Invalidate `FT2Font` cache when `fork()`ing.
- [PR #14522](#): Backport [PR #14040](#) on branch `v3.1.x` (Gracefully handle non-finite `z` in `tricontour` (issue [#10167](#)))

- [PR #14434](#): Backport [PR #14296](#) on branch v3.1.x (Fix barbs to accept array of bool for flip\_barb)
- [PR #14518](#): Backport [PR #14509](#) on branch v3.1.x (Fix too large icon spacing in Qt5 on non-HiDPI screens)
- [PR #14509](#): Fix too large icon spacing in Qt5 on non-HiDPI screens
- [PR #14514](#): Backport [PR #14256](#) on branch v3.1.x (Improve docstring of Axes.barbs)
- [PR #14256](#): Improve docstring of Axes.barbs
- [PR #14505](#): Backport [PR #14395](#) on branch v3.1.x (MAINT: work around non-zero exit status of "pdftops -v" command.)
- [PR #14504](#): Backport [PR #14445](#) on branch v3.1.x (FIX: fastpath clipped artists)
- [PR #14502](#): Backport [PR #14451](#) on branch v3.1.x (FIX: return points rather than path to fix regression)
- [PR #14445](#): FIX: fastpath clipped artists
- [PR #14497](#): Backport [PR #14491](#) on branch v3.1.x (Fix uses of PyObject\_IsTrue.)
- [PR #14491](#): Fix uses of PyObject\_IsTrue.
- [PR #14492](#): Backport [PR #14490](#) on branch v3.1.x (Fix links of parameter types)
- [PR #14490](#): Fix links of parameter types
- [PR #14489](#): Backport [PR #14459](#) on branch v3.1.x (Cleanup docstring of Draggable-Base.)
- [PR #14459](#): Cleanup docstring of DraggableBase.
- [PR #14485](#): Backport [PR #14429](#) on v3.1.x
- [PR #14486](#): Backport [PR #14403](#) on v3.1.
- [PR #14429](#): FIX: if the first elements of an array are masked keep checking
- [PR #14481](#): Backport [PR #14475](#) on branch v3.1.x (change ginoput docstring to match behavior)
- [PR #14482](#): Backport [PR #14464](#) on branch v3.1.x (Mention origin and extent tutorial in API docs for origin kwarg)
- [PR #14464](#): Mention origin and extent tutorial in API docs for origin kwarg
- [PR #14468](#): Backport [PR #14449](#): Improve docs on gridspec
- [PR #14475](#): change ginoput docstring to match behavior
- [PR #14477](#): Backport [PR #14461](#) on branch v3.1.x (Fix out of bounds read in backend\_tk.)
- [PR #14476](#): Backport [PR #14474](#) on branch v3.1.x (Fix default value in docstring of errorbar func)
- [PR #14461](#): Fix out of bounds read in backend\_tk.
- [PR #14474](#): Fix default value in docstring of errorbar func
- [PR #14473](#): Backport [PR #14472](#) on branch v3.1.x (Fix NameError in example code for setting label via method)
- [PR #14472](#): Fix NameError in example code for setting label via method

- [PR #14449](#): Improve docs on gridspec
- [PR #14450](#): Backport [PR #14422](#) on branch v3.1.x (Fix ReST note in span selector example)
- [PR #14446](#): Backport [PR #14438](#) on branch v3.1.x (Issue [#14372](#) - Add degrees to documentation)
- [PR #14438](#): Issue [#14372](#) - Add degrees to documentation
- [PR #14437](#): Backport [PR #14387](#) on branch v3.1.x (Fix clearing rubberband on nbagg)
- [PR #14387](#): Fix clearing rubberband on nbagg
- [PR #14435](#): Backport [PR #14425](#) on branch v3.1.x (Lic restore license paint)
- [PR #14296](#): Fix barbs to accept array of bool for flip\_barb
- [PR #14430](#): Backport [PR #14397](#) on branch v3.1.x (Correctly set clip\_path on pcolorfast return artist.)
- [PR #14397](#): Correctly set clip\_path on pcolorfast return artist.
- [PR #14409](#): Backport [PR #14335](#) on branch v3.1.x (Add explanation of animation.embed\_limit to matplotlibrc.template)
- [PR #14335](#): Add explanation of animation.embed\_limit to matplotlibrc.template
- [PR #14403](#): Revert "Preserve whitespace in svg output."
- [PR #14407](#): Backport [PR #14406](#) on branch v3.1.x (Remove extra iint in math\_symbol\_table for document)
- [PR #14398](#): Backport [PR #14394](#) on branch v3.1.x (Update link to "MathML torture test".)
- [PR #14394](#): Update link to "MathML torture test".
- [PR #14389](#): Backport [PR #14388](#) on branch v3.1.x (Fixed one little spelling error)
- [PR #14385](#): Backport [PR #14316](#) on branch v3.1.x (Improve error message for kiwi-solver import error (DLL load failed))
- [PR #14388](#): Fixed one little spelling error
- [PR #14384](#): Backport [PR #14369](#) on branch v3.1.x (Don't use deprecated mathcircled in docs.)
- [PR #14316](#): Improve error message for kiwisolver import error (DLL load failed)
- [PR #14369](#): Don't use deprecated mathcircled in docs.
- [PR #14375](#): Backport [PR #14374](#) on branch v3.1.x (Check that the figure patch is in bbox\_artists before trying to remove.)
- [PR #14374](#): Check that the figure patch is in bbox\_artists before trying to remove.
- [PR #14040](#): Gracefully handle non-finite z in tricontour (issue [#10167](#))
- [PR #14342](#): Backport [PR #14326](#) on branch v3.1.x (Correctly apply PNG palette when building ImageBase through Pillow.)
- [PR #14326](#): Correctly apply PNG palette when building ImageBase through Pillow.
- [PR #14341](#): Backport [PR #14337](#) on branch v3.1.x (Docstring cleanup)
- [PR #14337](#): Docstring cleanup

- [PR #14325](#): Backport [PR #14126](#) on branch v3.1.x (Simplify grouped bar chart example)
- [PR #14324](#): Backport [PR #14139](#) on branch v3.1.x (TST: be more explicit about identifying qt4/qt5 imports)
- [PR #14126](#): Simplify grouped bar chart example
- [PR #14323](#): Backport [PR #14290](#) on branch v3.1.x (Convert SymmetricalLogScale to numpydoc)
- [PR #14139](#): TST: be more explicit about identifying qt4/qt5 imports
- [PR #14290](#): Convert SymmetricalLogScale to numpydoc
- [PR #14321](#): Backport [PR #14313](#) on branch v3.1.x
- [PR #14313](#): Support masked array inputs for `to_rgba` and `to_rgba_array`.
- [PR #14320](#): Backport [PR #14319](#) on branch v3.1.x (Don't set missing history buttons.)
- [PR #14319](#): Don't set missing history buttons.
- [PR #14317](#): Backport [PR #14295](#): Fix bug in SymmetricalLogTransform.
- [PR #14302](#): Backport [PR #14255](#) on branch v3.1.x (Improve docsstring of `Axes.streamplot`)
- [PR #14255](#): Improve docsstring of `Axes.streamplot`
- [PR #14295](#): Fix bug in SymmetricalLogTransform.
- [PR #14294](#): Backport [PR #14282](#) on branch v3.1.x (Fix toolmanager's destroy subplots in tk)
- [PR #14282](#): Fix toolmanager's destroy subplots in tk
- [PR #14292](#): Backport [PR #14289](#) on branch v3.1.x (BUG: Fix performance regression when plotting values from Numpy array sub-classes)
- [PR #14289](#): BUG: Fix performance regression when plotting values from Numpy array sub-classes
- [PR #14287](#): Backport [PR #14286](#) on branch v3.1.x (fix minor typo)
- [PR #14284](#): Backport [PR #14279](#) on branch v3.1.x (In case fallback to Agg fails, let the exception propagate out.)
- [PR #14254](#): Merge up 30x
- [PR #14279](#): In case fallback to Agg fails, let the exception propagate out.
- [PR #14268](#): Backport [PR #14261](#) on branch v3.1.x (Updated polar documentation)
- [PR #14261](#): Updated polar documentation
- [PR #14264](#): Backport [PR #14260](#) on branch v3.1.x (Remove old OSX FAQ page)
- [PR #14260](#): Remove old OSX FAQ page
- [PR #14249](#): Backport [PR #14243](#) on branch v3.1.x (Update docstring of `makeMappingArray`)
- [PR #14250](#): Backport [PR #14149](#) on branch v3.1.x
- [PR #14252](#): Backport [PR #14248](#) on branch v3.1.x (Fix `TextBox` not respecting `eventson`)
- [PR #14253](#): Backport [PR #13596](#) on branch v3.1.x (Normalize properties passed to `bxp()`)

- [PR #14251](#): Backport [PR #14241](#) on branch v3.1.x (Fix linear segmented colormap with one element)
- [PR #13596](#): Normalize properties passed to `bxp()`.
- [PR #14248](#): Fix `TextBox` not respecting `eventson`
- [PR #14241](#): Fix linear segmented colormap with one element
- [PR #14243](#): Update docstring of `makeMappingArray`
- [PR #14238](#): Backport [PR #14164](#) on branch v3.1.x (Fix regexp for `dvipng` version detection)
- [PR #14149](#): Avoid using `axis([xlo, xhi, ylo, yhi])` in examples.
- [PR #14164](#): Fix regexp for `dvipng` version detection
- [PR #13739](#): Fix pressing tab breaks keymap in `CanvasTk`

## Issues (30):

- [#14620](#): Plotting on a log/logit scale overwrites axis inverting
- [#14615](#): Inverting an axis using its limits does not work for log scale
- [#14577](#): Calling `invert_yaxis()` on a 3D plot has either no effect or removes ticks
- [#14602](#): `NavigationToolbar2Tk` `save_figure` function bug
- [#1219](#): `Show` fails on figures created with the object-oriented system
- [#10167](#): Segmentation fault with `tricontour`
- [#13723](#): `RuntimeError` when saving PDFs via parallel processes (not threads!)
- [#14315](#): Improvement: Better error message if `kiwisolver` fails to import
- [#14356](#): `matplotlib.units.ConversionError` on scatter of dates with a `NaN` in the first position
- [#14467](#): Docs for `plt.ginput()` have the wrong default value for `show_clicks` keyword argument.
- [#14225](#): Matplotlib crashes on windows while maximizing plot window when using `Multicursor`
- [#14458](#): DOC: small inconsistency in `errobar` docstring
- [#14372](#): Document that `view_init()` arguments should be in degrees
- [#12201](#): issues clearing rubberband on `nbgg` at non-default browser zoom
- [#13576](#): `pcolorfast` misbehaves when changing axis limits
- [#14303](#): Unable to import matplotlib on Windows 10 v1903
- [#14283](#): `RendererSVG` CSS 'white-space' property conflicts with default HTML CSS
- [#14293](#): `imshow()` producing "inverted" colors since 3.0.3
- [#14322](#): Cannot import matplotlib with Python 3.7.x on Win10Pro
- [#14137](#): Qt5 test auto-skip is not working correctly
- [#14301](#): `scatter()` fails on nan-containing input when providing `edgecolor`
- [#14318](#): Don't try to set missing history buttons.
- [#14265](#): `symlog` loses some points since 3.1.0 (example given)

- [#14274](#): BUG: plotting with Numpy array subclasses is slow with Matplotlib 3.1.0 (regression)
- [#14263](#): import pyplot issue -
- [#14227](#): Update "working with Mpl on OSX" docs
- [#13448](#): boxplot doesn't normalize properties before applying them
- [#14226](#): Modify matplotlib TextBox value without triggering callback
- [#14232](#): LinearSegmentedColormap with N=1 gives confusing error message
- [#10365](#): Scatter plot with non-sequence 'c' color should give a better Error message.

## 6.1 Previous GitHub Stats

### 6.1.1 GitHub Stats for Matplotlib 3.0.2

GitHub stats for 2018/09/18 - 2018/11/09 (tag: v3.0.0)

These lists are automatically generated, and may be incomplete or contain duplicates.

We closed 170 issues and merged 224 pull requests.

The following 49 authors contributed 460 commits.

- Abhinuv Nitin Pitale
- Alon Hershenhorn
- Andras Deak
- Ankur Dedania
- Antony Lee
- Anubhav Shrimal
- Ayappan P
- azure-pipelines[bot]
- Ben Root
- Colin
- Colin Carroll
- Daniele Nicolodi
- David Haberthür
- David Stansby
- Dmitry Mottl
- Elan Ernest
- Elliott Sales de Andrade
- Eric Wieser
- esvhd
- Galen Lynch

- hannah
- Ildar Akhmetgaleev
- ImportanceOfBeingErnest
- Jody Klymak
- Joel Wanner
- Kai Muehlbauer
- Kevin Rose
- Kyle Sunden
- Marcel Martin
- Matthias Bussonnier
- MeeseeksMachine
- Michael Jancsy
- Nelle Varoquaux
- Nick Papior
- Nikita Kniazev
- Paul Hobson
- pharshalp
- Rasmus Diederichsen
- Ryan May
- saksmito
- Takafumi Arakaki
- teresy
- Thomas A Caswell
- thoo
- Tim Hoffmann
- Tobias Megies
- Tyler Makaro
- Will Handley
- Yuxin Wu

GitHub issues and pull requests:

Pull Requests (224):

- [PR #12785](#): Use level kwargs in irregular contour example
- [PR #12767](#): Make colorbars constructible with dataless ScalarMappables.
- [PR #12775](#): Add note to errorbar function about sign of errors
- [PR #12776](#): Fix typo in example (on-borad -> on-board).
- [PR #12771](#): Do not rely on external stack frame to exist

- PR #12526: Rename jquery files
- PR #12552: Update docs for writing image comparison tests.
- PR #12746: Use skipif, not xfail, for uncomparable image formats.
- PR #12747: Prefer `log.warning("%s", ...)` to `log.warning("%s" % ...)`.
- PR #11753: FIX: Apply aspect before drawing starts
- PR #12749: Move toolmanager warning from logging to warning.
- PR #12708: Run flake8 in a separate travis environment
- PR #12737: Improve docstring of Arc
- PR #12598: Support Cn colors with  $n \geq 10$ .
- PR #12670: FIX: add setter for hold to un-break basemap
- PR #12693: Workaround Text3D breaking `tight_layout()`
- PR #12727: Reorder API docs: separate file per module
- PR #12738: Add unobtrusive deprecation note to the first line of the docstring.
- PR #12740: DOC: constrained layout guide (fix: Spacing with colorbars)
- PR #11663: Refactor color parsing of Axes.scatter
- PR #12736: Move deprecation note to end of docstring
- PR #12704: Rename tkinter import from Tk to tk.
- PR #12730: MNT: merge ignore lines in .flake8
- PR #12707: Fix tk error when closing first pyplot figure
- PR #12715: Cleanup dviread.
- PR #12717: Delete some `if __name__ == "__main__"` clauses.
- PR #12726: Fix `test_non_gui_warning` for Azure (and mplcairo).
- PR #12720: Improve docs on Axes scales
- PR #12537: Improve error message on failing `test_pyplot_up_to_date`
- PR #12721: Make `get_scale_docs()` internal
- PR #12617: Set up CI with Azure Pipelines
- PR #12673: Fix for `_axes.scatter()` array index out of bound error
- PR #12676: Doc: document `textpath` module
- PR #12705: Improve docs on Axes limits and direction
- PR #12706: Extend sphinx Makefile to cleanup completely
- PR #12481: Warn if `plot_surface` Z values contain NaN
- PR #12709: Correctly remove nans when drawing paths with pycairo.
- PR #12685: Make ticks in `demo_axes_rgb.py` visible
- PR #12691: DOC: Link to "How to make a PR" tutorials as badge and in contributing
- PR #12684: Change ipython block to code-block
- PR #11974: Make code match comment in sankey.

- PR #12440: Make arguments to @deprecated/warn\_deprecated keyword-only.
- PR #12683: TST: mark test\_constrainedlayout.py::test\_colorbar\_location as flaky
- PR #12686: Remove deprecation warnings in tests
- PR #12470: Update AutoDateFormatter with locator
- PR #12656: FIX: fix error in colorbar.get\_ticks not having valid data
- PR #12586: Improve linestyles example
- PR #12006: Added stacklevel=2 to all warnings.warn calls (issue 10643)
- PR #12651: FIX: ignore non-finite bbox
- PR #12653: Don't warn when accessing deprecated properties from the class.
- PR #12608: ENH: allow matplotlib.use after getbackend
- PR #12658: Do not warn-depreacted when iterating over rcParams
- PR #12635: FIX: allow non bbox\_extra\_artists calls
- PR #12659: Add note that developer discussions are private
- PR #12543: Make rcsetup.py flak8 compliant
- PR #12642: Don't silence TypeErrors in fmt\_{x,y}data.
- PR #11667: DOC: update doc requirement
- PR #12442: Deprecate passing drawstyle with linestyle as single string.
- PR #12625: Shorten some docstrings.
- PR #12627: Be a bit more stringent on invalid inputs.
- PR #12561: Properly css-style exceptions in the documentation
- PR #12629: Fix issue with PyPy on macOS
- PR #10933: Remove "experimental" fontconfig font\_manager backend.
- PR #12630: Fix RcParams.\_\_len\_\_
- PR #12285: FIX: Don't apply tight\_layout if axes collapse
- PR #12548: undef \_XOPEN\_SOURCE breaks the build in AIX
- PR #12615: Fix travis OSX build
- PR #12600: Minor style fixes.
- PR #12607: STY: fix whitespace and escaping
- PR #12603: FIX: don't import macosx to check if eventloop running
- PR #12599: Fix formatting of docstring
- PR #12569: Don't confuse uintptr\_t and Py\_ssize\_t.
- PR #12572: Fix singleton hist labels
- PR #12581: Fix hist() error message
- PR #12570: Fix mathtext tutorial for build with Sphinx 1.8.
- PR #12487: Update docs/tests for the deprecation of aname and label1On/label2On/etc.
- PR #12521: Improve docstring of draw\_idle()

- PR #12573: BUG: mplot3d: Don't crash if azim or elev are non-integral
- PR #12574: Remove some unused imports
- PR #12568: Add note regarding builds of old Matplotlibs.
- PR #12555: Clarify horizontalalignment and verticalalignment in suptitle
- PR #12547: Disable sticky edge accumulation if no autoscaling.
- PR #12546: Avoid quadratic behavior when accumulating stickies.
- PR #12159: FIX: colorbar re-check norm before draw for autolabels
- PR #12501: Rectified plot error
- PR #11789: endless looping GIFs with PillowWriter
- PR #12525: Fix some flake8 issues
- PR #12431: FIX: allow single-string color for scatter
- PR #12216: Doc: Fix search for sphinx  $\geq 1.8$
- PR #12461: FIX: make add\_lines work with new colorbar
- PR #12241: FIX: make unused spines invisible
- PR #12516: Don't handle impossible values for align in hist()
- PR #12504: DOC: clarify min supported version wording
- PR #12507: FIX: make minor ticks formatted with science formatter as well
- PR #12500: Adjust the widths of the messages during the build.
- PR #12492: Simplify radar\_chart example.
- PR #12478: MAINT: numpy deprecates asccalar in 1.16
- PR #12363: FIX: errors in get\_position changes
- PR #12495: Fix duplicate condition in pathpatch3d example
- PR #11984: Strip out pkg-config machinery for agg and libqhull.
- PR #12463: Document Artist.cursor\_data() parameter
- PR #12489: Fix typo in documentation of ylim
- PR #12482: Test slider orientation
- PR #12317: Always install mpl\_toolkits.
- PR #12246: Be less tolerant of broken installs.
- PR #12477: Use  $N\{\text{MICRO SIGN}\}$  instead of  $N\{\text{GREEK SMALL LETTER MU}\}$  in Eng-Formatter.
- PR #12483: Kill FontManager.update\_fonts.
- PR #12448: Don't error if some font directories are not readable.
- PR #12474: Throw ValueError when irregularly gridded data is passed to streamplot.
- PR #12469: Clarify documentation of offsetbox.AnchoredText's prop kw argument
- PR #12468: Fix set\_ylim unit handling
- PR #12466: np.fromstring -> np.frombuffer.

- [PR #12369](#): Improved exception handling on animation failure
- [PR #12460](#): Deprecate `RendererBase.strip_math`.
- [PR #12457](#): Fix tutorial typos.
- [PR #12453](#): Rollback erroneous commit to `whats_new.rst` from [#10746](#)
- [PR #12452](#): Minor updates to the FAQ.
- [PR #10746](#): Adjusted `matplotlib.widgets.Slider` to have optional vertical orientatation
- [PR #12441](#): Get rid of a signed-compare warning.
- [PR #12430](#): Deprecate `Axes3D.plot_surface(shade=None)`
- [PR #12435](#): Fix `numpydoc` parameter formatting
- [PR #12434](#): Clarify documentation for `textprops` keyword parameter of `TextArea`
- [PR #12427](#): Document `Artist.get_cursor_data`
- [PR #12277](#): FIX: `datetime64` now recognized if in a list
- [PR #10322](#): Use `np.hypot` wherever possible.
- [PR #12423](#): Minor simplifications to `backend_svg`.
- [PR #12293](#): Make `pyplot` more tolerant wrt. 3rd-party subclasses.
- [PR #12360](#): Replace `axes_grid` by `axes_grid1` in test
- [PR #10356](#): fix detecting which artist(s) the mouse is over
- [PR #12416](#): Move font cache rebuild out of exception handler
- [PR #11891](#): Group some `print()`s in `backend_ps`.
- [PR #12165](#): Remove deprecated `mlab` code
- [PR #12394](#): DOC: fix CL tutorial to give same output from saved file and example
- [PR #12387](#): Update HTML animation as slider is dragged
- [PR #12408](#): Don't crash on invalid registry font entries on Windows.
- [PR #10088](#): Deprecate `Tick.{gridOn,tick1On,label1On,...}` in favor of `set_visible`.
- [PR #12149](#): `Mathtext` tutorial fixes
- [PR #12393](#): Deprecate to-days converters in `matplotlib.dates`
- [PR #12257](#): Document standard backends in `matplotlib.use()`
- [PR #12383](#): Revert change of parameter name in `annotate()`
- [PR #12385](#): CI: Added Appveyor Python 3.7 build
- [PR #12247](#): Machinery for deprecating properties.
- [PR #12371](#): Move check for `ImageMagick` Windows path to `bin_path()`.
- [PR #12384](#): Cleanup `axislines` style.
- [PR #12353](#): Doc: clarify default parameters in scatter docs
- [PR #12366](#): TST: Update test images for new Ghostscript.
- [PR #11648](#): FIX: colorbar placement in constrained layout
- [PR #12368](#): Don't use `stdlib` private API in `animation.py`.

- PR #12351: `dviread: find_tex_file`: Ensure the encoding on windows
- PR #12244: Merge `barchart` examples.
- PR #12372: Remove two examples.
- PR #12214: Improve docstring of `Annoation`
- PR #12347: DOC: add `_child_axes` to `axes_api.rst`
- PR #12304: TST: Merge Qt tests into one file.
- PR #12321: maint: `setupext.py` for freetype had a Catch case for missing `ft2build.h`
- PR #12340: Catch test deprecation warnings for `mlab.demean`
- PR #12334: Improve selection of inset indicator connectors.
- PR #12316: Fix some warnings from Travis
- PR #12268: FIX: remove unnecessary `self` in `super_`-calls, fixes #12265
- PR #12212: `font_manager`: Fixed problems with `Path(...).suffix`
- PR #12326: fixed minor spelling error in docstring
- PR #12296: Make `FooConverter` inherit from `ConversionInterface` in examples
- PR #12322: Fix the docs build.
- PR #12319: Fix Travis 3.6 builds
- PR #12309: Deduplicate implementations of `FooNorm.autoscale{, _None}`
- PR #12314: Deprecate `axis('normal')` in favor of `axis('auto')`.
- PR #12313: BUG: Fix typo in `view_limits()` for `MultipleLocator`
- PR #12307: Clarify missing-property error message.
- PR #12274: MNT: put back `_hold` as read-only attribute on `AxesBase`
- PR #12260: Fix docs : change from issue #12191, remove "if 1:" blocks in examples
- PR #12163: TST: Defer loading Qt framework until test is run.
- PR #12253: Handle utf-8 output by `kpathsea` on Windows.
- PR #12301: Ghostscript 9.0 requirement revisited
- PR #12294: Fix `expand_dims` warnings in `triinterpolate`
- PR #12292: TST: Modify the `bar3d` test to show three more angles
- PR #12297: Remove some `pytest` parameterising warnings
- PR #12261: FIX: `parasite axis2` demo
- PR #12278: Document inheriting docstrings
- PR #12262: Simplify empty-rasterized pdf test.
- PR #12269: Add some param docs to `BlockingInput` methods
- PR #12272: Fix `constrained` to `constrained`
- PR #12255: Deduplicate inherited docstrings.
- PR #12254: Improve docstrings of `Animations`
- PR #12258: Fix CSS for module-level data

- PR #12222: Remove extraneous if 1 statements in demo\_axisline\_style.py
- PR #12137: MAINT: Vectorize bar3d
- PR #12219: Merge OSXInstalledFonts into findSystemFonts.
- PR #12229: Less ACCEPTS, more numpydoc.
- PR #12209: Doc: Sort named colors example by palette
- PR #12237: Use (float, float) as parameter type for 2D positions in docstrings
- PR #12238: Typo in docs
- PR #12236: Make boilerplate-generated pyplot.py flake8 compliant
- PR #12231: CI: Speed up Appveyor repository cloning
- PR #12228: Fix trivial typo in docs.
- PR #12227: Use (float, float) as paramter type for 2D positions
- PR #12199: Allow disabling specific mouse actions in blocking\_input
- PR #12213: Change win32InstalledFonts return value
- PR #12207: FIX: dont' check for interactive framework if none required
- PR #11688: Don't draw axis (spines, ticks, labels) twice when using parasite axes.
- PR #12210: Axes.tick\_params() argument checking
- PR #12211: Fix typo
- PR #12200: Slightly clarify some invalid shape exceptions for image data.
- PR #12151: Don't pretend @deprecated applies to classmethods.
- PR #12190: Remove some unused variables and imports
- PR #12186: DOC: fix API note about get\_tightbbox
- PR #12203: Document legend's slowness when "best" location is used
- PR #12192: Exclude examples from lgtm analysis
- PR #12196: Give Carreau the ability to mention the backport bot.
- PR #12187: DOC: Update INSTALL.rst
- PR #12164: Fix Annotation.contains.
- PR #12177: FIX: remove cwd from mac font path search
- PR #12182: Fix Flash of Unstyled Content by removing remaining Flipcause integration
- PR #12184: DOC: update "Previous Whats New" for 2.2 with reference to cividis paper
- PR #12183: Doc: Don't use Sphinx 1.8
- PR #12171: Remove internal warning due to zsort deprecation
- PR #12166: Document preference order for backend auto selection
- PR #12154: Avoid triggering deprecation warnings with pytest 3.8.
- PR #12030: Speed up canvas redraw for GTK3Agg backend.
- PR #12157: Properly declare the interactive framework for the qt4foo backends.
- PR #12156: Cleanup the GridSpec demos.

- PR #12144: Add explicit getters and setters for `Annotation.anncoords`.
- PR #12152: Use `_warn_external` for deprecations warnings.
- PR #12148: BLD: pragmatic fix for building `basic_unit` example on py37
- PR #12147: DOC: update the `gh_stats` code

Issues (170):

- #12699: Annotations get cropped out of figures saved with `bbox_inches='tight'`
- #9217: Weirdness with inline figure DPI settings in Jupyter Notebook
- #4853: `%matplotlib notebook` creates much bigger figures than `%matplotlib inline`
- #12780: Vague/misleading exception message in `scatter()`
- #10239: Weird interaction with Tkinter
- #10045: `subplots_adjust()` breaks layout of tick labels
- #12765: Matplotlib draws incorrect color
- #11800: Gridspec tutorial
- #12757: up the figure
- #12724: Importing `pyplot` steals focus on macOS
- #12669: fixing `_hold` on `cartopy` broke `basemap`
- #12687: Plotting text on 3d axes before `tight_layout()` breaks `tight_layout()`
- #12734: Wishlist: functionally linked twin axes
- #12576: `RcParams` is fundamentally broken
- #12641: `_axes.py.scatter()` array index out of bound / calling from `seaborn`
- #12703: Error when closing first of several `pyplot` figures in `TkAgg`
- #12728: Deprecation Warnings
- #4124: Provide canonical examples of `mpl` in web frameworks
- #10574: Default color after setting `alpha` to `Patch` in `legened`
- #12702: couldn't find or load Qt platform plugin "windows" in "".
- #11139: "make clean" doesn't remove all the build doc files
- #12701: semilogy with `NaN` prevents display of Title (cairo backend)
- #12696: Process finished with exit code -1 due to matplotlib configuration
- #12692: `matplotlib.plot.show` always blocks the execution of python script
- #12433: Travis error is MacOS image tolerance of 0.005 for `test_constrained_layout.py::test_colorbar_location`
- #10017: `unicode_literals` considered harmful
- #12682: using `AxesImage.set_clim()` shrinks the colorbar
- #12620: Overlapping 3D objects
- #12680: matplotlib ui in thread still blocked
- #11908: Improve `linestyle` documentation

- #12650: Deprecation warnings when calling `help(matplotlib)`
- #10643: Most warnings calls do not set the `stacklevel`
- #12671: `make_axes_locatable` breaks with matplotlib 3.0
- #12664: `plt.scatter` crashes because overwrites the `colors` to an empty list
- #12188: matplotlib 3 pyplot on MacOS bounces rocket icon in dock
- #12648: Regression when calling `annotate` with nan values for the position
- #12362: In 3.0.0 backend cannot be set if `'get_backend()'` is run first
- #12649: Over-verbose deprecation warning about `examples.directory`
- #12661: In version 3.0.0 `make_axes_locatable + colorbar` does not produce expected result
- #12634: `axes_grid1` axes have no keyword argument `'bbox_extra_artists'`
- #12654: Broken 'Developer Discussions' link
- #12657: With v3.0.0 `mpl_toolkits.axes_grid1.make_axes_locatable().append_axes` breaks in Jupyter
- #12645: Markers are offset when `'facecolor'` or `'edgecolor'` are set to `'none'` when plotting data
- #12644: Memory leak with `plt.plot` in Jupyter Notebooks?
- #12632: Do we need input hooks macosx?
- #12535: AIX Support - Do not undef `_XOPEN_SOURCE`
- #12626: `AttributeError: module 'matplotlib' has no attribute 'artist'`
- #11034: Doc Typo: `matplotlib.axes.Axes.get_yticklabels / Axis.get_ticklabels`
- #12624: `make_axes_locatable` : Colorbar in the middle instead of bottom while saving a pdf, png.
- #11094: can not use GUI backends inside django request handlers
- #12613: transiently linked interactivity of unshared pair of axes generated with `make_axes_locatable`
- #12578: macOS builds are broken
- #12612: gui backends do not work inside of flask request handlers
- #12611: Matplotlib 3.0.0 Likely bug `TypeError: stackplot() got multiple values for argument 'x'`
- #12610: `matplotlibrc` causes import to fail 3.0.0 (didn't crash 2.y.z series)
- #12601: Can't import matplotlib
- #12597: Please soon add Chinese language support!! It's too difficult for new people handle character
- #12590: Matplotlib pypi distribution lacks packages for Python 2.7
- #3869: Numeric labels do not work with `plt.hist`
- #12580: Incorrect hist error message with bad color size
- #12100: document where to get nightly wheels

- #7205: Converting docstrings to numpydoc
- #12564: Saving plot as PNG file prunes tick labels
- #12161: Problems of using sharex options with lines plots and colormesh with colorbar
- #12256: tight\_layout for plot with non-clipped screen-unit items causes issues on zoom
- #12545: Program quit unnormally without reporting error
- #12532: Incorrect rendering of math symbols
- #12567: Calling pyplot.show() with TkAgg backend on x86 machine raises OverflowError.
- #12571: cannot install because Fatal Python error: initfsencoding: Unable to get the locale encoding
- #12566: Problem installing Version 1.3.1 -> missing pkg-config freetype and libagg
- #12556: Matplotlib 3.0.0 import hangs in clean environment
- #12197: Weird behaviour of supitle() when horizontalalignment is not 'center'
- #12550: colorbar resizes in animation
- #12155: Incorrect placement of Colorbar ticks using LogNorm
- #11787: Looping gifs with PillowWriter
- #12533: Plotting with alpha=0 with rasterized=True causes ValueError on saving to pdf
- #12438: Scatter doesn't accept a list of strings as color spec.
- #12429: scatter() does not accept gray strings anymore
- #12499: run my code failed after i Import pylab failed, python version is 3.6.6
- #12458: add\_lines misses lines for matplotlib.colorbar.ColorbarBase
- #12239: 3d axes are collapsed by tight\_layout
- #12414: Function to draw angle between two lines
- #12488: inconsistent colorbar tick labels for LogNorm
- #12515: pyplot.step broken in 3.0.0?
- #12355: Error for bbox\_inches='tight' in savefig with make\_axes\_locatable
- #12505: ImageGrid in 3.0
- #12502: How can I put the ticks of logarithmic coordinate in the axes?
- #12496: Matplotlib Can't Plot a Dataset
- #12486: rotate lable of legend ?
- #12291: Importing pyplot crashes on macOS due to missing fontlist-v300.json and then Permission denied: '/opt/local/share/fonts'
- #12480: "close\_event" for nbagg/notebook backend
- #12467: Documentation of AnchoredText's prop keyword argument is misleading
- #12288: New function signatures in pyplot break Cartopy
- #12445: Error on colorbar

- [#8760](#): Traceback from `animation.MovieWriter.saving` method is confusing because it provides no useful information
- [#9205](#): after the animation encoder (e.g. `ffmpeg`) fails, the animation framework itself fails internally in various ways while trying to report the error
- [#12357](#): Unclear error when saving Animation using `FFMpeg`
- [#12454](#): Formatting numerical legend
- [#9636](#): matplotlib crashes upon window resize
- [#11473](#): Continuous plotting cause memory leak 20-50kb/sec
- [#12018](#): No image pop-up or display for `plt.imshow()` and `plt.show()`
- [#11583](#): How to draw parallelepiped with real size scaling?
- [#12446](#): Polar Contour - `float()` argument must be a string or a number, not `'AxesParasiteParasiteAuxTrans'`
- [#12444](#): Issues with `gridspec/tight_layout` in matplotlib version 2.2.3
- [#11154](#): Unexpected behavior for `Axes3D.plot_surface(shade=None)`
- [#12409](#): Calling `savefig()` multiple times causes crash of Spyder IDE / IPython Kernel dying.
- [#9799](#): `FigureCanvasTkAgg` - "buffer is of wrong type" error during blit
- [#12439](#): `FileNotFoundError` for `font_manager`
- [#12437](#): `matplotlib-mac`
- [#12121](#): Documentation of `TextArea`'s `fontprops` keyword argument is misleading
- [#12279](#): `Axes.format_cursor_data` lacks documentation and seems unused
- [#12428](#): Simple plot spacing bug: `ylabel` gets wrongfully removed from plot
- [#11190](#): Images in the docs are too large.
- [#12271](#): error with `errorbar` with `datetime64`
- [#12405](#): `plt.stackplot()` does not work with 3.0.0
- [#12282](#): `Axes.imshow` tooltip does not get updated when another call to `Axes.imshow` is made
- [#12420](#): How to remove Rectangle Selector from figure?
- [#12391](#): Constrained Layout tutorial needs some cleanup....
- [#12406](#): Bug with font finding, and here is my fix as well.
- [#9051](#): `ParasiteAxes` over plotting
- [#12325](#): Annotation change from "s" to "text" in 3.0- documentation
- [#12397](#): `plt.show()` not working (can't get figures to display in external window) when using jupyter QTconsole
- [#12396](#): Defining `arrowprops` in draggable annotation disables the `pick_event`
- [#12389](#): Setting row edge color of matplotlib table
- [#12376](#): The output figure file is strange: there is a lot of blank area on the output figure.

- #11641: constrained\_layout and colorbar for a subset of axes
- #12373: Unexpected outcome with matplotlib.pyplot.pcolor()
- #12370: ImageGrid bug when using inline backend
- #12364: pdf image generated by matplotlib with semi transparent lines missing in Word on Windows.
- #12352: TeX rendering broken on master with windows
- #12354: Too many levels of symbolic links
- #12323: indicate\_inset\_zoom sometimes draws incorrect connector lines
- #12341: Figures not rendering in docker
- #12335: Matplotlib plt.Rectangle Incoherent Results
- #12265: ParasiteAxesAuxTrans pcolor/pcolormesh and contour/contourf broken
- #12337: AttributeError: module 'matplotlib.pyplot' has no attribute 'hold'
- #11673: Inconsistent font settings when changing style context
- #11693: The rcParams setting for figure(figsize does not change when run from another notebook
- #11725: New mode between non-interactive and interactive?
- #12134: tight\_layout flips images when making plots without displaying them
- #12310: plot fails with datetime64[ns] timezone aware objects (for example datetime64[ns, UTC+00:00] )
- #12191: "if 1:" blocks in examples
- #11288: FR: Figure.subplots add optional SubplotSpec parameter
- #12298: c and cmap for plot
- #12286: Sample code given in Matplotlib's site does not work.
- #11955: UnicodeDecodeError on importing pyplot in python2
- #12208: parasite axis2 demo now crashes with log x-axis
- #8871: Error when using quantities when plotting errorbars
- #6658: literature reference for 'viridis' colormap
- #6789: Tutorial pyplot\_scales.py crashes when used with plt.tight\_layout()
- #6922: imshow does not immediately update shared axes
- #11879: Unable to change filename when saving from figure window
- #12225: In histogram, bars whose count is larger than 2\*\*31 sometimes become negative
- #1461: DOC: keyword arguments to plt.axes, plt.subplot, and fig.add\_subplot
- #12173: Cannot import pyplot
- #12217: Python will suddenly not plot anymore
- #12120: Default legend behavior (loc='best') very slow for large amounts of data.
- #12176: import pyplot on MacOS without font cache will search entire subtree of current dir

- #12146: fix pdf docs
- #12160: MacOS: Cannot import name 'format\_exc'
- #12169: Cannot install 3.0.0 "python setup.py egg\_info" failed (freetype & png)
- #12168: pip install v3.0.0 'failed with exit status 1181'
- #12107: warnings re: deprecated pytest API with pytest 3.8
- #12162: <https://matplotlib.org/users/beginner.html> is outdated
- #12010: Popover over plot is very slow
- #6739: Make matplotlib fail more gracefully in headless environments
- #3679: Runtime detection for default backend
- #11340: matplotlib fails to install from source with intel compiler
- #11838: docs do not build on py3.7 due to small change in python handling of -m
- #12115: Plot in JS Animation has larger margin than "normal" PNG plot

### 6.1.2 GitHub Stats for Matplotlib 3.1.0

GitHub stats for 2018/09/18 - 2019/05/13 (tag: v3.0.0)

These lists are automatically generated, and may be incomplete or contain duplicates.

We closed 161 issues and merged 918 pull requests. The full list can be seen [on GitHub](#)

The following 150 authors contributed 3426 commits.

- Abhinuv Nitin Pitale
- Adam J. Stewart
- Alistair Muldal
- Alon Hershenhorn
- Andras Deak
- Ankur Dedania
- Antony Lee
- Anubhav Shrimal
- Ao Liu (frankliuao)
- Ayappan P
- azure-pipelines[bot]
- Bas van Schaik
- Ben Root
- Benjamin Bengfort
- Benjamin Congdon
- Bharat123rox
- Brigitta Sipocz
- btang02

- Carsten
- Carsten Schelp
- Cho Yin Yong
- Chris Zimmerman
- Christer Jensen
- Christoph Gohlke
- Christoph Reiter
- Christopher Bradshaw
- Colin
- Colin Carroll
- dabana
- Dana-Farber
- Daniele Nicolodi
- DanielMatu
- David Haberthür
- David Stansby
- Dietmar Schwertberger
- Dmitry Mottl
- E. G. Patrick Bos
- Elan Ernest
- Elliott Sales de Andrade
- Eric Firing
- Eric Larson
- Eric Wieser
- esvhd
- fredrik-1
- fuzzythecat
- Galen Lynch
- Gazing
- gwin-zegal
- hannah
- Harshal Prakash Patankar
- hershen
- Ildar Akhmetgaleev
- ImportanceOfBeingErnest
- Isa Hassen

- Jae-Joon Lee
- James A. Bednar
- James Adams
- Jan S. (Milania1)
- Jarrod Millman
- Jessica B. Hamrick
- Jody Klymak
- Joel T. Frederico
- Joel Wanner
- Johannes H. Jensen
- Joseph Albert
- Joshua Klein
- Jouni K. Seppänen
- Jun Tan
- Kai Muehlbauer
- Katrin Leinweber
- Kayla Ngan
- Kevin Rose
- Kjell Le
- KonradAdamczyk
- ksunden
- Kyle Sunden
- Leon Loopik
- Levi Kilcher
- LevN0
- luftek
- Maik Riechert
- Marcel Martin
- Mark Harfouche
- Marko Baštovanović
- Matthias Bussonnier
- Matthias Geier
- Matti Picus
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- Michael Droettboom
- Michael Jancsy

- Mike Frysinger
- Molly Rossow
- MortenSHUTE
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- Nelle Varoquaux
- Nick Papior
- Nicolas Courtemanche
- Nikita Kniazev
- njwhite
- Oliver Natt
- Paul
- Paul Hobson
- Paul Ivanov
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- Phil Elson
- Pierre Thibault
- QiCuiHub
- Rasmus Diederichsen
- Ratin\_Kumar
- Rob Harrigan
- Roman Yurchak
- Ryan May
- Ryan Morshead
- Saket Choudhary
- saksmi
- SBCV
- Sebastian Bullinger
- Sebastian Hegler
- Seunghoon Park
- simon-kraeusel
- smheidrich
- Stephane Raynaud
- Stephen-Chilcote
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- Taehoon Lee
- Takafumi Arakaki
- Taras
- Taras Kuzyo
- teresy
- Thein Oo
- Thomas A Caswell
- Thomas Hisch
- Thomas Robitaille
- thoo
- Tim Hoffmann
- Tobia De Koninck
- Tobias Megies
- Tyler Makaro
- V. Armando Solé
- Viraj Mohile
- Will Handley
- woclass
- Yasaman-Mah
- yeo
- Yuxin Wu
- Yuya
- Zhili (Jerry) Pan
- zhoubecky

GitHub issues and pull requests:

Pull Requests (918):

- [PR #14209](#): Backport [PR #14197](#) on branch v3.1.x (Minor cleanup of acorr/xcoor docs)
- [PR #14210](#): Make intro tutorial less jargony.
- [PR #14197](#): Minor cleanup of acorr/xcoor docs
- [PR #14203](#): Backport [PR #14202](#) on branch v3.1.x (Fix docstring of Line2D.set\_data.)
- [PR #14202](#): Fix docstring of Line2D.set\_data.
- [PR #14196](#): Backport [PR #14188](#) on branch v3.1.x (Clarify scope of MouseEvent attributes)
- [PR #14188](#): Clarify scope of MouseEvent attributes
- [PR #14194](#): Backport [PR #14167](#) on branch v3.1.x (Fix backend\_pgf header.)
- [PR #14193](#): Backport [PR #14153](#) on branch v3.1.x (Update qt\_compat.py test for already imported binding.)

- [PR #14167](#): Fix backend\_pgf header.
- [PR #14153](#): Update qt\_compat.py test for already imported binding.
- [PR #14190](#): Backport [PR #14176](#) on branch v3.1.x (Merge doc/api/api\_overview and doc/api/index.)
- [PR #14192](#): Unbreak testsuite for pytest 4.5.
- [PR #14189](#): Backport [PR #14186](#) on branch v3.1.x (Update FancyBboxPatch docs to numpydoc style)
- [PR #14176](#): Merge doc/api/api\_overview and doc/api/index.
- [PR #14186](#): Update FancyBboxPatch docs to numpydoc style
- [PR #14187](#): Backport [PR #13169](#) on branch v3.1.x (Add example code for current logo)
- [PR #14165](#): Backport [PR #14156](#) on branch v3.1.x (Fix glyph loading in textpath.)
- [PR #14156](#): Fix glyph loading in textpath.
- [PR #14162](#): Backport [PR #14150](#) on branch v3.1.x (Fix deprecation of withdash for figtext().)
- [PR #14150](#): Fix deprecation of withdash for figtext().
- [PR #14136](#): Backport [PR #14109](#) on branch v3.1.x
- [PR #14109](#): Some simple pyplot doc improvements
- [PR #14129](#): Backport [PR #14117](#) on branch v3.1.x (Simplify ribbon\_box example.)
- [PR #14128](#): Backport [PR #14057](#) on branch v3.1.x (Improve Gradient bar example)
- [PR #14127](#): Backport [PR #14125](#) on branch v3.1.x (Remove extra keyword from pytest.skip call.)
- [PR #14117](#): Simplify ribbon\_box example.
- [PR #14057](#): Improve Gradient bar example
- [PR #14125](#): Remove extra keyword from pytest.skip call.
- [PR #14123](#): Backport [PR #14119](#) on branch v3.1.x (Add ridge\_map to third party packages documentation)
- [PR #14119](#): Add ridge\_map to third party packages documentation
- [PR #14103](#): Backport [PR #14088](#) on branch v3.1.x (Cleanup major\_minor\_demo.)
- [PR #14102](#): Backport [PR #14100](#) on branch v3.1.x (Improve docstring of axes\_zoom\_effect example.)
- [PR #14099](#): Backport [PR #14090](#) on branch v3.1.x (Pep8ify some variable names in examples.)
- [PR #14100](#): Improve docstring of axes\_zoom\_effect example.
- [PR #14088](#): Cleanup major\_minor\_demo.
- [PR #14090](#): Pep8ify some variable names in examples.
- [PR #14097](#): Backport [PR #14079](#) on branch v3.1.x (Consistently use axs.flat instead of axs.flatten())
- [PR #14095](#): Backport [PR #14087](#) on branch v3.1.x (Cleanup date example.)
- [PR #14094](#): Backport [PR #14029](#) on branch v3.1.x (Fix doc building with numpydoc 0.9)

- [PR #14093](#): Backport [PR #14052](#) on branch v3.1.x (Check axes identity in `image.contains`.)
- [PR #14092](#): Backport [PR #14056](#) on branch v3.1.x (FIX: do not try to manage the visibility of un-drawn ticks)
- [PR #14091](#): Backport [PR #14078](#) on branch v3.1.x (Minor fix in multiple subplots example)
- [PR #14079](#): Consistently use `ax.flat` instead of `ax.flatten()`
- [PR #14087](#): Cleanup date example.
- [PR #14029](#): Fix doc building with `numpydoc 0.9`
- [PR #14052](#): Check axes identity in `image.contains`.
- [PR #14056](#): FIX: do not try to manage the visibility of un-drawn ticks
- [PR #14078](#): Minor fix in multiple subplots example
- [PR #14080](#): Backport [PR #14069](#) on branch v3.1.x (Don't try to use the colorbar formatter to format RGBA data.)
- [PR #14069](#): Don't try to use the colorbar formatter to format RGBA data.
- [PR #14074](#): Backport [PR #14019](#) on branch v3.1.x (Update docstring of `locator_params()`)
- [PR #14019](#): Update docstring of `locator_params()`
- [PR #14066](#): Backport [PR #14053](#) on branch v3.1.x (Improve `fill()` example)
- [PR #14065](#): Backport [PR #14059](#) on branch v3.1.x (Improve Scatter hist example)
- [PR #14067](#): Backport [PR #14062](#) on branch v3.1.x (Improve advanced quiver example)
- [PR #14062](#): Improve advanced quiver example
- [PR #14053](#): Improve `fill()` example
- [PR #14059](#): Improve Scatter hist example
- [PR #14064](#): Backport [PR #14043](#) on branch v3.1.x (Ensure errorbars are always drawn on top of bars in `ax.bar`)
- [PR #14043](#): Ensure errorbars are always drawn on top of bars in `ax.bar`
- [PR #14061](#): Backport [PR #14051](#) on branch v3.1.x (Add Yellowbrick to third party packages)
- [PR #14051](#): Add Yellowbrick to third party packages
- [PR #14050](#): Backport [PR #14048](#) on branch v3.1.x (Fix `Animation.save`)
- [PR #14049](#): Backport [PR #14047](#) on branch v3.1.x (Remove references to "Draws" in `matplotlib.patches`)
- [PR #14048](#): Fix `Animation.save`
- [PR #14047](#): Remove references to "Draws" in `matplotlib.patches`
- [PR #14037](#): Backport [PR #14033](#) on branch v3.1.x (Reword `add_subplot` docstring.)
- [PR #14036](#): Backport [PR #14001](#) on branch v3.1.x ([BUG] DOC: Remove broken references to `vischeck`)
- [PR #14033](#): Reword `add_subplot` docstring.

- [PR #14032](#): Backport [PR #14030](#) on branch v3.1.x (Update colorcet link)
- [PR #14030](#): Update colorcet link
- [PR #14027](#): Backport [PR #14026](#) on branch v3.1.x (Fix bug in plot\_directive that caused links to plots in different formats to be missing)
- [PR #14026](#): Fix bug in plot\_directive that caused links to plots in different formats to be missing
- [PR #14012](#): Backport [PR #14008](#) on branch v3.1.x (Don't install tests by default.)
- [PR #14017](#): Backport [PR #14015](#) on branch v3.1.x (Fix docstring of pyplot.clim())
- [PR #14015](#): Fix docstring of pyplot.clim()
- [PR #14008](#): Don't install tests by default.
- [PR #14006](#): Backport [PR #13998](#) on branch v3.1.x (Fix patch contains logic for patches that don't have any codes)
- [PR #14005](#): Backport [PR #14004](#) on branch v3.1.x (DOC: pin numpydoc to less than 0.9)
- [PR #13998](#): Fix patch contains logic for patches that don't have any codes
- [PR #13999](#): Backport [PR #13992](#) on branch v3.1.x (FIX: undeprecate MaxNLocator default\_params)
- [PR #13997](#): Backport [PR #13995](#) on branch v3.1.x (DOC: explain zorder for gridlines in grid docstring)
- [PR #13992](#): FIX: undeprecate MaxNLocator default\_params
- [PR #13995](#): DOC: explain zorder for gridlines in grid docstring
- [PR #13990](#): Backport [PR #13989](#) on branch v3.1.x (FIX: update not replace hist\_kwargs when density is passed)
- [PR #13989](#): FIX: update not replace hist\_kwargs when density is passed
- [PR #13975](#): Backport [PR #13966](#) on branch v3.1.x (Fix colorbar setting without artist)
- [PR #13976](#): Backport [PR #13973](#) on branch v3.1.x (BUG: Ensure docstrings are not accessed with -OO)
- [PR #13856](#): Whats new page for 3.1
- [PR #13966](#): Fix colorbar setting without artist
- [PR #13973](#): BUG: Ensure docstrings are not accessed with -OO
- [PR #13969](#): Backport [PR #13950](#) on branch v3.1.x (confidence\_ellipse\_markup)
- [PR #13950](#): confidence\_ellipse\_markup
- [PR #13965](#): Backport [PR #13962](#) on branch v3.1.x (Fix typo in code example in docstring.)
- [PR #13964](#): Backport [PR #13870](#) on branch v3.1.x (3.1.0 API changes page)
- [PR #13962](#): Fix typo in code example in docstring.
- [PR #13870](#): 3.1.0 API changes page
- [PR #13961](#): Backport [PR #13914](#) on branch v3.1.x (Improve Rainbow text example)

- [PR #13960](#): Backport [PR #13958](#) on branch v3.1.x (Remove transparent fancy legend example)
- [PR #13914](#): Improve Rainbow text example
- [PR #13958](#): Remove transparent fancy legend example
- [PR #13956](#): Backport [PR #13908](#) on branch v3.1.x (Enh control tick deconflict2)
- [PR #13955](#): Backport [PR #13941](#) on branch v3.1.x (Add project\_urls to setup)
- [PR #13908](#): Enh control tick deconflict2
- [PR #13954](#): Backport [PR #13949](#) on branch v3.1.x (DOC: Add documentation to Text.set\_fontfamily)
- [PR #13941](#): Add project\_urls to setup
- [PR #13949](#): DOC: Add documentation to Text.set\_fontfamily
- [PR #13951](#): Backport [PR #13939](#) on branch v3.1.x (Bunch of docstring cleanups.)
- [PR #13939](#): Bunch of docstring cleanups.
- [PR #13947](#): Backport [PR #13897](#) on branch v3.1.x (numpydocification.)
- [PR #13897](#): numpydocification.
- [PR #13946](#): Backport [PR #13924](#) on branch v3.1.x (Followup to deprecation of usetex parameter in get\_text\_path.)
- [PR #13924](#): Followup to deprecation of usetex parameter in get\_text\_path.
- [PR #13916](#): Backport [PR #13850](#) on branch v3.1.x (Cleanup STIX Font Demo)
- [PR #13915](#): Backport [PR #13835](#) on branch v3.1.x (Improve Connectionstyle Demo)
- [PR #13850](#): Cleanup STIX Font Demo
- [PR #13835](#): Improve Connectionstyle Demo
- [PR #13846](#): Backport [PR #13836](#) on branch v3.1.x (MNT: account for cpython deprecations)
- [PR #13898](#): Backport [PR #13896](#) on branch v3.1.x (Fix cbook.boxplot\_stats docstring)
- [PR #13896](#): Fix cbook.boxplot\_stats docstring
- [PR #13893](#): Backport [PR #13890](#) on branch v3.1.x (rst seealso -> numpydoc "See Also".)
- [PR #13890](#): rst seealso -> numpydoc "See Also".
- [PR #13888](#): Backport [PR #13862](#) on branch v3.1.x (Move 3.x API changes to prev\_api\_changes)
- [PR #13862](#): Move 3.x API changes to prev\_api\_changes
- [PR #13882](#): Backport [PR #13867](#) on branch v3.1.x (Rename "docs" to "contents" in navigation bar)
- [PR #13867](#): Rename "docs" to "contents" in navigation bar
- [PR #13881](#): Backport [PR #13874](#) on branch v3.1.x (Remove redundant call to Formatter.set\_locs() before .format\_ticks().)
- [PR #13874](#): Remove redundant call to Formatter.set\_locs() before .format\_ticks().
- [PR #13871](#): Backport [PR #13868](#) on branch v3.1.x (Correctly handle fallout of defining PY\_SSIZE\_T\_CLEAN on Windows.)

- [PR #13869](#): Backport [PR #13861](#) on branch v3.1.x (Fix remaining links in docs)
- [PR #13868](#): Correctly handle fallout of defining `PY_SSIZE_T_CLEAN` on Windows.
- [PR #13861](#): Fix remaining links in docs
- [PR #13849](#): Backport [PR #13845](#) on branch v3.1.x (Fix some broken documentation links)
- [PR #13845](#): Fix some broken documentation links
- [PR #13836](#): MNT: account for cpython deprecations
- [PR #13841](#): Backport [PR #12928](#) on branch v3.1.x (textpath encoding)
- [PR #13842](#): Backport [PR #13827](#) on branch v3.1.x (Better MovieWriter init error message)
- [PR #13838](#): Backport [PR #13570](#) on branch v3.1.x (Add new example for plotting a confidence\_ellipse)
- [PR #13827](#): Better MovieWriter init error message
- [PR #13839](#): Backport [PR #13815](#) on branch v3.1.x (Numpydocify `FontManager.findfont()`)
- [PR #13837](#): Backport [PR #8638](#) on branch v3.1.x (FIX: if bins input to hist is str, treat like no bins)
- [PR #12928](#): textpath encoding
- [PR #13815](#): Numpydocify `FontManager.findfont()`
- [PR #13570](#): Add new example for plotting a confidence\_ellipse
- [PR #8638](#): FIX: if bins input to hist is str, treat like no bins
- [PR #13831](#): Backport [PR #13780](#) on branch v3.1.x (numpydoc `ListedColormap` parameters)
- [PR #13780](#): numpydoc `ListedColormap` parameters
- [PR #13830](#): Backport [PR #13829](#) on branch v3.1.x (numpydoc `IndexFormatter`)
- [PR #13829](#): numpydoc `IndexFormatter`
- [PR #13828](#): Backport [PR #13821](#) on branch v3.1.x (Remove `mathcircled` from `mathtext` docs following its deprecation.)
- [PR #13821](#): Remove `mathcircled` from `mathtext` docs following its deprecation.
- [PR #13822](#): Backport [PR #13817](#) on branch v3.1.x (Remove borders from barcode example)
- [PR #13820](#): Backport [PR #13816](#) on branch v3.1.x (Correct windows env variable format)
- [PR #13816](#): Correct windows env variable format
- [PR #13817](#): Remove borders from barcode example
- [PR #13814](#): Merge pull request [#13805](#) from [timhoffm/pin-sphinx-1.x](#)
- [PR #13813](#): Backport [PR #13764](#) on branch v3.1.x (Deprecate `mathcircled`.)
- [PR #13764](#): Deprecate `mathcircled`.
- [PR #13805](#): Pin Sphinx to 1.x

- [PR #13807](#): Backport [PR #13800](#) on branch v3.1.x (Doc typos.)
- [PR #13800](#): Doc typos.
- [PR #13806](#): Backport [PR #13771](#) on branch v3.1.x (patches.Arc docstring update [#13759](#))
- [PR #13804](#): Backport [PR #13766](#) on branch v3.1.x (Search for fonts in XDG directory as well.)
- [PR #13771](#): patches.Arc docstring update [#13759](#)
- [PR #13766](#): Search for fonts in XDG directory as well.
- [PR #13794](#): Backport [PR #13695](#) on branch v3.1.x (numpydocify transform\_angles.)
- [PR #13793](#): Backport [PR #13762](#) on branch v3.1.x (Cleanup marker\_reference example.)
- [PR #13792](#): Backport [PR #13789](#) on branch v3.1.x (BUG: Fix function signature mismatch for set\_clim)
- [PR #13791](#): Backport [PR #13787](#) on branch v3.1.x (Fix failure to import matplotlib.animation on Windows.)
- [PR #13695](#): numpydocify transform\_angles.
- [PR #13762](#): Cleanup marker\_reference example.
- [PR #13789](#): BUG: Fix function signature mismatch for set\_clim
- [PR #13787](#): Fix failure to import matplotlib.animation on Windows.
- [PR #13781](#): Backport [PR #13777](#) on branch v3.1.x (Use class-based directive for mathmpl sphinxext.)
- [PR #13790](#): Backport [PR #13564](#) on branch v3.1.x (Add an option to log progress while saving animations)
- [PR #13564](#): Add an option to log progress while saving animations
- [PR #13777](#): Use class-based directive for mathmpl sphinxext.
- [PR #13765](#): Backport [PR #13761](#) on branch v3.1.x (Deprecate verbose-related rcParams.)
- [PR #13761](#): Deprecate verbose-related rcParams.
- [PR #13760](#): Backport [PR #13719](#) on branch v3.1.x (Doc: Update timeline example)
- [PR #13704](#): Backport [PR #13021](#) on branch v3.1.x (Undesirable behaviour of Mixed-ModeRenderer)
- [PR #13758](#): Backport [PR #13674](#) on branch v3.1.x (Preserve whitespace in svg output.)
- [PR #13719](#): Doc: Update timeline example
- [PR #13674](#): Preserve whitespace in svg output.
- [PR #13755](#): Backport [PR #13741](#) on branch v3.1.x (FIX: make title move above ticklabels)
- [PR #13754](#): Backport [PR #13712](#) on branch v3.1.x (Deprecate NavigationToolbar2QT.adj\_window (unused and always None).)
- [PR #13741](#): FIX: make title move above ticklabels
- [PR #13712](#): Deprecate NavigationToolbar2QT.adj\_window (unused and always None).

- [PR #13752](#): Backport [PR #13732](#) on branch v3.1.x (Fix doc markup.)
- [PR #13753](#): Backport [PR #13751](#) on branch v3.1.x (DOC/FIX: try merging comments)
- [PR #13751](#): DOC/FIX: try merging comments
- [PR #13732](#): Fix doc markup.
- [PR #13750](#): Backport [PR #13743](#) on branch v3.1.x (Fix doc warning)
- [PR #13743](#): Fix doc warning
- [PR #13747](#): Backport [PR #13745](#) on branch v3.1.x (Fix stem(use\_line\_collection))
- [PR #13748](#): Backport [PR #13716](#) on branch v3.1.x (Kill attributes that are never used/updated.)
- [PR #13716](#): Kill attributes that are never used/updated.
- [PR #13745](#): Fix stem(use\_line\_collection)
- [PR #13710](#): TST: only test agg\_filter extensions with baseline images
- [PR #13709](#): Backport [PR #8690](#) on branch v3.1.x
- [PR #13707](#): Backport [PR #12760](#) on branch v3.1.x (Deduplicate implementation of per-backend Tools.)
- [PR #13706](#): Backport [PR #13689](#) on branch v3.1.x (BUG: fix scaling of quiverkey when quiver scale\_units='xy')
- [PR #13705](#): Backport [PR #12419](#) on branch v3.1.x (Add DivergingNorm (again, again, again))
- [PR #13703](#): Backport [PR #12170](#) on branch v3.1.x (Deprecate considering \*args, \*\*kwargs in Timer.remove\_callback.)
- [PR #12760](#): Deduplicate implementation of per-backend Tools.
- [PR #13689](#): BUG: fix scaling of quiverkey when quiver scale\_units='xy'
- [PR #12419](#): Add DivergingNorm (again, again, again)
- [PR #8690](#): Adds support for rgba and rgb images to pcolorfast
- [PR #13021](#): Undesirable behaviour of MixedModeRenderer
- [PR #12170](#): Deprecate considering \*args, \*\*kwargs in Timer.remove\_callback.
- [PR #13700](#): Backport [PR #13588](#) on branch v3.1.x (FIX: fallback to viewlims if no data)
- [PR #13694](#): Backport [PR #13677](#) on branch v3.1.x (Log all failures to extract font properties.)
- [PR #13588](#): FIX: fallback to viewlims if no data
- [PR #13692](#): Backport [PR #13677](#) on branch v3.0.x (Log all failures to extract font properties.)
- [PR #13677](#): Log all failures to extract font properties.
- [PR #13691](#): Backport [PR #13687](#) on branch v3.1.x (Update stem example)
- [PR #13687](#): Update stem example
- [PR #13688](#): Backport [PR #13684](#) on branch v3.1.x (Use format\_data\_short to format image cursor data.)
- [PR #13684](#): Use format\_data\_short to format image cursor data.

- [PR #13686](#): Backport [PR #13363](#) on branch v3.1.x (Inline `iter_ticks` into `_update_ticks`, and use that in `mplot3d`.)
- [PR #13363](#): Inline `iter_ticks` into `_update_ticks`, and use that in `mplot3d`.
- [PR #13681](#): Backport [PR #13678](#) on branch v3.1.x (Fix font deduplication logic in `createFontList`.)
- [PR #13678](#): Fix font deduplication logic in `createFontList`.
- [PR #13669](#): Backport [PR #13667](#) on branch v3.1.x (Fix incorrect signature in `axis()` doc.)
- [PR #13667](#): Fix incorrect signature in `axis()` doc.
- [PR #13664](#): Backport [PR #12637](#) on branch v3.1.x (Tell IPython the correct GUI event loop to use for all backends.)
- [PR #13665](#): Backport [PR #13601](#) on branch v3.1.x (Add a `make-parameter-keyword-only-with-deprecation` decorator.)
- [PR #13601](#): Add a `make-parameter-keyword-only-with-deprecation` decorator.
- [PR #12637](#): Tell IPython the correct GUI event loop to use for all backends.
- [PR #13662](#): Backport [PR #13064](#) on branch v3.1.x (Don't explicitly add default include paths to Extensions)
- [PR #13064](#): Don't explicitly add default include paths to Extensions
- [PR #13658](#): Backport [PR #13652](#) on branch v3.1.x (Fix empty `FancyArrow` crash)
- [PR #13652](#): Fix empty `FancyArrow` crash
- [PR #13655](#): Backport [PR #11692](#) on branch v3.1.x (Deprecate `frameon` kwarg and `rcParam` to `savefig`.)
- [PR #13654](#): Backport [PR #13614](#) on branch v3.1.x (Fix polar get window extent)
- [PR #11692](#): Deprecate `frameon` kwarg and `rcParam` to `savefig`.
- [PR #13614](#): Fix polar get window extent
- [PR #13646](#): Backport [PR #13645](#) on branch v3.1.x (`widgets.py` fix examples `connect -> mpl_connect`)
- [PR #13645](#): `widgets.py` fix examples `connect -> mpl_connect`
- [PR #13644](#): Backport [PR #13612](#) on branch v3.1.x (Improve Demo Text Rotation Mode)
- [PR #13612](#): Improve Demo Text Rotation Mode
- [PR #13636](#): Backport [PR #13621](#) on branch v3.1.x (Remove `asfileobj=False` from a bunch of examples loading `sample_data`.)
- [PR #13635](#): Backport [PR #13632](#) on branch v3.1.x (Clarify tick collision API change doc.)
- [PR #13634](#): Backport [PR #13631](#) on branch v3.1.x (Switch deprecation of `Tick.label` to pending.)
- [PR #13621](#): Remove `asfileobj=False` from a bunch of examples loading `sample_data`.
- [PR #13632](#): Clarify tick collision API change doc.
- [PR #13631](#): Switch deprecation of `Tick.label` to pending.
- [PR #13628](#): Backport [PR #13603](#) on branch v3.1.x

- [PR #13603](#): FIX: continue to bail tight layout if rect supplied
- [PR #13627](#): Backport [PR #13622](#) on branch v3.1.x (Change title of named colors example)
- [PR #13626](#): Backport [PR #13549](#) on branch v3.1.x (Simplify some annotation() calls in examples.)
- [PR #13624](#): Backport [PR #13610](#) on branch v3.1.x (Update centered ticklabels example)
- [PR #13625](#): Backport [PR #13611](#) on branch v3.1.x (Fix text position in Fancytextbox demo)
- [PR #13622](#): Change title of named colors example
- [PR #13610](#): Update centered ticklabels example
- [PR #13611](#): Fix text position in Fancytextbox demo
- [PR #13607](#): Backport [PR #13605](#) on branch v3.1.x (Warn on attempts at semi-transparent outputs in ps backend.)
- [PR #13608](#): Backport [PR #13602](#) on branch v3.1.x (Deprecate cbook.is\_hashable.)
- [PR #13602](#): Deprecate cbook.is\_hashable.
- [PR #13605](#): Warn on attempts at semi-transparent outputs in ps backend.
- [PR #13599](#): Backport [PR #13590](#) on branch v3.1.x (Doc event loop requirements for Figure.show)
- [PR #13590](#): Doc event loop requirements for Figure.show
- [PR #13597](#): Backport [PR #12359](#) on branch v3.1.x (ENH: Add boolean support for axis())
- [PR #13594](#): Backport [PR #13592](#) on branch v3.1.x (DOC: Make canonical URLs point to versioned path.)
- [PR #13592](#): DOC: Make canonical URLs point to versioned path.
- [PR #12359](#): ENH: Add boolean support for axis()
- [PR #13587](#): Backport [PR #13573](#) on branch v3.1.x (Fix mplot3d transparency)
- [PR #13573](#): Fix mplot3d transparency
- [PR #13585](#): Backport [PR #13578](#) on branch v3.1.x (Revert invalid change in Centered Ticklabels example)
- [PR #13584](#): Backport [PR #13582](#) on branch v3.1.x (Cleanup two font-related examples.)
- [PR #13578](#): Revert invalid change in Centered Ticklabels example
- [PR #13582](#): Cleanup two font-related examples.
- [PR #13579](#): Backport [PR #13477](#) on branch v3.1.x (FIX: make EngFormatter respect axes.unicode\_minus rcParam)
- [PR #13577](#): Backport [PR #12832](#) on branch v3.1.x (Deprecate redundant log-scale transform classes.)
- [PR #13477](#): FIX: make EngFormatter respect axes.unicode\_minus rcParam
- [PR #12832](#): Deprecate redundant log-scale transform classes.
- [PR #13574](#): Backport [PR #12856](#) on branch v3.1.x (added property usemathtext to EngFormatter)

- [PR #12856](#): added property usemathtext to EngFormatter
- [PR #13572](#): Backport [PR #12899](#) on branch v3.1.x (Small cleanups.)
- [PR #13571](#): Backport [PR #11553](#) on branch v3.1.x (Improved Code for Segments Intersect)
- [PR #12899](#): Small cleanups.
- [PR #11553](#): Improved Code for Segments Intersect
- [PR #13568](#): Backport [PR #13563](#) on branch v3.1.x (FIX: inverted colorbar ticks)
- [PR #13563](#): FIX: inverted colorbar ticks
- [PR #13530](#): BUG: keep the ticks when the colorbar axis is inverted
- [PR #13565](#): Backport [PR #13550](#) on branch v3.1.x (Strip out Py2-compat in setupext.)
- [PR #13550](#): Strip out Py2-compat in setupext.
- [PR #13562](#): Backport [PR #13560](#) on branch v3.1.x (Improve GridSpec doc)
- [PR #13560](#): Improve GridSpec doc
- [PR #13558](#): Backport [PR #13546](#) on branch v3.1.x ( Modified docstring of the set\_ylabel and set\_xlabel)
- [PR #13559](#): Backport [PR #12062](#) on branch v3.1.x (Separate alpha and rgb interpolation then recombine to fix issue11316)
- [PR #13557](#): Backport [PR #13548](#) on branch v3.1.x (Deprecate TextWithDash.)
- [PR #12062](#): Separate alpha and rgb interpolation then recombine to fix issue11316
- [PR #13546](#): Modified docstring of the set\_ylabel and set\_xlabel
- [PR #13548](#): Deprecate TextWithDash.
- [PR #13549](#): Simplify some annotation() calls in examples.
- [PR #13552](#): Backport [PR #11241](#) on branch v3.1.x (Deprecate the MATPLOTLIBDATA environment variable.)
- [PR #11241](#): Deprecate the MATPLOTLIBDATA environment variable.
- [PR #13547](#): Backport [PR #9314](#) on branch v3.1.x (Simplify units.Registry.get\_converter.)
- [PR #13545](#): Backport [PR #13541](#) on branch v3.1.x (DOC: Remove mention of 'complex' mode in specgram docstring)
- [PR #9314](#): Simplify units.Registry.get\_converter.
- [PR #13541](#): DOC: Remove mention of 'complex' mode in specgram docstring
- [PR #13539](#): Backport [PR #12950](#) on branch v3.1.x (Inline or simplify FooFormatter.pprint\_val.)
- [PR #13538](#): Backport [PR #12748](#) on branch v3.1.x (Use the builtin GTK3 FileChooser rather than our custom subclass.)
- [PR #13537](#): Backport [PR #12781](#) on branch v3.1.x (Lazy import of private modules)
- [PR #12950](#): Inline or simplify FooFormatter.pprint\_val.
- [PR #12748](#): Use the builtin GTK3 FileChooser rather than our custom subclass.
- [PR #12781](#): Lazy import of private modules

- [PR #11218](#): fix pkg-config handling to make cross-compiling work
- [PR #13531](#): Backport [PR #11964](#) on branch v3.1.x (Simplify extension setup.)
- [PR #11964](#): Simplify extension setup.
- [PR #13529](#): Backport [PR #13525](#) on branch v3.1.x (Move some links in rst out of running text.)
- [PR #13528](#): Backport [PR #13526](#) on branch v3.1.x (DOC: fix Subplot calls)
- [PR #13525](#): Move some links in rst out of running text.
- [PR #13526](#): DOC: fix Subplot calls
- [PR #13523](#): Backport [PR #13521](#) on branch v3.1.x (Small cleanup to headings of 3d examples.)
- [PR #13521](#): Small cleanup to headings of 3d examples.
- [PR #13519](#): Backport [PR #12716](#) on branch v3.1.x (FIX: return the actual `ax.get_window_extent`)
- [PR #13518](#): Backport [PR #12839](#) on branch v3.1.x (BUG: Prevent Tick params calls from overwriting visibility without being told to)
- [PR #12716](#): FIX: return the actual `ax.get_window_extent`
- [PR #12839](#): BUG: Prevent Tick params calls from overwriting visibility without being told to
- [PR #13517](#): Fix heading hierarchy in annotation tutorial.
- [PR #13516](#): Backport [PR #13514](#) on branch v3.1.x (Add missing `show()` at end of example.)
- [PR #13514](#): Add missing `show()` at end of example.
- [PR #13512](#): Backport [PR #13511](#) on branch v3.1.x (Add missing `plt.show()` at end of example.)
- [PR #13511](#): Add missing `plt.show()` at end of example.
- [PR #13508](#): Backport [PR #13413](#) on branch v3.1.x (Simplify decade up- and down-rounding, and symmetrize expansion of degenerate log scales.)
- [PR #13509](#): Backport [PR #13492](#) on branch v3.1.x (Doc more release updates)
- [PR #13492](#): Doc more release updates
- [PR #13413](#): Simplify decade up- and down-rounding, and symmetrize expansion of degenerate log scales.
- [PR #13507](#): Backport [PR #13488](#) on branch v3.1.x (Animation: interactive zoom/pan with blitting does not work)
- [PR #13488](#): Animation: interactive zoom/pan with blitting does not work
- [PR #13505](#): Backport [PR #13459](#) on branch v3.1.x (Document histogramming pre-binned data.)
- [PR #13503](#): Backport [PR #10776](#) on branch v3.1.x (fix `FancyArrowPatch` picker fails depending on `arrowstyle`)
- [PR #13504](#): Backport [PR #13123](#) on branch v3.1.x (Add shading to `Axes3D.voxels`, and enable it by default)

- [PR #13502](#): Backport [PR #13180](#) on branch v3.1.x (Various TextPath cleanups.)
- [PR #13459](#): Document histogramming pre-binned data.
- [PR #13501](#): Backport [PR #13209](#) on branch v3.1.x (Deprecate support for (n, 1)-shaped error arrays in `errorbar()`.)
- [PR #13500](#): Backport [PR #12763](#) on branch v3.1.x (Remove deprecated `rcParams`.)
- [PR #13123](#): Add shading to `Axes3D.voxels`, and enable it by default
- [PR #13499](#): Backport [PR #13303](#) on branch v3.1.x (Unify checking of executable info.)
- [PR #10776](#): fix `FancyArrowPatch` picker fails depending on `arrowstyle`
- [PR #13180](#): Various `TextPath` cleanups.
- [PR #13498](#): Backport [PR #13314](#) on branch v3.1.x (Move major/minor tick overstrike logic to `Axis`.)
- [PR #13209](#): Deprecate support for (n, 1)-shaped error arrays in `errorbar()`.
- [PR #12763](#): Remove deprecated `rcParams`.
- [PR #13303](#): Unify checking of executable info.
- [PR #13497](#): Backport [PR #13057](#) on branch v3.1.x (Simplify `callable(self._contains)` checks)
- [PR #13314](#): Move major/minor tick overstrike logic to `Axis`.
- [PR #13057](#): Simplify `callable(self._contains)` checks
- [PR #13496](#): Backport [PR #13465](#) on branch v3.1.x (FIX: polar `set_rlim` allow bottom-only call)
- [PR #13465](#): FIX: polar `set_rlim` allow bottom-only call
- [PR #13495](#): Backport [PR #12232](#) on branch v3.1.x (Add helper function to check that an argument is in a list of strings.)
- [PR #12232](#): Add helper function to check that an argument is in a list of strings.
- [PR #11708](#): Revert "Skip wx interactive tests on OSX."
- [PR #13062](#): Update FAQ re: batch/webserver use.
- [PR #12904](#): Support forward/backward mouse buttons
- [PR #12150](#): Deprecate `stackrel`.
- [PR #13449](#): Let `boxplot()` defer `rcParams` application to `bxp()`
- [PR #13425](#): API: un-deprecate keyword only args to `set_xlim`, `set_ylim`
- [PR #13447](#): Update `axes_grid` docs
- [PR #13473](#): Deprecate `backend_wx.IDLE_DELAY`.
- [PR #13476](#): Add `font` to `pyplot.xkcd()`
- [PR #13475](#): Cleanup titles of embedding examples.
- [PR #13468](#): Suppress chaining of cache lookup failure in color conversion.
- [PR #13467](#): Add "c" shorthand for "color" for the `Text` class.
- [PR #13398](#): FIX: let pandas `IndexInt64` work for `boxplot`
- [PR #13375](#): Improve `Axis` selection in Qt figure options.

- PR #13421: DOC: update release guide
- PR #13275: Simple logging interface.
- PR #13427: Simplify check for tight-bbox finiteness.
- PR #13444: Allow constructing boxplots over multiple calls.
- PR #13385: Remove/rework uses of `np.where` where possible.
- PR #13441: Make AFM parser both more compliant and less strict.
- PR #13384: Replace `np.compress` by boolean indexing.
- PR #13422: Clarify `IndexError` for out-of-bounds indexing of `gridspec`.
- PR #13443: Remove some outdated comments from `rcsetup.py`.
- PR #13357: Inherit some docstrings in backend code.
- PR #12380: Stem speedup2
- PR #13368: FIX: Fix shape of hist output when input is multidimensional empty list
- PR #5590: [mpl\_toolkits] Fix picking for things drawn on parasite axes
- PR #13323: Move the call to `Formatter.set_locs` into `Formatter.format_ticks`.
- PR #13424: Deprecate `Quiver.color` in favor of `Quiver.get_facecolor()`.
- PR #13434: More smoketesting of `pcolorfast`.
- PR #13395: Cleanup `demo_curvelinear_grid`.
- PR #13411: Deemphasize numeric locations for `legend()` in docs.
- PR #13419: FIX: `secondary_axis` resize
- PR #13020: Deprecate `proj3d.mod`.
- PR #13030: Deprecate internal functions exposed in the public API of `mplot3d`
- PR #13408: `test_figure` style fixes.
- PR #11127: Legend for Scatter
- PR #11855: Adding the possible to add full command line in animation
- PR #13409: Add nonsingular to the locator base class, and use it in `set_*lim` too.
- PR #11859: ENH: add secondary x/y axis
- PR #13235: Vectorize `mplot3d.art3d.zalpha`.
- PR #10411: New "accepts units" decorator
- PR #13403: FIX: remove `idle_event`
- PR #13069: 5 minor divisions when major ticks are 2.5 units apart
- PR #13402: Fix empty `reshape2d`
- PR #11683: Reuse `axes_grid1`'s `AxisDict` in `axisartist`, instead of duplicating it.
- PR #12141: Let digits toggle axes nav only if they correspond to an existing axes.
- PR #9845: Add `inaxes` method to `FigureCanvas` to check whether point is in an axes.
- PR #13396: `mpl_toolkits` style fixes.
- PR #11497: Make CI fail if interactive toolkits can't be tested

- PR #11595: test doc rendering
- PR #13393: Deprecate `Spine.is_frame_like`.
- PR #13391: Remove colour specification from some examples
- PR #13386: Replace use of `np.<ufunc>` by operators (`</&/|`).
- PR #13389: Inherit more docstrings.
- PR #13387: Fix regression in `docstring.dedent_interpd`.
- PR #13383: Replace `np.take` by normal indexing.
- PR #13381: Avoid unneeded copies from `flatten()`.
- PR #13354: Properly deprecate non-1D inputs to `pie()`.
- PR #13379: Remove citation entry from FAQ.
- PR #13380: Minor simplifications to `scatter3d`.
- PR #13173: Decorator for deleting a parameter with a deprecation period.
- PR #8205: [MRG+1] `plot_date()` after `axhline()` doesn't rescale axes
- PR #11027: Specify custom tick space heuristic in `MaxNLocator`
- PR #13262: Shorten `setupext` and remove uninformative build log entries.
- PR #13377: Add private helper to internally suppress deprecations.
- PR #13376: Undeprecate case-insensitive "long" colornames.
- PR #13373: Deprecate `axis3d.Axis.get_tick_positions`.
- PR #13362: Kill the unused, private `_get_pixel_distance_along_axis`.
- PR #12772: Improve `plot()` docstring.
- PR #13359: DOC: change language a bit
- PR #13351: Fix: Log Colorbar `minorticks_off` reverted if ticks set
- PR #13356: More spelling fixes.
- PR #13125: Simplify and tighten the docstring handling API.
- PR #13346: Simplify parsing of tuple in C extension code.
- PR #13282: MAINT install of pinned vers for travis
- PR #13234: FIX: allow colorbar mappable norm to change and do right thing
- PR #13269: Rework a bit axes addition.
- PR #13330: Add `Axis.get_inverted` and `Axis.set_inverted`.
- PR #13117: Cleanup `matplotlib.use`
- PR #13335: Update and factor out `Axis.get_tick_positions`.
- PR #13324: Cleanup `ScalarFormatter`; preparatory to moving it to `format_ticks`.
- PR #13322: Update Axis docs
- PR #13342: Update some (mostly internal) docstrings in `image.py`.
- PR #11848: Country specific characters in Windows user folder name when locating `.tfm-file`

- PR #13309: bezier cleanups.
- PR #13334: Inherit some docstrings.
- PR #13332: Rewrite `convert_to_string` using `std::string`
- PR #13336: Update `imshow` docs.
- PR #13331: Try forcing font cache rebuild in flaky `ttc` test.
- PR #12105: API: make `MaxNLocator` trim out-of-view ticks before returning
- PR #13329: Pin `flake8<3.7` to mitigate issues with `flake8-per-file-ignores`
- PR #13319: Deprecate `dates.{str,bytes}pdate2num`.
- PR #13320: Kill some private, unused functions in `dates.py`.
- PR #12909: Let `Formatters` format all ticks at once.
- PR #13313: Better explanation of ticks
- PR #13310: Replace `*kw` by `*args`.
- PR #13285: Defer checking of `tex` install to when it is actually used.
- PR #13128: Parameter-renaming decorator
- PR #13307: Spelling fixes.
- PR #13304: TST: deregister `pandas`
- PR #13300: Trivial bezier cleanups.
- PR #11664: FIX: clean up unit conversion unpacking of data, particularly for dates and `pandas` series
- PR #9639: Unify querying of executable versions
- PR #13224: `numpydocify` (some of) `mpl_toolkits`.
- PR #13301: Replace `np.empty + ndarray.fill` by `np.full`.
- PR #13229: Prevent exception when running animation on `Agg` backend.
- PR #13263: In `imsave()`'s Pillow-handled case, don't create a temporary figure.
- PR #13294: Simplify some calculations in `polar.py`.
- PR #13295: Kill some commented-out code.
- PR #13298: Add note about thread safety to FAQ.
- PR #13299: Don't emit a non-GUI warning when building the docs on Linux.
- PR #13297: Minor cleanup to OSX FAQ.
- PR #13283: Fix doc style in `add_gridspec()`
- PR #13129: ENH: add a user-friendly verbose interface
- PR #13279: Remove a useless `catch_warnings()` from example.
- PR #13268: Select `RadioButtons` by closest in position.
- PR #13271: Fix animation speed in `double_pendulum` example
- PR #13265: Allow turning off minor ticks on `Colorbar` with `LogNorm`
- PR #13260: Improve docs for format determination in `savefig()/imsave()`.

- PR #12379: MAINT Use `np.full` when possible
- PR #12905: Add optional parameter `use_default_template` to `rc_file()`
- PR #13218: Fix checking of 'labels' argument to `Sankey.add`.
- PR #13256: DOC: reject MEP25 due to being stalled
- PR #13255: TST pandas support bar
- PR #13251: DEBUG-log font-matching results, and print failing logs on CI.
- PR #12818: Enh arbitrary scale
- PR #13187: FIX: bar mixed units, allow `ValueError` as well
- PR #13232: Fix incorrect kwarg being passed to `TextPath`.
- PR #13250: Replace `safezip()` by more informative error message in `errorbar()`.
- PR #13239: Improve `sankey` logging.
- PR #13247: Simplify and optimize png writing in `backend_pdf`.
- PR #12455: Warn when "best" loc of legend is used with lots of data
- PR #13233: Remove warning in `image_annotated_heatmap`, and `numpydocify` it.
- PR #13248: Remove an unused local variable in `backend_gtk3`.
- PR #13249: Deprecate an unused "internal" API.
- PR #13243: Rewrite `subplots_demo`
- PR #13240: FIX: spelling error of local variable in `category`
- PR #13026: MNT: add a logging call if a categorical string array is all convertible
- PR #13225: Fix a warning in the doc build.
- PR #13227: Make color lowercase in example to avoid warning.
- PR #13217: `numpydocify` `Sankey.add`.
- PR #10209: Various backend cleanups.
- PR #13113: Globally cache single `TexManager` instances.
- PR #13213: Broadcast 'orientations' arg to `Sankey.add`.
- PR #13219: Fix some `backend_bases` docstrings.
- PR #13214: Reformat `Sankey` exceptions.
- PR #13211: Deprecate case-insensitive colors.
- PR #13210: Suppress a warning in the test suite.
- PR #13189: Remove cairo-based backends from `backend fallback`.
- PR #13207: Allow saving PNGs through Pillow instead of the builtin `_png` module.
- PR #13124: Simplify parsing of `errorbar` input.
- PR #13162: DOC: better `argcheck` bar
- PR #8531: Added compression option to save TIFF images
- PR #13094: Allow passing arguments to `PIL.Image.save()`.
- PR #13202: Avoid private API in some examples.

- PR #13197: Cleanup the text of two `mpl_toolkits` examples.
- PR #13198: Cleanup `SkewT` example.
- PR #11914: Remove the `system_monitor` example.
- PR #13196: Deemphasize comment about extremely old Matplotlib versions in example.
- PR #13190: Show `returncode` when subprocess test fails
- PR #13163: Add explanatory comment to annotation box example
- PR #13104: Remove some more 1-tuples.
- PR #13105: Make `GridSpec.update` docstring match behavior.
- PR #13127: Deprecate `add_subplot(<no positional args>)` silently doing nothing.
- PR #13166: Simplify `Text.get_usetex`.
- PR #13188: Remove an outdated doc point regarding backend selection.
- PR #13107: Cleanup `BboxBase` docstrings.
- PR #13108: Capitalize some docstrings.
- PR #13115: Check for `sphinx_copybutton` when building the docs
- PR #13151: Update `RadioButtons` docs `numpydoc` style
- PR #13178: Remove `:func:` markup from `mlab` docstrings.
- PR #7461: [WIP] add matrix checking function for quiver input
- PR #13089: Ensure that arguments to `quiver()` are not matrices.
- PR #13179: Avoid calling a deprecated API in `axis_artist`.
- PR #13170: Don't try to find TeX-only fonts when layouting TeX text.
- PR #12957: Search also for user fonts on Windows (#12954)
- PR #12951: Make `Text._get_layout` simpler to follow.
- PR #11385: Add a `get_zaxis` method for 3d axes.
- PR #13172: Hyperlink DOIs to preferred resolver
- PR #13171: Document how to make colorbars "without" a `ScalarMappable`.
- PR #12903: FIX: `(broken)bar(h)` math before units
- PR #13167: Typos on subplot comments and example
- PR #13005: Improve error messages for unit conversion
- PR #13147: Extend `joinstyle` example
- PR #13165: Change doc string for `Axes.arrow()`
- PR #13155: Let `ffmpeg` report errors.
- PR #13149: Update errorbar limits example
- PR #13074: Move `_windowing` extension into `_tkagg`.
- PR #13146: Remove an outdated comment in `backend_wx`.
- PR #13126: FIX: minor log ticks overwrite
- PR #13148: Update example Step Demo

- [PR #13138](#): API: Use class-based directive in sphinxext
- [PR #11894](#): add `cache_frame_data` kwarg into `FuncAnimation`. fixes [#8528](#).
- [PR #13136](#): Small cleanups.
- [PR #13140](#): Remove an "cannot show figure in agg" warning in test suite.
- [PR #13134](#): Simplify color conversion backcompat shim.
- [PR #13141](#): Unpin pytest (pytest-cov's latest release is compatible with it).
- [PR #13133](#): Simplify the `polys3d` example.
- [PR #12158](#): MNT: simplify valid tick logic
- [PR #9867](#): Factor out common code between pdf and ps backends.
- [PR #10111](#): Add `set_data_3d` and `get_data_3d` to `Line3d`
- [PR #12245](#): Remove (some) features deprecated in mpl2.2
- [PR #13119](#): Deprecate `TextToPath.glyph_to_path`.
- [PR #13122](#): Pin `pytest`<4.1 to unbreak CI tests
- [PR #13100](#): Restore the font cache on Travis.
- [PR #12792](#): BUG: Ensure that distinct polygon collections are shaded identically
- [PR #13070](#): cairo backend: default to pycairo
- [PR #13114](#): BUG: calculate colorbar boundaries correctly from values
- [PR #13111](#): Delete an unused private method.
- [PR #10841](#): ENH: new date formatter
- [PR #13093](#): Remove unused fontconfig conf file.
- [PR #13063](#): Use default colour cycle in more examples
- [PR #13103](#): Remove `tight_bbox_test` example.
- [PR #13097](#): Replace 1-tuples by scalars where possible.
- [PR #13027](#): Qt5 reset signals after non-interactive plotting
- [PR #9787](#): Support (first font of) TTC files.
- [PR #11780](#): ENH: Allow arbitrary coordinates for `ConnectionPatch`
- [PR #12943](#): Update the `font_table` example.
- [PR #13091](#): Improve `MouseEvent` `str()`.
- [PR #13095](#): Remove a duplicate attribute setting.
- [PR #13090](#): Cleanup unused non-public imports.
- [PR #13060](#): Move doc-requirements from root folder
- [PR #13078](#): Convert `streamplot` to `numpydoc`
- [PR #13088](#): Don't use deprecated `np.random.random_integers`.
- [PR #13073](#): Drop `pytest` version check in `setuptools.py`.
- [PR #12933](#): Deprecate `backend_pgf.LatexManagerFactory`.
- [PR #12969](#): Clarify the implementation of `_process_plot_var_args`.

- PR #12472: Make `FontManager.defaultFont` a property, to avoid hardcoding the prefix.
- PR #11806: Allow to not draw the labels on pie chart
- PR #11983: Simplify version checks for freetype and libpng.
- PR #13050: FIX: always `eraseRect` in Qt widget
- PR #13065: FIX: print out the correct ip address when starting webagg
- PR #13061: Make examples that load `msft.csv` robust against locale changes.
- PR #13042: cairo: remove the `append_path()` fast path
- PR #13058: `pathlibify/cleanup triage_tests.py`.
- PR #12995: Don't split creation of deprecation message and choice of warning class.
- PR #12998: Init `MaxNLocator` params only once
- PR #11691: Make `Figure.frameon` a thin wrapper for the patch visibility.
- PR #11735: Change `{FigureCanvasAgg,RendererAgg}.buffer_rgba` to return a `memoryview`.
- PR #12831: Reuse scale from sharing axis when calling `cla()`.
- PR #12962: Deprecate setting the same property under two different aliases.
- PR #12973: Fix item check for pandas Series
- PR #13049: Add `boxplot.flierprops.markeredgewidth` rcParam
- PR #13048: Fix section names for `numpydoc`
- PR #10928: Simplify (quite a bit...) `_preprocess_data`
- PR #13039: Speed up `Path.iter_segments()`
- PR #12992: Adding rcParams['scatter.edgecolors'] defaulting to 'face'
- PR #13014: Drop pgi support for the GTK3 backend
- PR #12215: Cleanup initialization in `text()`
- PR #13029: Fix vertical alignment of text
- PR #12968: Simpler and stricter `process_plot_format`.
- PR #12989: Avoid spamming tests with warnings re: deprecation of `pprint_val`.
- PR #13032: fix typo in docstring in `axis_artist.py`
- PR #13025: MNT: add one more alias for `tacaswell` to `mailmap`
- PR #13010: Fix a format error in `documenting_mpl.rst`
- PR #12997: Add `sphinx-copybutton` to docs
- PR #12422: Scatter color: moving #10809 forward
- PR #12999: Format `MaxNLocator` with `numpydoc`
- PR #12991: Canonicalize weights extracted for AFM fonts.
- PR #12955: Cleanup `cursor_demo`.
- PR #12984: Cleanup GTK examples.
- PR #12986: Minor cleanup to `double_pendulum` example.

- PR #12959: Update the documentation of Cursor
- PR #12945: Correctly get weight & style hints from certain newer Microsoft fonts
- PR #12976: ENH: replace deprecated numpy header
- PR #12975: Fail-fast when trying to run tests with too-old pytest.
- PR #12970: Minor simplifications.
- PR #12974: Remove some checks for Py<3.6 in the test suite.
- PR #12779: Include scatter plots in Qt figure options editor.
- PR #12459: Improve formatting of imshow() cursor data when a colorbar exists.
- PR #12927: MAINT: Correctly handle empty lists in zip unpacking in mplot3d.art3d
- PR #12919: Suppress deprecation warning when testing drawstyle conflict
- PR #12956: Misc. cleanups.
- PR #12924: Deprecate public use of Formatter.pprint\_val.
- PR #12947: Support ~ as nonbreaking space in mathtext.
- PR #12944: Fix the title of testing\_api
- PR #12136: MAINT: Unify calculation of normal vectors from polygons
- PR #12880: More table documentation
- PR #12940: Avoid pyplot in showcase examples.
- PR #12935: os.PathLike exists on all supported Pythons now.
- PR #12936: Minor updates following bump to Py3.6+.
- PR #12932: Simplify argument checking in Table.\_\_getitem\_\_.
- PR #12930: Shorten an argument check.
- PR #12538: MNT: drop 3.5 testing for 3.1 branch
- PR #12868: Simplify use of Path.\_fast\_from\_codes\_and\_verts.
- PR #12300: API: Polar: allow flipped y/rlimits....
- PR #12861: Don't use deprecated wx.NewId().
- PR #12908: Allow all valid hist.bins strings to be set in the rcparams
- PR #12902: Kill dead code in textpath.
- PR #12885: Improve margins in formlayout
- PR #12877: fooImage -> foo\_image in testing/compare.py
- PR #12845: Deprecate silent dropping of unknown arguments to TextPath().
- PR #12852: Cleanup collections docs.
- PR #12888: Properly enable forward/backward buttons on GTK3
- PR #12865: Avoid 1-tick or 0-tick log-scaled axis.
- PR #12844: Remove unused, private \_process\_text\_args.
- PR #12881: Fix string comparison
- PR #12863: FIX: translate timedeltas in \_to\_ordinalf

- PR #12640: Introduce MouseButton enum for MouseEvent.
- PR #12897: Reword a bit the contour docs.
- PR #12898: Validate rcParams["image.origin"].
- PR #12882: Write error messages to logger instead of stderr
- PR #12889: Deprecate public access to the vendored formlayout module.
- PR #12891: Add Azure Pipelines build badge
- PR #12883: MAINT Use list comprehension
- PR #12886: Properly enable forward/backward buttons on Qt
- PR #12858: Bump oldest supported numpy to 1.11.
- PR #12876: Fix a typo
- PR #12739: make Axes.\_parse\_scatter\_color\_args static
- PR #12846: Deprecate Path.has\_nonfinite.
- PR #12829: Remove unused variables
- PR #12872: Inline references to RendererPS in backend\_ps.
- PR #12800: documenting dtype of hist counts
- PR #12842: Fix message in nbagg connection\_info()
- PR #12855: Cleanup axes/\_base.py.
- PR #12826: Minor code cleanup
- PR #12866: Simplify stride calculations in loglocator.
- PR #12867: Drop compat code for outdated MSVC.
- PR #12218: Improve table docs
- PR #12847: correctly format ticklabels when EngFormatter is used with usetex = True
- PR #12851: Keep Collections and Patches property aliases in sync.
- PR #12849: Update docstrings in path.py, and small cleanups.
- PR #12805: Don't insert spurious newlines by joining tex.preamble.
- PR #12827: Remove unused imports
- PR #12560: Add matplotlib.testing to the documentation
- PR #12821: MNT: remove debug from update\_title\_pos
- PR #12764: Cleanup Renderer/GraphicsContext docs.
- PR #12759: Warn on FreeType missing glyphs.
- PR #12799: Reword some colorbar docs.
- PR #12633: Added support for MacOSX backend for PyPy
- PR #12798: Replace assignments to array.shape by calls to reshape().
- PR #11851: Simpler check for whether a Framework Python build is being used.
- PR #12259: BUG: Fix face orientations of bar3d
- PR #12565: Make FontManager.score\_weight less lenient.

- PR #12674: Allow "real" LaTeX code for `pgf.preamble` in `matplotlibrc`
- PR #12770: Simplify implementation of `FontProperties.copy()`.
- PR #12753: MNT: remove `_hold` shims to support `basemap + cartopy`
- PR #12450: Attach a `FigureCanvasBase` by default to `Figures`.
- PR #12643: Allow unit input to `FancyArrowPatch`
- PR #12767: Make colorbars constructible with dataless `ScalarMappables`.
- PR #12526: Rename `jquery` files
- PR #12552: Update docs for writing image comparison tests.
- PR #12746: Use `skipif`, not `xfail`, for uncomparable image formats.
- PR #12747: Prefer `log.warning("%s", ...)` to `log.warning("%s" % ...)`.
- PR #11753: FIX: Apply aspect before drawing starts
- PR #12749: Move `toolmanager` warning from logging to warning.
- PR #12598: Support `Cn` colors with `n >= 10`.
- PR #12727: Reorder API docs: separate file per module
- PR #12738: Add unobtrusive deprecation note to the first line of the docstring.
- PR #11663: Refactor color parsing of `Axes.scatter`
- PR #12736: Move deprecation note to end of docstring
- PR #12704: Rename `tkinter` import from `Tk` to `tk`.
- PR #12715: Cleanup `dviread`.
- PR #12717: Delete some `if __name__ == "__main__"` clauses.
- PR #10575: FIX `patch.update_from` to also copy `_original_edge/facecolor`
- PR #12537: Improve error message on failing `test_pyplot_up_to_date`
- PR #12721: Make `get_scale_docs()` internal
- PR #12706: Extend `sphinx Makefile` to cleanup completely
- PR #12481: Warn if `plot_surface` Z values contain `NaN`
- PR #12685: Make ticks in `demo_axes_rgb.py` visible
- PR #12523: Run `flake8` before `pytest` on `travis`
- PR #12691: DOC: Link to "How to make a PR" tutorials as badge and in contributing
- PR #11974: Make code match comment in `sankey`.
- PR #12440: Make arguments to `@deprecated/warn_deprecated` keyword-only.
- PR #12470: Update `AutoDateFormatter` with `locator`
- PR #12586: Improve `linestyles` example
- PR #12006: Replace `warnings.warn` with `cbook._warn_external` or `logging.warning`
- PR #12659: Add note that developer discussions are private
- PR #12543: Make `rcsetup.py` `flake8` compliant
- PR #12642: Don't silence `TypeError`s in `fmt_{x,y}data`.

- PR #12442: Deprecate passing drawstyle with linestyle as single string.
- PR #12625: Shorten some docstrings.
- PR #12627: Be a bit more stringent on invalid inputs.
- PR #12629: Fix issue with PyPy on macOS
- PR #10933: Remove "experimental" fontconfig font\_manager backend.
- PR #12600: Minor style fixes.
- PR #12570: Fix mathtext tutorial for build with Sphinx 1.8.
- PR #12487: Update docs/tests for the deprecation of aname and label1On/label2On/etc.
- PR #12521: Improve docstring of draw\_idle()
- PR #12574: Remove some unused imports
- PR #12568: Add note regarding builds of old Matplotlibs.
- PR #12547: Disable sticky edge accumulation if no autoscaling.
- PR #12546: Avoid quadratic behavior when accumulating stickies.
- PR #11789: endless looping GIFs with PillowWriter
- PR #12525: Fix some flake8 issues
- PR #12516: Don't handle impossible values for align in hist()
- PR #12500: Adjust the widths of the messages during the build.
- PR #12492: Simplify radar\_chart example.
- PR #11984: Strip out pkg-config machinery for agg and libqhull.
- PR #12463: Document Artist.cursor\_data() parameter
- PR #12482: Test slider orientation
- PR #12317: Always install mpl\_toolkits.
- PR #12246: Be less tolerant of broken installs.
- PR #12477: Use N{MICRO SIGN} instead of N{GREEK SMALL LETTER MU} in Eng-Formatter.
- PR #12483: Kill FontManager.update\_fonts.
- PR #12474: Throw ValueError when irregularly gridded data is passed to streamplot.
- PR #12466: np.fromstring -> np.frombuffer.
- PR #12369: Improved exception handling on animation failure
- PR #12460: Deprecate RendererBase.strip\_math.
- PR #12453: Rollback erroneous commit to whats\_new.rst from #10746
- PR #12452: Minor updates to the FAQ.
- PR #10746: Adjusted matplotlib.widgets.Slider to have optional vertical orientatation
- PR #12441: Get rid of a signed-compare warning.
- PR #12430: Deprecate Axes3D.plot\_surface(shade=None)
- PR #12435: Fix numpydoc parameter formatting

- PR #12434: Clarify documentation for textprops keyword parameter of TextArea
- PR #12427: Document Artist.get\_cursor\_data
- PR #10322: Use np.hypot wherever possible.
- PR #10809: Fix for scatter not showing points with valid x/y but invalid color
- PR #12423: Minor simplifications to backend\_svg.
- PR #10356: fix detecting which artist(s) the mouse is over
- PR #10268: Dvi caching
- PR #10238: Call kpsewhich with more arguments at one time
- PR #10236: Cache kpsewhich results persistently
- PR #4675: Deprecate color keyword argument in scatter
- PR #5054: Diverging norm
- PR #12416: Move font cache rebuild out of exception handler
- PR #4762: Traitlets
- PR #5414: WIP: New FreeType wrappers
- PR #3875: ENH: passing colors (and other optional keyword arguments) to violinplot()
- PR #1959: PS backend optionally jpeg-compresses the embedded images
- PR #11891: Group some print()s in backend\_ps.
- PR #12165: Remove deprecated mlab code
- PR #12387: Update HTML animation as slider is dragged
- PR #12333: ENH: add colorbar method to axes
- PR #10088: Deprecate Tick.{gridOn,tick1On,label1On,...} in favor of set\_visible.
- PR #12393: Deprecate to-days converters in matplotlib dates
- PR #11232: FIX: fix figure.set\_dpi when pixel ratio not 1
- PR #12247: Machinery for deprecating properties.
- PR #12371: Move check for ImageMagick Windows path to bin\_path().
- PR #12384: Cleanup axislines style.
- PR #9565: Stem performance boost
- PR #12368: Don't use stdlib private API in animation.py.
- PR #12351: dviread: find\_tex\_file: Ensure the encoding on windows
- PR #12372: Remove two examples.
- PR #12356: Fix stripping of CRLF on Windows.
- PR #12283: FIX: errorbar xywhere should return ndarray
- PR #12304: TST: Merge Qt tests into one file.
- PR #12340: Catch test deprecation warnings for mlab.demean
- PR #12296: Make FooConverter inherit from ConversionInterface in examples
- PR #12309: Deduplicate implementations of FooNorm.autoscale{, \_None}

- PR #7716: [NF] Add 'truncate' and 'join' methods to colormaps.
- PR #12314: Deprecate `axis('normal')` in favor of `axis('auto')`.
- PR #12307: Clarify missing-property error message.
- PR #12260: Fix docs : change from issue #12191, remove "if 1:" blocks in examples
- PR #12253: Handle utf-8 output by kpathsea on Windows.
- PR #12292: TST: Modify the bar3d test to show three more angles
- PR #12284: Don't try to autoscale if no data present to autoscale to
- PR #12255: Deduplicate inherited docstrings.
- PR #12222: Remove extraneous if 1 statements in `demo_axisline_style.py`
- PR #12137: MAINT: Vectorize bar3d
- PR #12219: Merge `OSXInstalledFonts` into `findSystemFonts`.
- PR #12229: Less ACCEPTS, more numpydoc.
- PR #11621: TST: make E402 a universal flake8 ignore
- PR #12231: CI: Speed up Appveyor repository cloning
- PR #11661: Update `blocking_input.py`
- PR #12199: Allow disabling specific mouse actions in `blocking_input`
- PR #12210: `Axes.tick_params()` argument checking
- PR #12211: Fix typo
- PR #12200: Slightly clarify some invalid shape exceptions for image data.
- PR #12151: Don't pretend `@deprecated` applies to classmethods.
- PR #12190: Remove some unused variables and imports
- PR #12192: Exclude examples from lgtm analysis
- PR #12196: Give Carreau the ability to mention the backport bot.
- PR #12171: Remove internal warning due to `zsort` deprecation
- PR #12030: Speed up canvas redraw for GTK3Agg backend.
- PR #12156: Cleanup the GridSpec demos.
- PR #12144: Add explicit getters and setters for `Annotation.anncoords`.
- PR #12152: Use `_warn_external` for deprecations warnings.
- PR #12147: DOC: update the `gh_stats` code
- PR #12139: Unbreak build re: `mplot3d` style.
- PR #11367: Raise `TypeError` on unsupported kwargs of `spy()`
- PR #9990: Fix and document `lightsource` argument in `mplot3d`
- PR #12124: Correctly infer units from empty arrays
- PR #11994: Cleanup unused variables and imports
- PR #12122: MNT: re-add `cbook` import `art3d`
- PR #12086: FIX: make `MaxNLocator` only follow visible ticks for order of magnitude

- PR #12032: Remove unused imports
- PR #12093: Correct the removal of `-Wstrict-prototypes` from compiler flags.
- PR #12069: Style fixes for `mplot3d`.
- PR #11997: Cleanup some `axes_grid1` examples
- PR #12098: Improve layout of HTML animation
- PR #12094: Fine-tune logging notes in `contributing.rst`.
- PR #12079: Clarifications to **`im_show()`** doc regarding `interpolation='none'`.
- PR #12068: More style fixes.
- PR #11499: FIX: layout for mixed descent multiline text objects
- PR #11921: FIX: allow reshape 2-D to return a bare 1-d list
- PR #12070: Avoid some uses of `np.isscalar`.
- PR #12067: DOC: make `Line2D` docstring definition easier to find
- PR #12054: More style fixes.
- PR #12066: fix indentation in docstring interpolation for `spy`.
- PR #11931: Remove separate `autosummary_inher` template.
- PR #12049: Make `Poly3DCollection.set_zsort` less lenient.
- PR #12050: Various cleanups.
- PR #12038: Modernize `ArtistInspector` a bit...
- PR #12033: DOC: formatting fixes to `mplot3d`
- PR #12051: Is bool
- PR #12045: Fix 999.9... edge case in `ticker.EngFormatter` for negative numbers
- PR #12044: Update doc on the *progressive* and *optimize* keywords in `savefig`
- PR #12061: Small refactor/simplification.
- PR #12060: `INSTALL.rst` fixes
- PR #12055: Fix invalid escape in docstring.
- PR #12026: whitespace(-mostly) style cleanup.
- PR #12043: Deprecate `get_py2exe_datafiles`.
- PR #12046: Make `HTMLWriter` constructor a bit more strict.
- PR #12034: Doc markup fixes.
- PR #11972: FIX: close mem leak for repeated draw
- PR #12024: Fix typos
- PR #11996: Minor javascript cleanup
- PR #11989: Remove support for ghostscript 8.60.
- PR #12004: Update `acorr` and `xcorr` docs to match numpy docs
- PR #11998: No `clf()` needed after creating a figure
- PR #12001: Do not use an explicit `figum` in `plt.figure(1, ...)` in simple cases

- PR #11999: Do not use an explicit fignum `plt.figure(1)` in simple cases
- PR #11995: Don't use bare except statements
- PR #11993: DOC: fixed typos
- PR #11992: Use `pytest.warns` instead of home-baked warnings capture.
- PR #11975: Derive `plt.figlegend.__doc__` from `Figure.legend.__doc__`.
- PR #11980: Remove `__version__numpy__`; simplify dependencies check.
- PR #11982: Remove and old keyword documentation.
- PR #11981: Some extra typos
- PR #11979: Fix a couple of typos.
- PR #11959: `cbook.iterable` -> `np.iterable`.
- PR #11965: Move the removal of the `-Wstrict-prototypes` flag to `setup.py`.
- PR #11958: Remove unused code
- PR #11960: Make `jpl_units` a bit less painful to read.
- PR #11951: Improve Artist docstrings
- PR #11954: No need to define `_log` twice in `matplotlib.dates`.
- PR #11948: Minor fixes to docs and gitignore.
- PR #11777: Avoid incorrect warning in `savefig`
- PR #11942: Deprecate `Artist.aname` and `Axes.aname`
- PR #11935: Remove `ginput` demo example
- PR #11939: Improve alias signatures
- PR #11940: Do not use aliases of properties in internal code
- PR #11941: Fix `test_large_subscript_title()`
- PR #11938: More docstring cleanup of `Line2D`.
- PR #11920: Add LGTM.com code quality badge
- PR #11922: Improve docstrings of `Line2D`
- PR #11924: Minor formatting update on alias docstrings
- PR #11926: Minor fix to `ginput_demo`.
- PR #11912: BLD: update PR template for `flake8`
- PR #11909: Simplify `linestyle` and `fillstyle` reference docs.
- PR #11502: FIX: move `title(s)` up if subscripts hang too low.
- PR #11906: fix format of `bar_of_pie` example
- PR #11741: Factor out common code between `Patch.draw` and `FancyArrowPatch.draw`.
- PR #11784: Argument checking for `grid()`
- PR #11888: Factor out a subprocess log-and-check helper.
- PR #11740: Deprecate support for 3rd-party backends without `set_hatch_color`.
- PR #11884: Deprecate the `tk_window_focus` function.

- PR #11689: Don't cache the renderer on the Axes instance.
- PR #11698: For property, use decorator or lambdas.
- PR #11872: Make all builtin cmaps picklable.
- PR #11870: More style fixes.
- PR #11873: Remove mention of deprecated/removed methods from mlab's docstring.
- PR #11869: Style fixes.
- PR #11874: Remove some remnants of Py2-handling in test\_rcparams.
- PR #11865: example file for making a bar of pie chart
- PR #11868: mathtext.py style fixes.
- PR #11854: Accept anything that's not a directory for \$MATPLOTLIBRC.
- PR #11589: WIP ENH secondary axes:
- PR #8449: Including Additional Metadata using the SVG Backend
- PR #11465: ENH: optimize Collection non-affine transform to call transform once

Issues (161):

- #4001: Qt5 Backend: dblclick is always False on 'mouse\_release\_event'
- #14152: qt\_compat.py performing wrong test for PyQt5
- #10875: Annotation.contains and FancyArrow.contains return incorrect values
- #458: JPG quality keyword in savefig
- #4354: scatter not showing valid x/y points with invalid color
- #14113: scatter could not raise when colors are provided but position data are empty
- #14003: numpydoc 0.9 breaks doc build
- #14054: ticks sometimes disappear when zooming interactively
- #10189: The data decorator does not integrate well with numpydoc
- #14034: pyplot plot raises ValueError when plotting NaN against datetime dates
- #14039: bar plot yerr lines/caps should respect zorder
- #14042: dynamic\_image.py + saving animation broken
- #14013: osx backend not usable with ipython/jupyter from conda?
- #13993: Tests files installed by default?
- #13991: MaxNLocator.default\_params deprecation may break Cartopy
- #5045: Axes.grid() not honoring specified "zorder" kwarg
- #4371: LaTeX and PGF preambles do not allow commas
- #13982: hist() no longer respects range=... when density=True
- #13963: Dataless colorbars break when updated
- #10381: Issue when setting scatter color in separate method call
- #13618: Minor ticklabels are missing at positions of major ticks.
- #13880: Adding documentation for Text.fontfamily default, set\_fontfamily(None)?

- #13865: Appveyor broken
- #8636: plt.hist chooses improper range when using string-based bin options
- #7300: weird mathtext doc markup
- #8862: Replace mathcircled by textcircled
- #13759: DOC: matplotlib.patches.Arc
- #13785: Imshow gives values out of the extent
- #13786: Cannot import matplotlib.animation
- #13561: Progress of animation.save (for long animations)
- #13735: title doesn't move for ticklables....
- #12175: Example link near markevery in the "What's new in 3.0" page is malformed/broken
- #13713: Boxplot xlim not correctly calculated
- #11070: Add a "density" kwarg to hist2d
- #11337: Cannot plot fully masked array against datetimes
- #10165: Adapt stem plot
- #10976: ENH: secondary axis for a x or y scale.
- #10763: Cairo in 2.2.0 not working for new backends
- #9737: setupext should not explicitly add /usr/{,local/}include to the include path
- #11217: Crash on zero-length FancyArrow
- #13623: do not cause warning in seaborn
- #13480: Segfault on help('modules') command when matplotlib is installed
- #13604: legend's framealpha kwarg does not apply when writing to an eps file
- #12311: 'off' vs. False bug
- #10237: Setting an alpha value to a Poly3DCollection
- #11781: fill\_between interpolation & nan issue
- #1077: 3d plots with aspect='equal'
- #11761: Still naming inconsistency in API on axes limits
- #11623: Regression: "TypeError: Period('2000-12-31', 'D') is not a string" when a Series with date index was plotted
- #12655: auto-ticks do not handle values near bounds gracefully
- #13487: labelpad is not the spacing between the axis and the label
- #13540: Docs for matplotlib.pyplot.specgram() reference an unsupported mode setting
- #8997: Proposal: Grid arrangement by number of plots
- #6928: Cannot run setup.py build with numpy master
- #12697: Axes are drawn at wrong positions
- #13478: FuncAnimation: interactive zoom/pan with blitting does not work
- #11575: Setting axis ticks in log scale produces duplicate tick labels.

- #13464: `set_rlim(bottom=...)` no longer works
- #12628: Write canonical example of how to use Matplotlib inside a webserver
- #10022: boxplot: positions used to take `Int64Index`
- #11647: Disable buttons in `ginput`
- #12987: issues parsing AFM fonts
- #12667: Colorbar ticks....
- #13137: Travis for Python 3.7 sometimes fails due to missing font
- #7969: Stem is slow and will crash if I try to close the window
- #13002: Hist color kwarg broken for multiple empty datasets
- #5581: `[mpl_toolkits]` Things drawn on parasite axes don't fire pick events
- #13417: Secondary axis doesn't resize properly
- #8120: Inconsistent `inset_axes` position between `show()`, `savefig(format='png')` and `savefig(format='pdf')`
- #8947: Different result, slower runtime of heatmap between 2.0.0 and 2.0.1
- #13264: Use of logging in matplotlib
- #11602: animation error
- #12925: Python pandas datetime plot xticks in unexpected location
- #11025: AxesGrid ticks missing on x-axis
- #10974: Examples not shown in API docs for many methods.
- #13392: boxplot broken for empty inputs
- #12345: Need more tests for units and errorbar
- #10361: `FigureCanvas.draw()` with `tight_layout()` needs to be called twice with Matplotlib 2.1.0
- #11376: Temporary styling ignores color cycle
- #11546: `import time`
- #13286: `AttributeError: 'float' object has no attribute 'deg2rad'`
- #11508: bi-directional perceptually flat colormaps in matplotlib?
- #12918: Mac shows an icon in the dock when using `matplotlib.pyplot`.
- #13339: Log Colorbar `minorticks_off` reverted if ticks set...
- #13228: MPL 3 + Colorbar + PowerNorm bug
- #13096: `Matplotlib.get_backend()/matplotlib.use()` cause `NSException` with Anaconda
- #7712: Number of ticks for dates still gives overlapping labels
- #9978: General poor default formatting of datetimes on plot x-axis
- #13253: `imsave` outputs JPEG with wrong dimension
- #11391: Use data argument for scatter plotting timestamps from pandas
- #13145: `widgets.RadioButtons`: select by closest in position
- #13267: "double-pendulum" example's speed not correct / varying

- #13257: Allow turning off minorticks for Colorbar with LogNorm?
- #13237: Sankey basic gallery example is not rendered properly.
- #12836: matplotlib.rc\_file resets to default template before updating rcparams
- #13186: ax.bar throws when x axis is pandas datetime
- #5397: Expose compression and filter PNG options through savefig
- #13142: Cannot plot bar graph with dates: "TypeError: ufunc subtract cannot use operands with types dtype('<M8[ns]') and dtype('float64')"
- #8530: Feature request: TIFF LZW compression support in savefig()
- #13139: font family ['serif'] not found. Falling back to DejaVu Sans
- #1558: Graceful handling of a numpy matrix
- #12954: Fonts installed in the user directory are not detected (Windows 1809)
- #3644: Feature Request: manually set colorbar without mappable
- #12862: broken\_barh appears not to work with datetime/timedelta objects
- #11290: ax.bar doesn't work correctly when width is a timedelta64 object
- #13156: DOC: matplotlib.pyplot.arrow
- #12990: Unclear error message for plt.xticks(names)
- #12769: Failing to save an animated graph with matplotlib.animation
- #13112: LogNorm colorbar prints double tick labels after set\_ticks()
- #13132: BUG: matplotlib.sphinxext.plot\_directive uses old function-based API
- #8528: Funcanimation memory leak?
- #8914: line3D set\_data only takes in x and y data
- #8768: One one tick in a log-scale axis
- #13121: Tests fail with pytest 4.1
- #13098: Likely incorrect code(?) in colorbar.py
- #12562: Clean up unused imports
- #12106: plt.plot does not plot anything with named arguments
- #5145: Python [Error 17]No usable Temporary file name found
- #13012: qt5agg image quality changes when window is out of focus
- #13055: 127.0.0.1 hardcoded in webagg backend server
- #12971: Pandas Series not supported as data kwarg
- #13022: boxplot not showing symbols with seaborn style sheet
- #13028: Bad rotation\_mode/center\_baseline combination even if rotation=0
- #12745: Sphinx copy button for code block
- #12801: scatter() should not drop data points at nonfinite coordinates
- #12358: Dropping support for Py3.5 and numpy 1.10
- #12994: Axes range with set\_xticks with categoricals

- #12993: Semantics of `set_xticks` for categoricals
- #12946: `~` in `mathrm` leads to Unknown symbol: `mathrm`
- #10704: Add documentation for `set_rlim`
- #11202: Using of `ax.set_ylim()` for polar plot leads to "posx and posy should be finite values" error
- #12859: DeprecationWarning: `NewId()` is deprecated in wxPython.
- #12817: Multiple places where Type Errors on `chook.warn_deprecated` will happen
- #12308: #12253 FIX: Handle utf-8 output by `kpathsea` on Windows - possibly causing issues
- #12804: Usetex produces preamble with one character per line
- #12808: Issue with minor tick spacing in colorbar with custom `Normalize` class
- #12138: Faces of `Axes3d.bar3d` are not oriented correctly
- #12591: Adding `FancyArrowPatch` with datetime coordinates fails
- #11139: "make clean" doesn't remove all the build doc files
- #11908: Improve `linestyle` documentation
- #10643: Most warnings calls do not set the `stacklevel`
- #12532: Incorrect rendering of math symbols
- #11787: Looping gifs with `PillowWriter`
- #9205: after the animation encoder (e.g. `ffmpeg`) fails, the animation framework itself fails internally in various ways while trying to report the error
- #11154: Unexpected behavior for `Axes3D.plot_surface(shade=None)`
- #12121: Documentation of `TextArea`'s `fontprops` keyword argument is misleading
- #12191: "if 1:" blocks in examples
- #12107: warnings re: deprecated `pytest` API with `pytest 3.8`
- #12010: `Popover` over plot is very slow
- #12118: `Scatter`: empty `np.array`s with non-numeric dtypes cause `TypeError`
- #12072: `MaxNLocator` changes the scientific notation exponent with different number of tick labels
- #11795: Un-align animations created with `to_jshtml()`?
- #10201: Available fonts are ignored by `font_manager`
- #12065: Keyword *interpolation* behaving improperly while saving to SVG with **`savefig()`**
- #11498: Test layout with big descenders and multiple lines inconsistent.
- #11468: Layout managers have problems with titles containing `MathText`
- #11899: Histogram of list of datetimes
- #11956: apparent memory leak with live plotting
- #11587: Missing filled contours when using `contourf`
- #11716: errorbar pickling fails when specifying y error bars

- [#11557](#): Hoping add a drawing function 'patch' in matplotlib

## Previous Github Stats



## PREVIOUS WHAT'S NEW

### 7.1 List of changes to Matplotlib prior to 2015

This is a list of the changes made to Matplotlib from 2003 to 2015. For more recent changes, please refer to the [what's new](#) or the [API changes](#).

**2015-11-16 Levels passed to `contour(f)` and `tricontour(f)` must be in increasing order.**

2015-10-21 Added `TextBox` widget

2015-10-21 Added `get_ticks_direction()`

**2015-02-27 Added the rcParam `'image.composite_image'` to permit users** to decide whether they want the vector graphics backends to combine all images within a set of axes into a single composite image. (If images do not get combined, users can open vector graphics files in Adobe Illustrator or Inkscape and edit each image individually.)

**2015-02-19 Rewrite of C++ code that calculates contours to add support for** corner masking. This is controlled by the `'corner_mask'` keyword in plotting commands `'contour'` and `'contourf'`. - IMT

**2015-01-23 Text bounding boxes are now computed with advance width rather than** ink area. This may result in slightly different placement of text.

**2014-10-27 Allowed selection of the backend using the `MPLBACKEND` environment** variable. Added documentation on backend selection methods.

**2014-09-27 Overhauled `colors.LightSource`. Added `LightSource.hillshade` to** allow the independent generation of illumination maps. Added new types of blending for creating more visually appealing shaded relief plots (e.g. `blend_mode="overlay"`, etc, in addition to the legacy `"hsv"` mode).

2014-06-10 Added `Colorbar.remove()`

2014-06-07 Fixed bug so radial plots can be saved as ps in py3k.

**2014-06-01 Changed the `fmt` kwarg of `errorbar` to support the** the mpl convention that `"none"` means `"don't draw it"`, and to default to the empty string, so that plotting of data points is done with the `plot()` function defaults. Deprecated use of the `None` object in place `"none"`.

**2014-05-22 Allow the `linscale` keyword parameter of `symlog` scale to be** smaller than one.

**2014-05-20 Added logic to `FontManager` to invalidate font-cache if** if `font-family` rcparams have changed.

2014-05-16 Fixed the positioning of multi-line text in the PGF backend.

**2014-05-14 Added `Axes.add_image()` as the standard way to add `AxesImage` instances to `Axes`.** This improves the consistency with `add_artist()`, `add_collection()`, `add_container()`, `add_line()`, `add_patch()`, and `add_table()`.

2014-05-02 Added colorblind-friendly colormap, named 'Wistia'.

**2014-04-27 Improved input clean up in `Axes.{h|v}lines`** Coerce input into a 1D ndarray (after dealing with units).

2014-04-27 removed un-needed cast to float in stem

**2014-04-23 Updated references to "ipython -pylab"** The preferred method for invoking pylab is now using the "%pylab" magic. -Chris G.

**2014-04-22 Added (re-)generate a simple automatic legend to "Figure Options"** dialog of the Qt4Agg backend.

**2014-04-22 Added an example showing the difference between** `interpolation = 'none'` and `interpolation = 'nearest'` in `imshow()` when saving vector graphics files.

**2014-04-22 Added violin plotting functions.** See `Axes.violinplot`, `Axes.violin`, `cbook.violin_stats` and `mlab.GaussianKDE` for details.

**2014-04-10 Fixed the triangular marker rendering error. The "Up" triangle was** rendered instead of "Right" triangle and vice-versa.

**2014-04-08 Fixed a bug in `parasite_axes.py` by making a list out** of a generator at line 263.

**2014-04-02 Added `clipon=False` to patch creation of wedges and shadows** in `pie`.

**2014-02-25 In `backend_qt4agg` changed from using `update` -> `repaint` under** windows. See comment in source near `self._priv_update` for longer explanation.

**2014-03-27 Added tests for `pie ccw` parameter. Removed `pdf` and `svg` images** from tests for `pie linewidth` parameter.

**2014-03-24 Changed the behaviour of axes to not ignore leading or trailing** patches of height 0 (or width 0) while calculating the x and y axis limits. Patches having both `height == 0` and `width == 0` are ignored.

**2014-03-24 Added bool kwarg (`manage_xticks`) to `boxplot` to enable/disable** the management of the xlimits and ticks when making a boxplot. Default in True which maintains current behavior by default.

**2014-03-23 Fixed a bug in `projections/polar.py` by making sure that the `theta`** value being calculated when given the mouse coordinates stays within the range of 0 and  $2 * \pi$ .

**2014-03-22 Added the keyword arguments `wedgeprops` and `textprops` to `pie`.** Users can control the wedge and text properties of the pie in more detail, if they choose.

**2014-03-17 Bug was fixed in `append_axes` from the `AxesDivider` class would not** append axes in the right location with respect to the reference locator axes

2014-03-13 Add parameter 'clockwise' to function `pie`, True by default.

2014-02-28 Added 'origin' kwarg to `spy`

**2014-02-27 Implemented separate horizontal/vertical axes padding to the** `ImageGrid` in the `AxesGrid` toolkit

**2014-02-27 Allowed markevery property of matplotlib.lines.Line2D to be, an int** numpy fancy index, slice object, or float. The float behaviour turns on markers at approximately equal display-coordinate-distances along the line.

**2014-02-25 In backend\_qt4agg changed from using update -> repaint under** windows. See comment in source near self.\_priv\_update for longer explanation.

**2014-01-02 triplot now returns the artist it adds and support of line and** marker kwargs has been improved. GBY

**2013-12-30 Made streamplot grid size consistent for different types of density** argument. A 30x30 grid is now used for both density=1 and density=(1, 1).

**2013-12-03 Added a pure boxplot-drawing method that allow a more complete** customization of boxplots. It takes a list of dicts contains stats. Also created a function (cbook.boxplot\_stats) that generates the stats needed.

**2013-11-28 Added qhull extension module to perform Delaunay triangulation more** robustly than before. It is used by tri.Triangulation (and hence all pyplot.tri\* methods) and mlab.griddata. Deprecated matplotlib.delaunay module. - IMT

**2013-11-05 Add power-law normalization method. This is useful for, e.g.,** showing small populations in a "hist2d" histogram.

**2013-10-27 Added get\_rlabel\_position and set\_rlabel\_position methods to** PolarAxes to control angular position of radial tick labels.

**2013-10-06 Add stride-based functions to mlab for easy creation of 2D arrays** with less memory.

**2013-10-06 Improve window and detrend functions in mlab, particulart support for** 2D arrays.

2013-10-06 Improve performance of all spectrum-related mlab functions and plots.

**2013-10-06 Added support for magnitude, phase, and angle spectrums to** axes.specgram, and support for magnitude, phase, angle, and complex spectrums to mlab-specgram.

**2013-10-06 Added magnitude\_spectrum, angle\_spectrum, and phase\_spectrum plots,** as well as magnitude\_spectrum, angle\_spectrum, phase\_spectrum, and complex\_spectrum functions to mlab

**2013-07-12 Added support for datetime axes to 2d plots. Axis values are passed** through Axes.convert\_xunits/Axes.convert\_yunits before being used by contour/contourf, pcolormesh and pcolor.

**2013-07-12 Allowed matplotlib.dates.date2num, matplotlib.dates.num2date, and** matplotlib.dates.datestr2num to accept n-d inputs. Also factored in support for n-d arrays to matplotlib.dates.DateConverter and matplotlib.units.Registry.

**2013-06-26 Refactored the axes module: the axes module is now a folder,** containing the following submodule:

- `_subplots.py`, containing all the subplots helper methods
- `_base.py`, containing several private methods and a new `_AxesBase` class. This `_AxesBase` class contains all the methods that are not directly linked to plots of the "old" Axes
- `_axes.py` contains the Axes class. This class now inherits from `_AxesBase`: it contains all "plotting" methods and labelling methods.

This refactoring should not affect the API. Only private methods are not importable from the axes module anymore.

**2013-05-18 Added support for arbitrary rasterization resolutions to the SVG backend.** Previously the resolution was hard coded to 72 dpi. Now the backend class takes a `image_dpi` argument for its constructor, adjusts the image bounding box accordingly and forwards a magnification factor to the image renderer. The code and results now resemble those of the PDF backend. - MW

**2013-05-08 Changed behavior of hist when given stacked=True and normed=True.** Histograms are now stacked first, then the sum is normalized. Previously, each histogram was normalized, then they were stacked.

2013-04-25 Changed all instances of:

```
from matplotlib import MatplotlibDeprecationWarning as mplDeprecation to:
from cbook import mplDeprecation
and removed the import into the matplotlib namespace in __init__.py Thomas Caswell
```

**2013-04-15 Added 'axes.xmargin' and 'axes.ymargin' to rcParams to set default margins on auto-scaling.** - TAC

2013-04-16 Added `patheffect` support for `Line2D` objects. -JJL

**2013-03-31 Added support for arbitrary unstructured user-specified triangulations to Axes3D.tricontour[f]** - Damon McDougall

**2013-03-19 Added support for passing linestyle kwarg to step so all plot kwargs are passed to the underlying plot call.** -TAC

**2013-02-25 Added classes CubicTriInterpolator, UniformTriRefiner, TriAnalyzer to matplotlib.tri module.** - GBy

**2013-01-23 Add 'savefig.directory' to rcParams to remember and fill in the last directory saved to for figure save dialogs** - Martin Spacek

**2013-01-13 Add eventplot method to axes and pyplot and EventCollection class to collections.**

**2013-01-08 Added two extra titles to axes which are flush with the left and right edges of the plot respectively.** Andrew Dawson

2013-01-07 Add `framealpha` keyword argument to `legend` - PO

2013-01-16 Till Stensitzki added a baseline feature to `stackplot`

**2012-12-22 Added classes for interpolation within triangular grids** (`LinearTriInterpolator`) and to find the triangles in which points lie (`TrapezoidMap-TriFinder`) to `matplotlib.tri` module. - IMT

**2012-12-05 Added MatplotlibDeprecationWarning class for signaling deprecation.** Matplotlib developers can use this class as follows:

```
from matplotlib import MatplotlibDeprecationWarning as mplDeprecation
```

In light of the fact that Python builtin `DeprecationWarnings` are ignored by default as of Python 2.7, this class was put in to allow for the signaling of deprecation, but via `UserWarnings` which are not ignored by default. - PI

- 2012-11-27 Added the *mtext* parameter for supplying `matplotlib.text.Text` instances** to `RendererBase.draw_tex` and `RendererBase.draw_text`. This allows backends to utilize additional text attributes, like the alignment of text elements. - pwuertz
- 2012-11-26 deprecate `matplotlib/mpl.py`, which was used only in `pylab.py` and is** now replaced by the more suitable `import matplotlib as mpl`. - PI
- 2012-11-25 Make `rc_context` available via `pyplot` interface - PI
- 2012-11-16 `plt.set_cmap` no longer throws errors if there is not already** an active colorable artist, such as an image, and just sets up the colormap to use from that point forward. - PI
- 2012-11-16 Added the function `_get_rgba_face`, which is identical to `_get_rgb_face`** except it return a (r,g,b,a) tuple, to `Line2D`. Modified `Line2D.draw` to use `_get_rgba_face` to get the markerface color so that any alpha set by `markerfacecolor` will be respected. - Thomas Caswell
- 2012-11-13 Add a symmetric log normalization class to `colors.py`.** Also added some tests for the normalization class. Till Stensitzki
- 2012-11-12 Make `axes.stem` take at least one argument.** Uses a default `range(n)` when the first arg not provided. Damon McDougall
- 2012-11-09 Make `plt.subplot()` without arguments act as `subplot(111)` - PI
- 2012-11-08 Replaced `plt.figure` and `plt.subplot` calls by the newer, more** convenient single call to `plt.subplots()` in the documentation examples - PI
- 2012-10-05 Add support for saving animations as animated GIFs. - JVDP
- 2012-08-11 Fix path-closing bug in `Patches.Polygon`, so that regardless** of whether the path is the initial one or was subsequently set by `set_xy()`, `get_xy()` will return a closed path if and only if `get_closed()` is `True`. Thanks to Jacob Vanderplas. - EF
- 2012-08-05 When a norm is passed to `contourf`, either or both of the `vmin`, `vmax`** attributes of that norm are now respected. Formerly they were respected only if both were specified. In addition, `vmin` and/or `vmax` can now be passed to `contourf` directly as `kwargs`. - EF
- 2012-07-24 `contourf` handles the `extend` kwarg by mapping the extended** ranges outside the normed 0-1 range so that they are handled by colormap colors determined by the `set_under` and `set_over` methods. Previously the extended ranges were mapped to 0 or 1 so that the "under" and "over" colormap colors were ignored. This change also increases slightly the color contrast for a given set of contour levels. - EF
- 2012-06-24 Make use of `mathtext` in tick labels configurable - DSD
- 2012-06-05 Images loaded through PIL are now ordered correctly - CG
- 2012-06-02 Add new `Axes` method and `pyplot` function, `hist2d`. - PO
- 2012-05-31 Remove support for `'cairo.<format>'` style of backend specification.** Deprecate `'cairo.format'` and `'savefig.extension'` `rcParams` and replace with `'savefig.format'`. - Martin Spacek
- 2012-05-29 `pcolormesh` now obeys the passed in "edgecolor" kwarg.** To support this, the "shading" argument to `pcolormesh` now only takes "flat" or "gouraud". To achieve the old "faceted" behavior, pass `"edgecolors='k'"`. - MGD
- 2012-05-22 Added `radius` kwarg to pie charts. - HH

- 2012-05-22 Collections now have a setting "offset\_position" to select whether** the offsets are given in "screen" coordinates (default, following the old behavior) or "data" coordinates. This is currently used internally to improve the performance of hexbin.
- As a result, the "draw\_path\_collection" backend methods have grown a new argument "offset\_position". - MGD
- 2012-05-04 Add a new argument to pie charts - startingangle - that** allows one to specify the angle offset for the first wedge of the chart. - EP
- 2012-05-03 symlog scale now obeys the logarithmic base. Previously, it was** completely ignored and always treated as base e. - MGD
- 2012-05-03 Allow linscalex/y keyword to symlog scale that allows the size of** the linear portion relative to the logarithmic portion to be adjusted. - MGD
- 2012-04-14 Added new plot style: stackplot. This new feature supports stacked** area plots. - Damon McDougall
- 2012-04-06 When path clipping changes a LINETO to a MOVETO, it also** changes any CLOSEPOLY command to a LINETO to the initial point. This fixes a problem with pdf and svg where the CLOSEPOLY would then draw a line to the latest MOVETO position instead of the intended initial position. - JKS
- 2012-03-27 Add support to ImageGrid for placing colorbars only at** one edge of each column/row. - RMM
- 2012-03-07 Refactor movie writing into useful classes that make use of** pipes to write image data to ffmpeg or mencoder. Also improve settings for these and the ability to pass custom options. - RMM
- 2012-02-29 errorevery keyword added to errorbar to enable errorbar** subsampling. fixes issue #600.
- 2012-02-28 Added plot\_trisurf to the mplot3d toolkit. This supports plotting** three dimensional surfaces on an irregular grid. - Damon McDougall
- 2012-01-23 The radius labels in polar plots no longer use a fixed** padding, but use a different alignment depending on the quadrant they are in. This fixes numerical problems when (rmax - rmin) gets too small. - MGD
- 2012-01-08 Add axes.streamplot to plot streamlines of a velocity field.** Adapted from Tom Flannaghan streamplot implementation. -TSY
- 2011-12-29 ps and pdf markers are now stroked only if the line width** is nonzero for consistency with agg, fixes issue #621. - JKS
- 2011-12-27 Work around an EINTR bug in some versions of subprocess. - JKS
- 2011-10-25 added support for operatorname to mathtext,** including the ability to insert spaces, such as  $\$operatorname\{arg,max\}$  - PI
- 2011-08-18 Change api of Axes.get\_tightbbox and add an optional** keyword parameter *call\_axes\_locator*. - JJL
- 2011-07-29 A new rcParam "axes.formatter.use\_locale" was added, that,** when True, will use the current locale to format tick labels. This means that, for example, in the fr\_FR locale, ',' will be used as a decimal separator. - MGD
- 2011-07-15 The set of markers available in the plot() and scatter()** commands has been unified. In general, this gives more options to both than were previously available, however, there is one backward-incompatible change to the markers in scatter:

"d" used to mean "diamond", it now means "narrow diamond". "D" can be used for a "diamond".

-MGD

**2011-07-13 Fix numerical problems in symlog scale, particularly when** `linthresh <= 1.0`. Symlog plots may look different if one was depending on the old broken behavior - MGD

**2011-07-10 Fixed argument handling error in tripcolor/triplot/tricontour,** issue #203. - IMT

**2011-07-08 Many functions added to mplot3d.axes3d to bring Axes3D objects** more feature-parity with regular Axes objects. Significant revisions to the documentation as well. - BVR

**2011-07-07 Added compatibility with IPython strategy for picking** a version of Qt4 support, and an rcParam for making the choice explicitly: `backend.qt4`. - EF

**2011-07-07 Modified AutoMinorLocator to improve automatic choice of** the number of minor intervals per major interval, and to allow one to specify this number via a kwarg. - EF

**2011-06-28 3D versions of scatter, plot, plot\_wireframe, plot\_surface,** `bar3d`, and some other functions now support empty inputs. - BVR

**2011-06-22 Add set\_theta\_offset, set\_theta\_direction and set\_theta\_zero\_location** to polar axes to control the location of 0 and directionality of theta. - MGD

**2011-06-22 Add axes.labelweight parameter to set font weight to axis** labels - MGD.

2011-06-20 Add pause function to pyplot. - EF

**2011-06-16 Added bottom keyword parameter for the stem command.** Also, implemented a legend handler for the stem plot. - JJL

2011-06-16 Added legend.frameon rcParams. - Mike Kaufman

2011-05-31 Made backend\_qt4 compatible with PySide. - Gerald Storer

**2011-04-17 Disable keyboard auto-repeat in qt4 backend by ignoring** key events resulting from auto-repeat. This makes constrained zoom/pan work. - EF

**2011-04-14 interpolation="nearest" always interpolate images. A new mode "none"** is introduced for no interpolation - JJL

**2011-04-03 Fixed broken pick interface to AsteriskCollection objects** used by scatter. - EF

**2011-04-01 The plot directive Sphinx extension now supports all of the** features in the Numpy fork of that extension. These include doctest formatting, an 'include-source' option, and a number of new configuration options. - MGD

**2011-03-29 Wrapped ViewVCCachedServer definition in a factory function.** This class now inherits from urllib2.HTTPSHandler in order to fetch data from github, but HTTPSHandler is not defined if python was built without SSL support. - DSD

2011-03-10 Update pytz version to 2011c, thanks to Simon Cross. - JKS

2011-03-06 Add standalone tests.py test runner script. - JKS

**2011-03-06 Set edgecolor to 'face' for scatter asterisk-type** symbols; this fixes a bug in which these symbols were not responding to the `c` kwarg. The symbols have no face area, so only the edgecolor is visible. - EF

- 2011-02-27 Support libpng version 1.5.x; suggestion by Michael Albert.** Changed installation specification to a minimum of libpng version 1.2. - EF
- 2011-02-20 xlabel accepts a callable as an fmt kwarg; modified patch** by Daniel Hyams. - EF
- 2011-02-18 scatter([], []) is now valid. Also fixed issues** with empty collections - BVR
- 2011-02-07 Quick workaround for dviread bug #3175113 - JKS
- 2011-02-05 Add chook memory monitoring for Windows, using** tasklist. - EF
- 2011-02-05 Speed up Normalize and LogNorm by using in-place** operations and by using float32 for float32 inputs and for ints of 2 bytes or shorter; based on patch by Christoph Gohlke. - EF
- 2011-02-04 Changed imshow to use rgba as uint8 from start to** finish, instead of going through an intermediate step as double precision; thanks to Christoph Gohlke. - EF
- 2011-01-13 Added zdir and offset arguments to contourf3d to** bring contourf3d in feature parity with contour3d. - BVR
- 2011-01-04 Tag 1.0.1 for release at r8896
- 2011-01-03 Added display of ticker offset to 3d plots. - BVR
- 2011-01-03 Turn off tick labeling on interior subplots for** `pyplots.subplots` when `sharex/sharey` is True. - JDH
- 2010-12-29 Implement `axes_divider.HBox` and `VBox`. -JJL
- 2010-11-22 Fixed error with Hammer projection. - BVR
- 2010-11-12 Fixed the placement and angle of axis labels in 3D plots. - BVR
- 2010-11-07 New rc parameters `examples.download` and `examples.directory`** allow bypassing the download mechanism in `get_sample_data`. - JKS
- 2010-10-04 Fix JPEG saving bug: only accept the kwargs documented** by PIL for JPEG files. - JKS
- 2010-09-15 Remove unused `_wxagg` extension and `numerix.h`. - EF
- 2010-08-25 Add new framework for doing animations with `examples`. - RM
- 2010-08-21 Remove unused and inappropriate methods from Tick classes:** `set_view_interval`, `get_minpos`, and `get_data_interval` are properly found in the `Axis` class and don't need to be duplicated in `XTick` and `YTick`. - EF
- 2010-08-21 Change `Axis.set_view_interval()` so that when updating an** existing interval, it respects the orientation of that interval, and can enlarge but not reduce the interval. This fixes a bug in which `Axis.set_ticks` would change the view limits of an inverted axis. Whether `set_ticks` should be affecting the `viewLim` at all remains an open question. - EF
- 2010-08-16 Handle NaN's correctly in path analysis routines. Fixes a** bug where the best location for a legend was not calculated correctly when the line contains NaNs. - MGD
- 2010-08-14 Fix bug in patch alpha handling, and in bar color kwarg - EF
- 2010-08-12 Removed all traces of numerix module after 17 months of** deprecation warnings. - EF

- 2010-08-05 Added keyword arguments 'thetaunits' and 'runits' for polar plots.**  
Fixed PolarAxes so that when it set default Formatters, it marked them as such.  
Fixed semilogx and semilogy to no longer blindly reset the ticker information on the non-log axis. Axes.arrow can now accept unitized data. - JRE
- 2010-08-03 Add support for MPLSETUPCFG variable for custom setup.cfg filename.**  
Used by sage buildbot to build an mpl w/ no gui support - JDH
- 2010-08-01 Create directory specified by MPLCONFIGDIR if it does not exist.** - ADS
- 2010-07-20 Return Qt4's default cursor when leaving the canvas - DSD
- 2010-07-06 Tagging for mpl 1.0 at r8502
- 2010-07-05 Added Ben Root's patch to put 3D plots in arbitrary axes,** allowing you to mix 3d and 2d in different axes/subplots or to have multiple 3D plots in one figure. See examples/mplot3d/subplot3d\_demo.py - JDH
- 2010-07-05 Preferred kwarg names in set\_xlim are now 'left' and 'right'; in set\_ylim, 'bottom' and 'top';** original kwargs are still accepted without complaint. - EF
- 2010-07-05 TkAgg and FtkAgg backends are now consistent with other** interactive backends: when used in scripts from the command line (not from ipython -pylab), show blocks, and can be called more than once. - EF
- 2010-07-02 Modified CXX/WrapPython.h to fix "swab bug" on solaris so** mpl can compile on Solaris with CXX6 in the trunk. Closes tracker bug 3022815 - JDH
- 2010-06-30 Added autoscale convenience method and corresponding** pyplot function for simplified control of autoscaling; and changed axis, set\_xlim, and set\_ylim so that by default, they turn off the autoscaling on the relevant axis or axes. Therefore one can call set\_xlim before plotting a line, for example, and the limits will be retained. - EF
- 2010-06-20 Added Axes.tick\_params and corresponding pyplot function** to control tick and tick label appearance after an Axes has been created. - EF
- 2010-06-09 Allow Axes.grid to control minor gridlines; allow** Axes.grid and Axis.grid to control major and minor gridlines in the same method call. - EF
- 2010-06-06 Change the way we do split/dividend adjustments in** finance.py to handle dividends and fix the zero division bug reported in sf bug 2949906 and 2123566. Note that volume is not adjusted because the Yahoo CSV does not distinguish between share split and dividend adjustments making it near impossible to get volume adjustment right (unless we want to guess based on the size of the adjustment or scrape the html tables, which we don't) - JDH
- 2010-06-06 Updated dateutil to 1.5 and pytz to 2010h.
- 2010-06-02 Add error\_kw kwarg to Axes.bar(). - EF
- 2010-06-01 Fix pcolormesh() and QuadMesh to pass on kwargs as** appropriate. - RM
- 2010-05-18 Merge mpl\_toolkits.gridspec into the main tree. - JJJ
- 2010-05-04 Improve backend\_qt4 so it displays figures with the** correct size - DSD
- 2010-04-20 Added generic support for connecting to a timer for events. This** adds TimerBase, TimerGTK, TimerQT, TimerWx, and TimerTk to the backends and a new\_timer() method to each backend's canvas to allow ease of creating a new timer. - RM
- 2010-04-20 Added margins() Axes method and pyplot function. - EF
- 2010-04-18 update the axes\_grid documentation. -JJL

- 2010-04-18 Control MaxNLocator parameters after instantiation**, and via  
 Axes.locator\_params method, with corresponding pyplot function. -EF
- 2010-04-18 Control ScalarFormatter offsets directly and via the**  
 Axes.ticklabel\_format() method, and add that to pyplot. -EF
- 2010-04-16 Add a close\_event to the backends. -RM
- 2010-04-06 modify axes\_grid examples to use axes\_grid1 and axisartist. -JLL
- 2010-04-06 rebase axes\_grid using axes\_grid1 and axisartist modules. -JLL
- 2010-04-06 axes\_grid toolkit is splitted into two separate modules**, axes\_grid1 and  
 axisartist. -JLL
- 2010-04-05 Speed up import: import pytz only if and when it is** needed. It is not  
 needed if the rc timezone is UTC. - EF
- 2010-04-03 Added color kwarg to Axes.hist(), based on work by** Jeff Klukas. - EF
- 2010-03-24 refactor colorbar code so that no cla() is necessary when** mappable is  
 changed. -JLL
- 2010-03-22 fix incorrect rubber band during the zoom mode when mouse** leaves the  
 axes. -JLL
- 2010-03-21 x/y key during the zoom mode only changes the x/y limits. -JLL
- 2010-03-20 Added pyplot.sca() function suggested by JLL. - EF
- 2010-03-20 Added conditional support for new Tooltip API in gtk backend. - EF
- 2010-03-20 Changed plt.fig\_subplot() to plt.subplots() after discussion on** list, and  
 changed its API to return axes as a numpy object array (with control of dimensions via  
 squeeze keyword). FP.
- 2010-03-13 Manually brought in commits from branch:

```

-----
r8191 | leejjoon | 2010-03-13 17:27:57 -0500 (Sat, 13 Mar 2010) | 1 line
fix the bug that handles for scatter are incorrectly set when dpi!=72.
Thanks to Ray Speth for the bug report.
    
```

2010-03-03 Manually brought in commits from branch via diff/patch (svnmerge is broken):

```

-----
r8175 | leejjoon | 2010-03-03 10:03:30 -0800 (Wed, 03 Mar 2010) | 1 line
fix arguments of allow_rasterization.draw_wrapper
-----
r8174 | jdh2358 | 2010-03-03 09:15:58 -0800 (Wed, 03 Mar 2010) | 1 line
added support for favicon in docs build
-----
r8173 | jdh2358 | 2010-03-03 08:56:16 -0800 (Wed, 03 Mar 2010) | 1 line
applied Mattias get_bounds patch
-----
r8172 | jdh2358 | 2010-03-03 08:31:42 -0800 (Wed, 03 Mar 2010) | 1 line
    
```

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```
fix svnmerge download instructions
```

```
-----  
r8171 | jdh2358 | 2010-03-03 07:47:48 -0800 (Wed, 03 Mar 2010) | 1 line
```

2010-02-25 add annotation\_demo3.py that demonstrates new functionality. -JJL

**2010-02-25 refactor Annotation to support arbitrary Transform as xycoords or textcoords.** Also, if a tuple of two coordinates is provided, they are interpreted as coordinates for each x and y position. -JJL

**2010-02-24 Added pyplot.fig\_subplot(), to create a figure and a group of subplots** in a single call. This offers an easier pattern than manually making figures and calling add\_subplot() multiple times. FP

**2010-02-17 Added Gokhan's and Mattias' customizable keybindings patch** for the toolbar. You can now set the keymap.\* properties in the matplotlibrc file. Newbindings were added for toggling log scaling on the x-axis. JDH

**2010-02-16 Committed TJ's filled marker patch** for left|right|bottom|top|full filled markers. See examples/pylab\_examples/filledmarker\_demo.py. JDH

**2010-02-11 Added 'bootstrap' option to boxplot. This allows bootstrap** estimates of median confidence intervals. Based on an initial patch by Paul Hobson. - ADS

**2010-02-06 Added setup.cfg "basedirlist" option to override setting** in setuext.py "basedir" dictionary; added "gnu0" platform requested by Benjamin Drung. - EF

2010-02-06 Added 'xy' scaling option to EllipseCollection. - EF

**2010-02-03 Made plot\_directive use a custom PlotWarning category, so that** warnings can be turned into fatal errors easily if desired. - FP

**2010-01-29 Added draggable method to Legend to allow mouse drag** placement. Thanks Adam Fraser. JDH

**2010-01-25 Fixed a bug reported by Olle Engdegard, when using histograms** with stepfilled and log=True - MM

2010-01-16 Upgraded CXX to 6.1.1 - JDH

**2009-01-16 Don't create minor ticks on top of existing major ticks.** Patch by Neil Crighton. -ADS

**2009-01-16 Ensure three minor ticks always drawn (SF# 2924245). Patch** by Neil Crighton. -ADS

**2010-01-16 Applied patch by Ian Thomas to fix two contouring** problems: now contourf handles interior masked regions, and the boundaries of line and filled contours coincide. - EF

**2009-01-11 The color of legend patch follows the rc parameters** axes.facecolor and axes.edgecolor. -JJL

**2009-01-11 adjustable of Axes can be "box-forced" which allow** sharing axes. -JJL

**2009-01-11 Add add\_click and pop\_click methods in** BlockingContourLabeler. -JJL

2010-01-03 Added rcParams['axes.color\_cycle'] - EF

2010-01-03 Added Pierre's qt4 formlayout editor and toolbar button - JDH

**2009-12-31 Add support for using math text as marker symbols (Thanks to tcb)**

- MGD

2009-12-31 Commit a workaround for a regression in PyQt4-4.6.{0,1} - DSD

2009-12-22 Fix cmap data for gist\_earth\_r, etc. -JJL

**2009-12-20 spines: put spines in data coordinates, add set\_bounds()** call. -ADS

**2009-12-18 Don't limit notch size in boxplot to q1-q3 range, as this** is effectively making the data look better than it is. - ADS

**2009-12-18 mlab.prcntile handles even-length data, such that the median** is the mean of the two middle values. - ADS

2009-12-15 Add raw-image (unsampled) support for the ps backend. - JJL

**2009-12-14 Add patch\_artist kwarg to boxplot, but keep old default.** Convert box-plot\_demo2.py to use the new patch\_artist. - ADS

**2009-12-06 axes\_grid: reimplemented AxisArtist with FloatingAxes support.** Added new examples. - JJL

**2009-12-01 Applied Laurent Dufrechou's patch to improve blitting with** the qt4 backend - DSD

**2009-11-13 The pdf backend now allows changing the contents of** a pdf file's information dictionary via PdfPages.infodict. - JKS

**2009-11-12 font\_manager.py should no longer cause EINTR on Python 2.6** (but will on the 2.5 version of subprocess). Also the fc-list command in that file was fixed so now it should actually find the list of fontconfig fonts. - JKS

**2009-11-10 Single images, and all images in renderers with** option\_image\_nocomposite (i.e. agg, macosx and the svg backend when rcParams['svg.image\_noscale'] is True), are now drawn respecting the zorder relative to other artists. (Note that there may now be inconsistencies across backends when more than one image is drawn at varying zorders, but this change introduces correct behavior for the backends in which it's easy to do so.)

**2009-10-21 Make AutoDateLocator more configurable by adding options** to control the maximum and minimum number of ticks. Also add control of the intervals to be used for ticking. This does not change behavior but opens previously hard-coded behavior to runtime modification'. - RMM

**2009-10-19 Add "path\_effects" support for Text and Patch. See** examples/pylab\_examples/patheffect\_demo.py -JJL

**2009-10-19 Add "use\_clabeltext" option to clabel. If True, clabels** will be created with ClabelText class, which recalculates rotation angle of the label during the drawing time. -JJL

**2009-10-16 Make AutoDateFormatter actually use any specified** timezone setting. This was only working correctly when no timezone was specified. - RMM

2009-09-27 Beginnings of a capability to test the pdf backend. - JKS

**2009-09-27 Add a savefig.extension rparam to control the default** filename extension used by savefig. - JKS

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2009-09-21 Tagged for release 0.99.1

2009-09-20 Fix usetex spacing errors in pdf backend. - JKS

- 2009-09-20 Add Sphinx extension to highlight IPython console sessions**, originally authored (I think) by Michael Droetboom. - FP
- 2009-09-20 Fix off-by-one error in dviread.Tfm, and additionally protect** against exceptions in case a dvi font is missing some metrics. - JKS
- 2009-09-15 Implement draw\_text and draw\_tex method of backend\_base using** the textpath module. Implement draw\_tex method of the svg backend. - JJJ
- 2009-09-15 Don't fail on AFM files containing floating-point bounding boxes - JKS
- 2009-09-13 AxesGrid** [add modified version of colorbar. Add colorbar] location howto. - JJJ
- 2009-09-07 AxesGrid** [implemented axisline style.] Added a demo examples/axes\_grid/demo\_axisline\_style.py- JJJ
- 2009-09-04 Make the textpath class as a separate module** (textpath.py). Add support for mathtext and tex.- JJJ
- 2009-09-01 Added support for Gouraud interpolated triangles.** pcolormesh now accepts shading='gouraud' as an option. - MGD
- 2009-08-29 Added matplotlib.testing package, which contains a Nose** plugin and a decorator that lets tests be marked as KnownFailures - ADS
- 2009-08-20 Added scaled dict to AutoDateFormatter for customized** scales - JDH
- 2009-08-15 Pyplot interface: the current image is now tracked at the** figure and axes level, addressing tracker item 1656374. - EF
- 2009-08-15 Docstrings are now manipulated with decorators defined** in a new module, docstring.py, thanks to Jason Coombs. - EF
- 2009-08-14 Add support for image filtering for agg back end. See the example** demo\_agg\_filter.py. -JJL
- 2009-08-09 AnnotationBbox added. Similar to Annotation, but works with** OffsetBox instead of Text. See the example demo\_annotation\_box.py. -JJL
- 2009-08-07 BboxImage implemented. Two examples, demo\_bboximage.py and** demo\_ribbon\_box.py added. - JJJ
- 2009-08-07 In an effort to simplify the backend API, all clipping rectangles** and paths are now passed in using GraphicsContext objects, even on collections and images. Therefore:

```
draw_path_collection(self, master_transform, cliprect, clippath,
    clippath_trans, paths, all_transforms, offsets, offsetTrans, facecolors,
    edgcolors, linewidths, linestyle, antialiaseds, urls)
```

becomes:

```
draw_path_collection(self, gc, master_transform, paths, all_transforms,
    offsets, offsetTrans, facecolors, edgcolors, linewidths, linestyle, an-
    tialiaseds, urls)
```

```
draw_quad_mesh(self, master_transform, cliprect, clippath,
    clippath_trans, meshWidth, meshHeight, coordinates, offsets, offsetTrans,
    facecolors, antialiased, showedges)
```

becomes:

```
draw_quad_mesh(self, gc, master_transform, meshWidth, meshHeight,
    coordinates, offsets, offsetTrans, facecolors, antialiased, showedges)
```

```
draw_image(self, x, y, im, bbox, clippath=None, clippath_trans=None)
```

becomes:

```
draw_image(self, gc, x, y, im)
```

- MGD

2009-08-06 Tagging the 0.99.0 release at svn r7397 - JDH

- fixed an alpha colormapping bug posted on sf 2832575
- fix typo in axes\_divider.py. use nanmin, nanmax in angle\_helper.py (patch by Christoph Gohlke)
- remove dup gui event in enter/leave events in gtk
- lots of fixes for os x binaries (Thanks Russell Owen)
- attach gtk events to mpl events - fixes sf bug 2816580
- applied sf patch 2815064 (middle button events for wx) and patch 2818092 (resize events for wx)
- fixed boilerplate.py so it doesn't break the ReST docs.
- removed a couple of cases of mlab.load
- fixed rec2csv win32 file handle bug from sf patch 2831018
- added two examples from Josh Hemann: examples/pylab\_examples/barchart\_demo2.py and examples/pylab\_examples/boxplot\_demo2.py
- handled sf bugs 2831556 and 2830525; better bar error messages and backend driver configs
- added miktex win32 patch from sf patch 2820194
- apply sf patches 2830233 and 2823885 for osx setup and 64 bit; thanks Michiel

**2009-08-04 Made cbook.get\_sample\_data make use of the ETag and Last-Modified** headers of mod\_dav\_svn. - JKS

**2009-08-03 Add PathCollection; modify contourf to use complex** paths instead of simple paths with cuts. - EF

2009-08-03 Fixed boilerplate.py so it doesn't break the ReST docs. - JKS

**2009-08-03 pylab no longer provides a load and save function.** These are available in matplotlib.mlab, or you can use numpy.loadtxt and numpy.savetxt for text files, or np.save and np.load for binary numpy arrays. - JDH

**2009-07-31 Added cbook.get\_sample\_data for urllib enabled fetching and** cacheing of data needed for examples. See examples/misc/sample\_data\_demo.py - JDH

2009-07-31 Tagging 0.99.0.rc1 at 7314 - MGD

**2009-07-30 Add set\_cmap and register\_cmap, and improve get\_cmap,** to provide convenient handling of user-generated colormaps. Reorganized \_cm and cm modules. - EF

2009-07-28 Quiver speed improved, thanks to tip by Ray Speth. -EF

2009-07-27 Simplify argument handling code for plot method. -EF

2009-07-25 Allow "plot(1, 2, 'r\*')" to work. - EF

- 2009-07-22 Added an 'interp' keyword to griddata so the faster linear** interpolation method can be chosen. Default is 'nn', so default behavior (using natural neighbor method) is unchanged (JSW)
- 2009-07-22 Improved boilerplate.py so that it generates the correct** signatures for pyplot functions. - JKS
- 2009-07-19 Fixed the docstring of Axes.step to reflect the correct** meaning of the kwargs "pre" and "post" - See SF bug [https://sourceforge.net/tracker/index.php?func=detail&aid=2823304&group\\_id=80706&atid=560720](https://sourceforge.net/tracker/index.php?func=detail&aid=2823304&group_id=80706&atid=560720) - JDH
- 2009-07-18 Fix support for hatches without color fills to pdf and svg** backends. Add an example of that to hatch\_demo.py. - JKS
- 2009-07-17 Removed fossils from swig version of agg backend. - EF
- 2009-07-14 initial submission of the annotation guide. -JJL
- 2009-07-14 axes\_grid** [minor improvements in anchored\_artists and] inset\_locator. -JJL
- 2009-07-14 Fix a few bugs in ConnectionStyle algorithms. Add** ConnectionPatch class. -JJL
- 2009-07-11 Added a fillstyle Line2D property for half filled markers** - see examples/pylab\_examples/fillstyle\_demo.py JDH
- 2009-07-08 Attempt to improve performance of qt4 backend, do not call** QApplication.processEvents while processing an event. Thanks Ole Streicher for tracking this down - DSD
- 2009-06-24 Add withheader option to mlab.rec2csv and changed** use\_mrecords default to False in mlab.csv2rec since this is partially broken - JDH
- 2009-06-24 backend\_agg.draw\_marker quantizes the main path (as in the** draw\_path). - JJL
- 2009-06-24 axes\_grid: floating axis support added. - JJL
- 2009-06-14 Add new command line options to backend\_driver.py to support** running only some directories of tests - JKS
- 2009-06-13 partial cleanup of mlab and its importation in pylab - EF
- 2009-06-13 Introduce a rotation\_mode property for the Text artist. See** examples/pylab\_examples/demo\_text\_rotation\_mode.py -JJL
- 2009-06-07 add support for bz2 files per sf support request 2794556** - JDH
- 2009-06-06 added a properties method to the artist and inspector to** return a dict mapping property name -> value; see sf feature request 2792183 - JDH
- 2009-06-06 added Neil's auto minor tick patch; sf patch #2789713 - JDH
- 2009-06-06 do not apply alpha to rgba color conversion if input is** already rgba - JDH
- 2009-06-03 axes\_grid** [Initial check-in of curvilinear grid support. See] examples/axes\_grid/demo\_curvilinear\_grid.py - JJL
- 2009-06-01 Add set\_color method to Patch - EF
- 2009-06-01 Spine is now derived from Patch - ADS
- 2009-06-01 use cbook.is\_string\_like() instead of isinstance() for spines - ADS
- 2009-06-01 cla() support for spines - ADS

2009-06-01 Removed support for gtk < 2.4. - EF

**2009-05-29 Improved the animation\_blit\_qt4 example, which was a mix** of the object-oriented and pylab interfaces. It is now strictly object-oriented - DSD

2009-05-28 Fix axes\_grid toolkit to work with spine patch by ADS. - JJJ

**2009-05-28 Applied fbianco's patch to handle scroll wheel events in** the qt4 backend - DSD

2009-05-26 Add support for "axis spines" to have arbitrary location. -ADS

**2009-05-20 Add an empty matplotlibrc to the tests/ directory so that running** tests will use the default set of rcparams rather than the user's config. - RMM

**2009-05-19 Axis.grid(): allow use of which='major,minor' to have grid** on major and minor ticks. -ADS

**2009-05-18 Make psd(), csd(), and cohere() wrap properly for complex/two-sided** versions, like specgram() (SF #2791686) - RMM

**2009-05-18 Fix the linespacing bug of multiline text (#1239682). See** examples/pylab\_examples/multiline.py -JJJ

**2009-05-18 Add annotation\_clip attr. for text.Annotation class.** If True, annotation is only drawn when the annotated point is inside the axes area. -JJJ

**2009-05-17 Fix bug(#2749174) that some properties of minor ticks are not** conserved -JJJ

**2009-05-17 applied Michiel's sf patch 2790638 to turn off gtk event** loop in setupext for pygtk>=2.15.10 - JDH

**2009-05-17 applied Michiel's sf patch 2792742 to speed up Cairo and** macosx collections; speedups can be 20x. Also fixes some bugs in which gc got into inconsistent state

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2008-05-17 Release 0.98.5.3 at r7107 from the branch - JDH

**2009-05-13 An optional offset and bbox support in restore\_bbox.** Add animation\_blit\_gtk2.py. -JJJ

**2009-05-13 psfrag in backend\_ps now uses baseline-alignment** when preview.sty is used ((default is bottom-alignment). Also, a small api improvement in OffsetBox -JJJ

**2009-05-13 When the x-coordinate of a line is monotonically** increasing, it is now automatically clipped at the stage of generating the transformed path in the draw method; this greatly speeds up zooming and panning when one is looking at a short segment of a long time series, for example. - EF

2009-05-11 aspect=1 in log-log plot gives square decades. -JJJ

**2009-05-08 clabel takes new kwarg, rightside\_up; if False, labels** will not be flipped to keep them rightside-up. This allows the use of clabel to make streamfunction arrows, as requested by Evan Mason. - EF

**2009-05-07 'labelpad' can now be passed when setting x/y labels.** This allows controlling the spacing between the label and its axis. - RMM

**2009-05-06 print\_ps now uses mixed-mode renderer.** Axes.draw rasterize artists whose zorder smaller than rasterization\_zorder. -JJJ

2009-05-06 Per-artist Rasterization, originally by Eric Bruning. -JJ

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- 2009-05-05 Add an example that shows how to make a plot that updates** using data from another process. Thanks to Robert Cimrman - RMM
- 2009-05-05 Add Axes.get\_legend\_handles\_labels method. - JJJ
- 2009-05-04 Fix bug that Text.Annotation is still drawn while set to** not visible. - JJJ
- 2009-05-04 Added TJ's fill\_betweenx patch - JDH
- 2009-05-02 Added options to plotfile based on question from** Joseph Smidt and patch by Matthias Michler. - EF
- 2009-05-01 Changed add\_artist and similar Axes methods to** return their argument. - EF
- 2009-04-30 Incorrect eps bbox for landscape mode fixed - JJJ
- 2009-04-28 Fixed incorrect bbox of eps output when usetex=True. - JJJ
- 2009-04-24 Changed use of os.open\* to instead use subprocess.Popen.** os.popen\* are deprecated in 2.6 and are removed in 3.0. - RMM
- 2009-04-20 Worked on axes\_grid documentation. Added** axes\_grid.inset\_locator. - JJJ
- 2009-04-17 Initial check-in of the axes\_grid toolkit. - JJJ
- 2009-04-17 Added a support for bbox\_to\_anchor in** offsetbox.AnchoredOffsetbox. Improved a documentation. - JJJ
- 2009-04-16 Fixed a offsetbox bug that multiline texts are not** correctly aligned. - JJJ
- 2009-04-16 Fixed a bug in mixed mode renderer that images produced by** an rasterizing backend are placed with incorrect size. - JJJ
- 2009-04-14 Added Jonathan Taylor's Reinier Heeres' port of John** Porters' mplot3d to svn trunk. Package in mpl\_toolkits.mplot3d and demo is examples/mplot3d/demo.py. Thanks Reiner
- 2009-04-06 The pdf backend now escapes newlines and linefeeds in strings.** Fixes sf bug #2708559; thanks to Tiago Pereira for the report.
- 2009-04-06 texmanager.make\_dvi now raises an error if LaTeX failed to** create an output file. Thanks to Joao Luis Silva for reporting this. - JKS
- 2009-04-05 \_png.read\_png() reads 12 bit PNGs (patch from** Tobias Wood) - ADS
- 2009-04-04 Allow log axis scale to clip non-positive values to** small positive value; this is useful for errorbars. - EF
- 2009-03-28 Make images handle nan in their array argument.** A helper, cbook.safe\_masked\_invalid() was added. - EF
- 2009-03-25 Make contour and contourf handle nan in their Z argument. - EF
- 2009-03-20 Add AuxTransformBox in offsetbox.py to support some** transformation. anchored\_text.py example is enhanced and renamed (anchored\_artists.py). - JJJ
- 2009-03-20 Add "bar" connection style for annotation - JJJ
- 2009-03-17 Fix bugs in edge color handling by contourf, found** by Jae-Joon Lee. - EF
- 2009-03-14 Added 'LightSource' class to colors module for** creating shaded relief maps. shading\_example.py added to illustrate usage. - JSW
- 2009-03-11 Ensure wx version >= 2.8; thanks to Sandro Tosi and** Chris Barker. - EF

- 2009-03-10 Fix join style bug in pdf. - JKS
- 2009-03-07 Add pyplot access to figure number list - EF
- 2009-02-28 hashing of FontProperties accounts current rcParams - JJJ
- 2009-02-28 Prevent double-rendering of shared axis in twinx, twiny - EF
- 2009-02-26 Add optional bbox\_to\_anchor argument for legend class - JJJ
- 2009-02-26 Support image clipping in pdf backend. - JKS
- 2009-02-25 Improve tick location subset choice in FixedLocator. - EF
- 2009-02-24 Deprecate numerix, and strip out all but the numpy** part of the code. - EF
- 2009-02-21 Improve scatter argument handling; add an early error** message, allow inputs to have more than one dimension. - EF
- 2009-02-16 Move plot\_directive.py to the installed source tree. Add** support for in-line code content - MGD
- 2009-02-16 Move mathmpl.py to the installed source tree so it is** available to other projects. - MGD
- 2009-02-14 Added the legend title support - JJJ
- 2009-02-10 Fixed a bug in backend\_pdf so it doesn't break when the setting** pdf.use14corefonts=True is used. Added test case in unit/test\_pdf\_use14corefonts.py. - NGR
- 2009-02-08 Added a new imsave function to image.py and exposed it in** the pyplot interface - GR
- 2009-02-04 Some reorganization of the legend code. anchored\_text.py** added as an example. - JJJ
- 2009-02-04 Add extent keyword arg to hexbin - ADS
- 2009-02-04 Fix bug in mathtext related to dots and ldots - MGD
- 2009-02-03 Change default joinstyle to round - MGD
- 2009-02-02 Reduce number of marker XObjects in pdf output - JKS
- 2009-02-02 Change default resolution on polar plot to 1 - MGD
- 2009-02-02 Avoid malloc errors in ttconv for fonts that don't have** e.g., PostName (a version of Tahoma triggered this) - JKS
- 2009-01-30 Remove support for pyExceclerator in exceltools - use xlwt** instead - JDH
- 2009-01-29 Document 'resolution' kwarg for polar plots. Support it** when using pyplot.polar, not just Figure.add\_axes. - MGD
- 2009-01-29 Rework the nan-handling/clipping/quantizing/simplification** framework so each is an independent part of a pipeline. Expose the C++-implementation of all of this so it can be used from all Python backends. Add rcParam "path.simplify\_threshold" to control the threshold of similarity below which vertices will be removed.
- 2009-01-26 Improved tight bbox option of the savefig. - JJJ
- 2009-01-26 Make curves and NaNs play nice together - MGD
- 2009-01-21 Changed the defaults of acorr and xcorr to use** usevlines=True, maxlags=10 and normed=True since these are the best defaults

- 2009-01-19 Fix bug in quiver argument handling. - EF
- 2009-01-19 Fix bug in backend\_gtk: don't delete nonexistent toolbar. - EF
- 2009-01-16 Implement bbox\_inches option for savefig. If bbox\_inches is "tight", try to determine the tight bounding box.** - JJL
- 2009-01-16 Fix bug in is\_string\_like so it doesn't raise an unnecessary exception.** - EF
- 2009-01-16 Fix an infinite recursion in the unit registry when searching for a converter for a sequence of strings. Add a corresponding test.** - RM
- 2009-01-16 Bugfix of C typedef of MPL\_Int64 that was failing on Windows XP 64 bit, as reported by George Goussard on numpy mailing list.** - ADS
- 2009-01-16 Added helper function LinearSegmentedColormap.from\_list to facilitate building simple custom colormaps.** See examples/pylab\_examples/custom\_cmap\_fromlist.py - JDH
- 2009-01-16 Applied Michiel's patch for macosx backend to fix rounding bug.** Closed sf bug 2508440 - JSW
- 2009-01-10 Applied Michiel's hatch patch for macosx backend and draw\_idle patch for qt.** Closes sf patched 2497785 and 2468809 - JDH
- 2009-01-10 Fix bug in pan/zoom with log coordinates. - EF
- 2009-01-06 Fix bug in setting of dashed negative contours. - EF
- 2009-01-06 Be fault tolerant when len(linestyles)>NLev in contour. - MM
- 2009-01-06 Added marginals kwarg to hexbin to plot marginal densities** JDH
- 2009-01-06 Change user-visible multipage pdf object to PdfPages to avoid accidents with the file-like PdfFile.** - JKS
- 2009-01-05 Fix a bug in pdf usetex: allow using non-embedded fonts. - JKS
- 2009-01-05 optional use of preview.sty in usetex mode. - JJL
- 2009-01-02 Allow multipage pdf files. - JKS
- 2008-12-31 Improve pdf usetex by adding support for font effects (slanting and extending).** - JKS
- 2008-12-29 Fix a bug in pdf usetex support, which occurred if the same Type-1 font was used with different encodings, e.g., with Minion Pro and MnSymbol.** - JKS
- 2008-12-20 fix the dpi-dependent offset of Shadow. - JJL
- 2008-12-20 fix the hatch bug in the pdf backend. minor update** in docs and example - JJL
- 2008-12-19 Add axes\_locator attribute in Axes. Two examples are added.**
- JJL
- 2008-12-19 Update Axes.legend documnetation. /api/api\_changes.rst is also updated to describe chages in keyword parameters. Issue a warning if old keyword parameters are used.** - JJL
- 2008-12-18 add new arrow style, a line + filled triangles. -JJL
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- 2008-12-18 Re-Released 0.98.5.2 from v0\_98\_5\_maint at r6679** Released 0.98.5.2 from v0\_98\_5\_maint at r6667

2008-12-18 Removed configobj, experimental traits and doc/mpl\_data link - JDH

**2008-12-18 Fix bug where a line with NULL data limits prevents** subsequent data limits from calculating correctly - MGD

2008-12-17 Major documentation generator changes - MGD

**2008-12-17 Applied macosx backend patch with support for path** collections, quadmesh, etc... - JDH

**2008-12-17 fix dpi-dependent behavior of text bbox and arrow in annotate** -JJL

**2008-12-17 Add group id support in artist. Two examples which** demonstrate svg filter are added. -JJL

2008-12-16 Another attempt to fix dpi-dependent behavior of Legend. -JJL

2008-12-16 Fixed dpi-dependent behavior of Legend and fancybox in Text.

**2008-12-16 Added markevery property to Line2D to support subsampling** of markers - JDH

**2008-12-15 Removed mpl\_data symlink in docs. On platforms that do not** support symlinks, these become copies, and the font files are large, so the distro becomes unnecessarily bloated. Keeping the mpl\_examples dir because relative links are harder for the plot directive and the \*.py files are not so large. - JDH

**2008-12-15 Fix \$ in non-math text with usetex off. Document** differences between usetex on/off - MGD

2008-12-15 Fix anti-aliasing when auto-snapping - MGD

2008-12-15 Fix grid lines not moving correctly during pan and zoom - MGD

**2008-12-12 Preparations to eliminate maskedarray rcParams key: its** use will now generate a warning. Similarly, importing the obsolete numerix.numpya will generate a warning. - EF

**2008-12-12 Added support for the numpy.histogram() weights parameter** to the axes hist() method. Docs taken from numpy - MM

2008-12-12 Fixed warning in hist() with numpy 1.2 - MM

**2008-12-12 Removed external packages: configobj and enthought.traits** which are only required by the experimental traitled config and are somewhat out of date. If needed, install them independently, see:

<http://code.enthought.com/pages/traits.html>

and:

<http://www.voidspace.org.uk/python/configobj.html>

**2008-12-12 Added support to assign labels to histograms of multiple** data. - MM

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2008-12-11 Released 0.98.5 at svn r6573

**2008-12-11 Use subprocess.Popen instead of os.popen in dviread** (Windows problem reported by Jorgen Stenarson) - JKS

**2008-12-10 Added Michael's font\_manager fix and Jae-Joon's** figure/subplot fix. Bumped version number to 0.98.5 - JDH

2008-12-09 Released 0.98.4 at svn r6536

2008-12-08 Added mdehoun's native macosx backend from sf patch 2179017 - JDH

**2008-12-08 Removed the prints in the set\_\*style commands. Return the list** of pprinted strings instead - JDH

**2008-12-08 Some of the changes Michael made to improve the output of the** prop-erty tables in the rest docs broke of made difficult to use some of the interactive doc helpers, e.g., setp and getp. Having all the rest markup in the ipython shell also confused the docstrings. I added a new rc param docstring.harcopy, to format the docstrings differently for hardcopy and other use. Ther ArtistInspector could use a little refactoring now since there is duplication of effort between the rest out put and the non-rest output - JDH

**2008-12-08 Updated spectral methods (psd, csd, etc.) to scale one-sided** densities by a factor of 2 and, optionally, scale all densities by the sampling frequency. This gives better MatLab compatibility. -RM

2008-12-08 Fixed alignment of ticks in colorbars. -MGD

**2008-12-07 drop the deprecated "new" keyword of np.histogram() for numpy 1.2 or** later. -JLL

**2008-12-06 Fixed a bug in svg backend that new\_figure\_manager() ignores keywords** arguments such as figsize, etc. -JLL

**2008-12-05 Fixed a bug that the handlelength of the new legend class set too short** when numpoints=1 -JLL

**2008-12-04 Added support for data with units (e.g., dates) to Axes.fill\_between.** -RM

**2008-12-04 Added fancybox keyword to legend. Also applied some changes for bet-**ter look, including baseline adjustment of the multiline texts so that it is center aligned. -JLL

**2008-12-02 The transmuter classes in the patches.py are reorganized as** subclasses of the Style classes. A few more box and arrow styles are added. -JLL

**2008-12-02 Fixed a bug in the new legend class that didn't allowed** a tuple of coordi-nate vlaues as loc. -JLL

**2008-12-02 Improve checks for external dependencies, using subprocess** (instead of deprecated popen\*) and distutils (for version checking) - DSD

**2008-11-30 Reimplementation of the legend which supports baseline alignment,** multi-column, and expand mode. - JLL

**2008-12-01 Fixed histogram autoscaling bug when bins or range are given** explicitly (fixes Debian bug 503148) - MM

**2008-11-25 Added rcParam axes.unicode\_minus which allows plain hypen** for minus when False - JDH

**2008-11-25 Added scatterpoints support in Legend. patch by Erik Tollerud** - JLL

2008-11-24 Fix crash in log ticking. - MGD

**2008-11-20 Added static helper method BrokenHBarCollection.span\_where** and Axes/pyplot method fill\_between. See examples/pylab/fill\_between.py - JDH

- 2008-11-12 Add `x_isdata` and `y_isdata` attributes to Artist instances**, and use them to determine whether either or both coordinates are used when updating `dataLim`. This is used to fix autoscaling problems that had been triggered by `axhline`, `axhspan`, `axvline`, `axvspan`. - EF
- 2008-11-11 Update the `psd()`, `csd()`, `cohere()`, and `specgram()` methods** of Axes and the `csd()`, `cohere()`, and `specgram()` functions in `mlab` to be in sync with the changes to `psd()`. In fact, under the hood, these all call the same core to do computations. - RM
- 2008-11-11 Add `'pad_to'` and `'sides'` parameters to `mlab.psd()`** to allow controlling of zero padding and returning of negative frequency components, respectively. These are added in a way that does not change the API. - RM
- 2008-11-10 Fix handling of `c` kwarg by `scatter`; generalize `is_string_like`** to accept `numpy` and `numpy.ma` string array scalars. - RM and EF
- 2008-11-09 Fix a possible EINTR problem in `dviread`, which might help** when saving pdf files from the qt backend. - JKS
- 2008-11-05 Fix bug with zoom to rectangle and twin axes - MGD
- 2008-10-24 Added Jae Joon's fancy arrow, box and annotation** enhancements - see `examples/pylab_examples/annotation_demo2.py`
- 2008-10-23 Autoscaling is now supported with shared axes - EF
- 2008-10-23 Fixed exception in `dviread` that happened with Minion - JKS
- 2008-10-21 `set_xlim`, `ylim` now return a copy of the `viewlim` array** to avoid modify in-place surprises
- 2008-10-20 Added image thumbnail generating function** `matplotlib.image.thumbnail`. See `examples/misc/image_thumbnail.py` - JDH
- 2008-10-20 Applied `scatleg` patch based on ideas and work by Erik Tollerud** and Jae-Joon Lee. - MM
- 2008-10-11 Fixed bug in pdf backend: if you pass a file object** for output instead of a filename, e.g., in a web app, we now flush the object at the end. - JKS
- 2008-10-08 Add path simplification support to paths with gaps. - EF
- 2008-10-05 Fix problem with AFM files that don't specify the font's** full name or family name. - JKS
- 2008-10-04 Added `'scilimits'` kwarg to `Axes.ticklabel_format()` method**, for easy access to the `set_powerlimits` method of the major `ScalarFormatter`. - EF
- 2008-10-04 Experimental new kwarg `borderpad` to replace `pad` in `legend`**, based on suggestion by Jae-Joon Lee. - EF
- 2008-09-27 Allow `spy` to ignore zero values in sparse arrays**, based on patch by Tony Yu. Also fixed plot to handle empty data arrays, and fixed handling of markers in `figlegend`. - EF
- 2008-09-24 Introduce `drawstyles` for lines. Transparently split `linestyles`** like `'steps-` into `drawstyle 'steps'` and `linestyle '-'`. Legends always use `drawstyle 'default'`. - MM
- 2008-09-18 Fixed `quiver` and `quiverkey` bugs (failure to scale properly** when resizing) and added additional methods for determining the arrow angles - EF
- 2008-09-18 Fix polar interpolation to handle negative values of `theta` - MGD

**2008-09-14 Reorganized cbook and mlab methods related to numerical** calculations that have little to do with the goals of those two modules into a separate module `numerical_methods.py`. Also, added ability to select points and stop point selection with keyboard in `ginput` and manual contour labeling code. Finally, fixed contour labeling bug. - DMK

2008-09-11 Fix backtick in Postscript output. - MGD

**2008-09-10 [ 2089958 ] Path simplification for vector output backends** Leverage the simplification code exposed through `path_to_polygons` to simplify certain well-behaved paths in the vector backends (PDF, PS and SVG). `"path.simplify"` must be set to `True` in `matplotlibrc` for this to work. - MGD

**2008-09-10 Add "filled" kwarg to Path.intersects\_path and Path.intersects\_bbox.** - MGD

**2008-09-07 Changed full arrows slightly to avoid an xpdf rendering** problem reported by Friedrich Hagedorn. - JKS

**2008-09-07 Fix conversion of quadratic to cubic Bezier curves in PDF and PS** backends. Patch by Jae-Joon Lee. - JKS

2008-09-06 Added 5-point star marker to plot command - EF

2008-09-05 Fix hatching in PS backend - MGD

2008-09-03 Fix log with base 2 - MGD

**2008-09-01 Added support for bilinear interpolation in NonUniformImage;** patch by Gregory Lielens. - EF

**2008-08-28 Added support for multiple histograms with data of** different length - MM

2008-08-28 Fix step plots with log scale - MGD

2008-08-28 Fix masked arrays with markers in non-Agg backends - MGD

2008-08-28 Fix `clip_on` kwarg so it actually works correctly - MGD

2008-08-25 Fix locale problems in SVG backend - MGD

2008-08-22 fix quiver so masked values are not plotted - JSW

2008-08-18 improve interactive pan/zoom in qt4 backend on windows - DSD

**2008-08-11 Fix more bugs in NaN/inf handling. In particular, path simplification** (which does not handle NaNs or infs) will be turned off automatically when infs or NaNs are present. Also masked arrays are now converted to arrays with NaNs for consistent handling of masks and NaNs - MGD and EF

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2008-08-03 Released 0.98.3 at svn r5947

2008-08-01 Backported memory leak fixes in `_ttconv.cpp` - MGD

2008-07-31 Added masked array support to `griddata`. - JSW

**2008-07-26 Added optional C and reduce\_C function arguments to** `axes.hexbin()`. This allows `hexbin` to accumulate the values of `C` based on the `x,y` coordinates and display in hexagonal bins. - ADS

**2008-07-24 Deprecated (raise NotImplementedError) all the mlab2** functions from `matplotlib.mlab` out of concern that some of them were not clean room implementations. JDH

- 2008-07-24 Rewrite of a significant portion of the clabel code (class ContourLabeler) to improve inlining.** - DMK
- 2008-07-22 Added Barbs polygon collection (similar to Quiver) for plotting** wind barbs. Added corresponding helpers to Axes and pyplot as well. (examples/pylab\_examples/barb\_demo.py shows it off.) - RMM
- 2008-07-21 Added scikits.delaunay as matplotlib.delaunay. Added griddata** function in matplotlib.mlab, with example (griddata\_demo.py) in pylab\_examples. griddata function will use mpl\_toolkits.\_natgrid if installed. - JSW
- 2008-07-21 Re-introduced offset\_copy that works in the context of the new** transforms. - MGD
- 2008-07-21 Committed patch by Ryan May to add get\_offsets and set\_offsets** to Collections base class - EF
- 2008-07-21 Changed the "asarray" strategy in image.py so that colormapping** of masked input should work for all image types (thanks Klaus Zimmerman) - EF
- 2008-07-20 Rewrote cbook.delete\_masked\_points and corresponding** unit test to support rgb color array inputs, datetime inputs, etc. - EF
- 2008-07-20 Renamed unit/axes\_unit.py to cbook\_unit.py and modified** in accord with Ryan's move of delete\_masked\_points from axes to cbook. - EF
- 2008-07-18 Check for nan and inf in axes.delete\_masked\_points().** This should help hexbin and scatter deal with nans. - ADS
- 2008-07-17 Added ability to manually select contour label locations.** Also added a waitforbuttonpress function. - DMK
- 2008-07-17 Fix bug with NaNs at end of path (thanks, Andrew Straw for the report)** - MGD
- 2008-07-16 Improve error handling in texmanager, thanks to Ian Henry for** reporting - DSD
- 2008-07-12 Added support for external backends with the "module://my\_backend"** syntax - JDH
- 2008-07-11 Fix memory leak related to shared axes. Grouper should** store weak references. - MGD
- 2008-07-10 Bugfix: crash displaying fontconfig pattern - MGD
- 2008-07-10 Bugfix: [ 2013963 ] update\_datalim\_bounds in Axes not works - MGD
- 2008-07-10 Bugfix: [ 2014183 ] multiple imshow() causes gray edges - MGD
- 2008-07-09 Fix rectangular axes patch on polar plots bug - MGD
- 2008-07-09 Improve mathtext radical rendering - MGD
- 2008-07-08 Improve mathtext superscript placement - MGD
- 2008-07-07 Fix custom scales in pcolormesh (thanks Matthew Turk) - MGD
- 2008-07-03 Implemented findobj method for artist and pyplot - see** examples/pylab\_examples/findobj\_demo.py - JDH
- 2008-06-30 Another attempt to fix TextWithDash - DSD
- 2008-06-30 Removed Qt4 NavigationToolbar2.destroy - it appears to** have been unnecessary and caused a bug reported by P. Raybaut - DSD

2008-06-27 Fixed tick positioning bug - MM

**2008-06-27 Fix dashed text bug where text was at the wrong end of the dash** - MGD

2008-06-26 Fix mathtext bug for expressions like  $x_{\leftarrow}$  - MGD

2008-06-26 Fix direction of horizontal/vertical hatches - MGD

**2008-06-25 Figure.figurePatch renamed Figure.patch, Axes.axesPatch renamed Axes.patch, Axes.axesFrame renamed Axes.frame, Axes.get\_frame, which returns Axes.patch, is deprecated. Examples and users guide updated** - JDH

2008-06-25 Fix rendering quality of pcolor - MGD

2008-06-24 Released 0.98.2 at svn r5667 - (source only for debian) JDH

2008-06-24 Added "transparent" kwarg to savefig. - MGD

**2008-06-24 Applied Stefan's patch to draw a single centered marker over a line with numpoints==1** - JDH

2008-06-23 Use splines to render circles in scatter plots - MGD

2008-06-22 Released 0.98.1 at revision 5637

**2008-06-22 Removed axes3d support and replaced it with a NotImplementedError** for one release cycle

2008-06-21 fix marker placement bug in backend\_ps - DSD

2008-06-20 [ 1978629 ] scale documentation missing/incorrect for log - MGD

**2008-06-20 Added closed kwarg to PolyCollection. Fixes bug [ 1994535 ]** still missing lines on graph with svn (r 5548). - MGD

**2008-06-20 Added set/get\_closed method to Polygon; fixes error** in hist - MM

**2008-06-19 Use relative font sizes (e.g., 'medium' and 'large') in rcsetup.py** and matplotlibrc.template so that text will be scaled by default when changing rcParams['font.size'] - EF

**2008-06-17 Add a generic PatchCollection class that can contain any kind of patch.** - MGD

**2008-06-13 Change pie chart label alignment to avoid having labels** overwrite the pie - MGD

**2008-06-12 Added some helper functions to the mathtext parser** to return bitmap arrays or write pngs to make it easier to use mathtext outside the context of an mpl figure. modified the mathpng sphinxext to use the mathtext png save functionality - see examples/api/mathtext\_asarray.py - JDH

**2008-06-11 Use matplotlib.mathtext to render math expressions in** online docs - MGD

**2008-06-11 Move PNG loading/saving to its own extension module, and** remove duplicate code in \_backend\_agg.cpp and \_image.cpp that does the same thing - MGD

**2008-06-11 Numerous mathtext bugfixes, primarily related to** dpi-independence - MGD

- 2008-06-10 Bar now applies the label only to the first patch only, and sets `'_nolegend_'` for the other patch labels.** This lets autolegend work as expected for hist and bar - see [https://sourceforge.net/tracker/index.php?func=detail&aid=1986597&group\\_id=80706&atid=560720](https://sourceforge.net/tracker/index.php?func=detail&aid=1986597&group_id=80706&atid=560720) JDH
- 2008-06-10 Fix text baseline alignment bug. [ 1985420 ] Repair of baseline alignment** in `Text._get_layout`. Thanks Stan West - MGD
- 2008-06-09 Committed Gregor's image resample patch to downsampling** images with new `rcparam` `image.resample` - JDH
- 2008-06-09 Don't install Enthought.Traits along with matplotlib.** For matplotlib developers convenience, it can still be installed by setting an option in `setup.cfg` while we figure decide if there is a future for the traited config - DSD
- 2008-06-09 Added range keyword arg to `hist()` - MM
- 2008-06-07 Moved list of backends to `rcsetup.py`; made use of lower case** for backend names consistent; use `validate_backend` when importing backends subpackage - EF
- 2008-06-06 `hist()` revision, applied ideas proposed by Erik Tollerud and Olle Engdegard:** make `histtype='step'` unfilled by default and introduce `histtype='stepfilled'`; use default color cycle; introduce reverse cumulative histogram; new align keyword - MM
- 2008-06-06 Fix closed polygon patch and also provide the option to not close the polygon** - MGD
- 2008-06-05 Fix some dpi-changing-related problems with PolyCollection,** as called by `Axes.scatter()` - MGD
- 2008-06-05 Fix image drawing so there is no extra space to the right or bottom** - MGD
- 2006-06-04 Added a figure title command `suptitle` as a Figure method** and `pyplot` command - see `examples/figure_title.py` - JDH
- 2008-06-02 Added support for log to hist with `histtype='step'` and fixed** a bug for log-scale stacked histograms - MM

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2008-05-29 Released 0.98.0 at revision 5314

- 2008-05-29 `matplotlib.image.imread` now no longer always returns RGBA** - if the image is luminance or RGB, it will return a `MxN` or `MxNx3` array if possible. Also `uint8` is no longer always forced to float.
- 2008-05-29 Implement path clipping in PS backend - JDH
- 2008-05-29 Fixed two bugs in `texmanager.py`:** improved comparison of `dvipng` versions fixed a bug introduced when `get_grey` method was added - DSD
- 2008-05-28 Fix crashing of PDFs in `xpdf` and `ghostscript` when two-byte** characters are used with Type 3 fonts - MGD
- 2008-05-28 Allow keyword args to configure widget properties as requested** in [http://sourceforge.net/tracker/index.php?func=detail&aid=1866207&group\\_id=80706&atid=560722](http://sourceforge.net/tracker/index.php?func=detail&aid=1866207&group_id=80706&atid=560722) - JDH
- 2008-05-28 Replaced `'-'` with `u'u2212'` for minus sign as requested in** [http://sourceforge.net/tracker/index.php?func=detail&aid=1962574&group\\_id=80706&atid=560720](http://sourceforge.net/tracker/index.php?func=detail&aid=1962574&group_id=80706&atid=560720)

- 2008-05-28 zero width/height Rectangles no longer influence the autoscaler.** Useful for log histograms with empty bins - JDH
- 2008-05-28 Fix rendering of composite glyphs in Type 3 conversion** (particularly as evidenced in the Eunjin.ttf Korean font) Thanks Jae-Joon Lee for finding this!
- 2008-05-27 Rewrote the cm.ScalarMappable callback infrastructure to** use cbook.CallbackRegistry rather than custom callback handling. Amy users of add\_observer/notify of the cm.ScalarMappable should use the cm.ScalarMappable.callbacksSM CallbackRegistry instead. JDH
- 2008-05-27 Fix TkAgg build on Ubuntu 8.04 (and hopefully a more general solution** for other platforms, too.)
- 2008-05-24 Added PIL support for loading images to imread (if PIL is available)** - JDH
- 2008-05-23 Provided a function and a method for controlling the plot color cycle.** - EF
- 2008-05-23 Major revision of hist(). Can handle 2D arrays and create** stacked histogram plots; keyword 'width' deprecated and rwidth (relative width) introduced; align='edge' changed to center of bin - MM
- 2008-05-22 Added support for ReST-based documentation using Sphinx.** Documents are located in doc/, and are broken up into a users guide and an API reference. To build, run the make.py files. Sphinx-0.4 is needed to build generate xml, which will be useful for rendering equations with mathml, use sphinx from svn until 0.4 is released - DSD
- 2008-05-21 Fix segfault in TkAgg backend - MGD
- 2008-05-21 Fix a "local variable unreferenced" bug in plotfile - MM
- 2008-05-19 Fix crash when Windows can not access the registry to** determine font path [Bug 1966974, thanks Patrik Simons] - MGD
- 2008-05-16 removed some unneeded code w/ the python 2.4 requirement.** cbook no longer provides compatibility for reversed, enumerate, set or izip. removed lib/subprocess, mpl1, sandbox/units, and the swig code. This stuff should remain on the maintenance branch for archival purposes. JDH
- 2008-05-16 Reorganized examples dir - JDH
- 2008-05-16 Added 'elinewidth' keyword arg to errorbar, based on patch** by Christopher Brown - MM
- 2008-05-16 Added 'cumulative' keyword arg to hist to plot cumulative** histograms. For normed hists, this is normalized to one - MM
- 2008-05-15 Fix Tk backend segfault on some machines - MGD
- 2008-05-14 Don't use stat on Windows (fixes font embedding problem) - MGD
- 2008-05-09 Fix /singlequote (') in Postscript backend - MGD
- 2008-05-08 Fix kerning in SVG when embedding character outlines - MGD
- 2008-05-07 Switched to future numpy histogram semantic in hist - MM
- 2008-05-06 Fix strange colors when blitting in QtAgg and Qt4Agg - MGD
- 2008-05-05 pass notify\_axes\_change to the figure's add\_axobserver** in the qt backends, like we do for the other backends. Thanks Glenn Jones for the report - DSD
- 2008-05-02 Added step histograms, based on patch by Erik Tollerud. - MM

- 2008-05-02 On PyQt <= 3.14 there is no way to determine the underlying Qt version.** [1851364] - MGD
- 2008-05-02 Don't call sys.exit() when pyemf is not found [1924199]** - MGD
- 2008-05-02 Update \_subprocess.c from upstream Python 2.5.2 to get a few memory and reference-counting-related bugfixes.** See bug 1949978. - MGD
- 2008-04-30 Added some record array editing widgets for gtk - see examples/rec\_edit\*.py** - JDH
- 2008-04-29 Fix bug in mlab.sqrtm - MM
- 2008-04-28 Fix bug in SVG text with Mozilla-based viewers (the symbol tag is not supported)** - MGD
- 2008-04-27 Applied patch by Michiel de Hoon to add hexbin axes method and pyplot function** - EF
- 2008-04-25 Enforce python >= 2.4; remove subprocess build - EF
- 2008-04-25 Enforce the numpy requirement at build time - JDH
- 2008-04-24 Make numpy 1.1 and python 2.3 required when importing matplotlib** - EF
- 2008-04-24 Fix compilation issues on VS2003 (Thanks Martin Spacek for all the help)** - MGD
- 2008-04-24 Fix sub/superscripts when the size of the font has been changed** - MGD
- 2008-04-22 Use "svg.embed\_char\_paths" consistently everywhere - MGD
- 2008-04-20 Add support to MaxNLocator for symmetric axis autoscaling. - EF
- 2008-04-20 Fix double-zoom bug. - MM
- 2008-04-15 Speed up color mapping. - EF
- 2008-04-12 Speed up zooming and panning of dense images. - EF
- 2008-04-11 Fix global font rcParam setting after initialization time.** - MGD
- 2008-04-11 Revert commits 5002 and 5031, which were intended to** avoid an unnecessary call to draw(). 5002 broke saving figures before show(). 5031 fixed the problem created in 5002, but broke interactive plotting. Unnecessary call to draw still needs resolution - DSD
- 2008-04-07 Improve color validation in rc handling, suggested** by Lev Givon - EF
- 2008-04-02 Allow to use both linestyle definition arguments, '-' and 'solid' etc.** in plots/collections - MM
- 2008-03-27 Fix saving to Unicode filenames with Agg backend** (other backends appear to already work...) (Thanks, Christopher Barker) - MGD
- 2008-03-26 Fix SVG backend bug that prevents copying and pasting in Inkscape** (thanks Kaushik Ghose) - MGD
- 2008-03-24 Removed an unnecessary call to draw() in the backend\_qt\*** mouseReleaseEvent. Thanks to Ted Drain - DSD
- 2008-03-23 Fix a pdf backend bug which sometimes caused the outermost gsave to** not be balanced with a grestore. - JKS

- 2008-03-20 Fixed a minor bug in ContourSet.\_process\_linestyles when**  
len(linestyles)==Nlev - MM
- 2008-03-19 Changed ma import statements to "from numpy import ma";** this should work with past and future versions of numpy, whereas "import numpy.ma as ma" will work only with numpy >= 1.05, and "import numerix.npyma as ma" is obsolete now that maskedarray is replacing the earlier implementation, as of numpy 1.05.
- 2008-03-14 Removed an apparently unnecessary call to** FigureCanvasAgg.draw in backend\_qt\*agg. Thanks to Ted Drain - DSD
- 2008-03-10 Workaround a bug in backend\_qt4agg's blitting due to a** buffer width/bbox width mismatch in \_backend\_agg's copy\_from\_bbox - DSD
- 2008-02-29 Fix class Wx toolbar pan and zoom functions (Thanks Jeff Peery)** - MGD
- 2008-02-16 Added some new rec array functionality to mlab** (rec\_summarize, rec2txt and rec\_groupby). See examples/rec\_groupby\_demo.py. Thanks to Tim M for rec2txt.
- 2008-02-12 Applied Erik Tollerud's span selector patch - JDH
- 2008-02-11 Update plotting() doc string to refer to getp/setp. - JKS
- 2008-02-10 Fixed a problem with square roots in the pdf backend with** usetex. - JKS
- 2008-02-08 Fixed minor \_\_str\_\_ bugs so getp(gca()) works. - JKS
- 2008-02-05 Added getters for title, xlabel, ylabel, as requested** by Brandon Kieth - EF
- 2008-02-05 Applied Gael's ginput patch and created** examples/gininput\_demo.py - JDH
- 2008-02-03 Expose interpnames, a list of valid interpolation** methods, as an AxesImage class attribute. - EF
- 2008-02-03 Added BoundaryNorm, with examples in colorbar\_only.py and** image\_masked.py. - EF
- 2008-02-03 Force dpi=72 in pdf backend to fix picture size bug. - JKS
- 2008-02-01 Fix doubly-included font problem in Postscript backend - MGD
- 2008-02-01 Fix reference leak in ft2font Glyph objects. - MGD
- 2008-01-31 Don't use unicode strings with usetex by default - DSD
- 2008-01-31 Fix text spacing problems in PDF backend with some fonts,** such as STIXGeneral.
- 2008-01-31 Fix sqrt with radical number (broken by making [ and ]** work below) - MGD
- 2008-01-27 Applied Martin Teichmann's patch to improve the Qt4** backend. Uses Qt's builtin toolbars and statusbars. See bug 1828848 - DSD
- 2008-01-10 Moved toolkits to mpl\_toolkits, made mpl\_toolkits** a namespace package - JSWHIT
- 2008-01-10 Use setup.cfg to set the default parameters (tkagg,** numpy) when building windows installers - DSD
- 2008-01-10 Fix bug displaying [ and ] in mathtext - MGD
- 2008-01-10 Fix bug when displaying a tick value offset with scientific** notation. (Manifests itself as a warning that the times symbol can not be found). - MGD

**2008-01-10 Use setup.cfg to set the default parameters (tkagg, numpy) when building windows installers** - DSD

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2008-01-06 Released 0.91.2 at revision 4802

**2007-12-26 Reduce too-late use of matplotlib.use() to a warning** instead of an exception, for backwards compatibility - EF

2007-12-25 Fix bug in errorbar, identified by Noriko Minakawa - EF

**2007-12-25 Changed masked array importing to work with the upcoming** numpy 1.05 (now the maskedarray branch) as well as with earlier versions. - EF

**2007-12-16 rec2csv saves doubles without losing precision. Also, it does not close** filehandles passed in open. - JDH,ADS

**2007-12-13 Moved rec2gtk to matplotlib.toolkits.gtktools and rec2excel to** matplotlib.toolkits.exceltools - JDH

**2007-12-12 Support alpha-blended text in the Agg and Svg backends** - MGD

2007-12-10 Fix SVG text rendering bug. - MGD

**2007-12-10 Increase accuracy of circle and ellipse drawing by using an** 8-piece bezier approximation, rather than a 4-piece one. Fix PDF, SVG and Cairo backends so they can draw paths (meaning ellipses as well). - MGD

2007-12-07 Issue a warning when drawing an image on a non-linear axis. - MGD

**2007-12-06 let widgets.Cursor initialize to the lower x and y bounds** rather than 0,0, which can cause havoc for dates and other transforms - DSD

2007-12-06 updated references to mpl data directories for py2exe - DSD

2007-12-06 fixed a bug in rcsetup, see bug 1845057 - DSD

**2007-12-05 Fix how fonts are cached to avoid loading the same one multiple times.** (This was a regression since 0.90 caused by the refactoring of font\_manager.py) - MGD

2007-12-05 Support arbitrary rotation of usetex text in Agg backend. - MGD

2007-12-04 Support '|' as a character in mathtext - MGD

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2007-11-27 Released 0.91.1 at revision 4517

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2007-11-27 Released 0.91.0 at revision 4478

**2007-11-13 All backends now support writing to a file-like object, not** just a regular file. savefig() can be passed a file-like object in place of a file path. - MGD

**2007-11-13 Improved the default backend selection at build time:** SVG -> Agg -> TkAgg -> WXAgg -> GTK -> GTKAgg. The last usable backend in this progression will be chosen in the default config file. If a backend is defined in setup.cfg, that will be the default backend - DSD

**2007-11-13 Improved creation of default config files at build time for** traitled config package - DSD

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**2007-11-12 Exposed all the build options in setup.cfg. These options are** read into a dict called "options" by setupext.py. Also, added "-mpl" tags to the version strings for packages provided by matplotlib. Versions provided by mpl will be identified and updated on subsequent installs - DSD

**2007-11-12 Added support for STIX fonts. A new rcParam, mathtext.fontset,** can be used to choose between:

**'cm'**: The TeX/LaTeX Computer Modern fonts

**'stix'**: The STIX fonts (see stixfonts.org)

**'stixsans'**: The STIX fonts, using sans-serif glyphs by default

**'custom'**: A generic Unicode font, in which case the mathtext font must be specified using mathtext.bf, mathtext.it, mathtext.sf etc.

Added a new example, stix\_fonts\_demo.py to show how to access different fonts and unusual symbols.

- MGD

**2007-11-12 Options to disable building backend extension modules moved** from setup.py to setup.cfg - DSD

**2007-11-09 Applied Martin Teichmann's patch 1828813: a QPainter is used in** paintEvent, which has to be destroyed using the method end(). If matplotlib raises an exception before the call to end - and it does if you feed it with bad data - this method end() is never called and Qt4 will start spitting error messages

**2007-11-09 Moved pyparsing back into matplotlib namespace. Don't use** system pyparsing, API is too variable from one release to the next - DSD

**2007-11-08 Made pylab use straight numpy instead of oldnumeric** by default - EF

**2007-11-08 Added additional record array utilities to mlab (rec2excel,** rec2gtk, rec\_join, rec\_append\_field, rec\_drop\_field) - JDH

2007-11-08 Updated pytz to version 2007g - DSD

2007-11-08 Updated pyparsing to version 1.4.8 - DSD

**2007-11-08 Moved csv2rec to recutils and added other record array** utilities - JDH

2007-11-08 If available, use existing pyparsing installation - DSD

**2007-11-07 Removed old enthought.traits from lib/matplotlib, added** Gael Varoquaux's enthought.traits-2.6b1, which is stripped of setup tools. The package is installed to site-packages if not already available - DSD

**2007-11-05 Added easy access to minor tick properties; slight mod** of patch by Pierre G-M - EF

**2007-11-02 Committed Phil Thompson's patch 1599876, fixes to Qt4Agg** backend and qt4 blitting demo - DSD

**2007-11-02 Committed Phil Thompson's patch 1599876, fixes to Qt4Agg** backend and qt4 blitting demo - DSD

**2007-10-31 Made log color scale easier to use with contourf;** automatic level generation now works. - EF

2007-10-29 TRANSFORMS REFACTORING

The primary goal of this refactoring was to make it easier to extend matplotlib to support new kinds of projections. This is primarily an internal improvement, and the possible user-visible changes it allows are yet to come.

The transformation framework was completely rewritten in Python (with Numpy). This will make it easier to add news kinds of transformations without writing C/C++ code.

Transforms are composed into a 'transform tree', made of transforms whose value depends on other transforms (their children). When the contents of children change, their parents are automatically updated to reflect those changes. To do this an "invalidation" method is used: when children change, all of their ancestors are marked as "invalid". When the value of a transform is accessed at a later time, its value is recomputed only if it is invalid, otherwise a cached value may be used. This prevents unnecessary recomputations of transforms, and contributes to better interactive performance.

The framework can be used for both affine and non-affine transformations. However, for speed, we want use the backend renderers to perform affine transformations whenever possible. Therefore, it is possible to perform just the affine or non-affine part of a transformation on a set of data. The affine is always assumed to occur after the non-affine. For any transform:

full transform == non-affine + affine

Much of the drawing has been refactored in terms of compound paths. Therefore, many methods have been removed from the backend interface and replaced with a handful to draw compound paths. This will make updating the backends easier, since there is less to update. It also should make the backends more consistent in terms of functionality.

User visible changes:

- POLAR PLOTS: Polar plots are now interactively zoomable, and the r-axis labels can be interactively rotated. Straight line segments are now interpolated to follow the curve of the r-axis.
- Non-rectangular clipping works in more backends and with more types of objects.
- Sharing an axis across figures is now done in exactly the same way as sharing an axis between two axes in the same figure:

```
fig1 = figure()
fig2 = figure()

ax1 = fig1.add_subplot(111)
ax2 = fig2.add_subplot(111, sharex=ax1, sharey=ax1)
```

- linestyle now include steps-pre, steps-post and steps-mid. The old step still works and is equivalent to step-pre.
- Multiple line styles may be provided to a collection.

See API\_CHANGES for more low-level information about this refactoring.

2007-10-24 Added ax kwarg to Figure.colorbar and pyplot.colorbar - EF

**2007-10-19 Removed a gsave/grestore pair surrounding `_draw_ps`, which** was causing a loss graphics state info (see "EPS output problem - scatter & edgecolors" on mpl-dev, 2007-10-29) - DSD

- 2007-10-15 Fixed a bug in patches.Ellipse that was broken for** `aspect='auto'`. Scale free ellipses now work properly for equal and auto on Agg and PS, and they fall back on a polygonal approximation for nonlinear transformations until we convince ourselves that the spline approximation holds for nonlinear transformations. Added `unit/ellipse_compare.py` to compare spline with vertex approx for both aspects. JDH
- 2007-10-05 remove generator expressions from texmanager and mpltraits.** generator expressions are not supported by python-2.3 - DSD
- 2007-10-01 Made matplotlib.use() raise an exception if called after** backends has been imported. - EF
- 2007-09-30 Modified update\* methods of Bbox and Interval so they work** with reversed axes. Prior to this, trying to set the ticks on a reversed axis failed with an uninformative error message. - EF
- 2007-09-30 Applied patches to axes3d to fix index error problem - EF
- 2007-09-24 Applied Eike Welk's patch reported on mpl-dev on 2007-09-22** Fixes a bug with multiple plot windows in the qt backend, ported the changes to `backend_qt4` as well - DSD
- 2007-09-21 Changed cbook.reversed to yield the same result as the** python reversed builtin - DSD
- 2007-09-13 The usetex support in the pdf backend is more usable now,** so I am enabling it. - JKS
- 2007-09-12 Fixed a Axes.bar unit bug - JDH
- 2007-09-10 Made `skiprows=1` the default on `csv2rec` - JDH
- 2007-09-09 Split out the plotting part of pylab and put it in** `pyplot.py`; removed `numerix` from the remaining `pylab.py`, which imports everything from `pyplot.py`. The intention is that apart from cleanups, the result of importing from `pylab` is nearly unchanged, but there is the new alternative of importing from `pyplot` to get the state-engine graphics without all the numeric functions. Numpified examples; deleted two that were obsolete; modified some to use `pyplot`. - EF
- 2007-09-08 Eliminated `gd` and `paint` backends - EF
- 2007-09-06 `.bmp` file format is now longer an alias for `.raw`
- 2007-09-07 Added clip path support to pdf backend. - JKS
- 2007-09-06 Fixed a bug in the embedding of Type 1 fonts in PDF.** Now it doesn't crash `Preview.app`. - JKS
- 2007-09-06 Refactored image saving code so that all GUI backends can** save most image types. See `FILETYPES` for a matrix of backends and their supported file types. Backend canvases should no longer write their own `print_figure()` method - instead they should write a `print_xxx` method for each filetype they can output and add an entry to their class-scoped `filetypes` dictionary. - MGD
- 2007-09-05 Fixed Qt version reporting in `setuptools.py` - DSD
- 2007-09-04 Embedding Type 1 fonts in PDF, and thus usetex support** via `dviread`, sort of works. To test, enable it by renaming `_draw_tex` to `draw_tex`. - JKS
- 2007-09-03 Added ability of errorbar show limits via caret or** arrowhead ends on the bars; patch by Manual Metz. - EF

**2007-09-03 Created type1font.py, added features to AFM and FT2Font** (see API\_CHANGES), started work on embedding Type 1 fonts in pdf files. - JKS

2007-09-02 Continued work on dviread.py. - JKS

**2007-08-16 Added a set\_extent method to AxesImage, allow data extent** to be modified after initial call to imshow - DSD

**2007-08-14 Fixed a bug in pyplot4 subplots-adjust. Thanks to** Xavier Gnata for the report and suggested fix - DSD

**2007-08-13 Use pickle to cache entire fontManager; change to using** font\_manager module-level function findfont wrapper for the fontManager.findfont method - EF

2007-08-11 Numpification and cleanup of mlab.py and some examples - EF

2007-08-06 Removed mathtext2

**2007-07-31 Refactoring of distutils scripts.**

- Will not fail on the entire build if an optional Python package (e.g., Tkinter) is installed but its development headers are not (e.g., tk-devel). Instead, it will continue to build all other extensions.
- Provide an overview at the top of the output to display what dependencies and their versions were found, and (by extension) what will be built.
- Use pkg-config, when available, to find freetype2, since this was broken on Mac OS-X when using MacPorts in a non-standard location.

**2007-07-30 Reorganized configuration code to work with traited config** objects. The new config system is located in the matplotlib.config package, but it is disabled by default. To enable it, set NEWCONFIG=True in matplotlib.\_init\_.py. The new configuration system will still use the old matplotlibrc files by default. To switch to the experimental, traited configuration, set USE\_TRAITED\_CONFIG=True in config.\_init\_.py.

**2007-07-29 Changed default pcolor shading to flat; added aliases** to make collection kwargs agree with setter names, so updating works; related minor cleanups. Removed quiver\_classic, scatter\_classic, pcolor\_classic. - EF

2007-07-26 Major rewrite of mathtext.py, using the TeX box layout model.

There is one (known) backward incompatible change. The font commands (cal, rm, it, tt) now behave as TeX does: they are in effect until the next font change command or the end of the grouping. Therefore uses of  $\$cal\{R\}\$$  should be changed to  $\$\{cal R\}\$$ . Alternatively, you may use the new LaTeX-style font commands (mathcal, mathrm, mathit, mathtt) which do affect the following group, e.g.,  $\$mathcal\{R\}\$$ .

Other new features include:

- Math may be interspersed with non-math text. Any text with an even number of  $\$$ 's (non-escaped) will be sent to the mathtext parser for layout.
- Sub/superscripts are less likely to accidentally overlap.
- Support for sub/superscripts in either order, e.g.,  $\$x^i_j\$$  and  $\$x_j^i\$$  are equivalent.
- Double sub/superscripts (e.g.,  $\$x_i_j\$$ ) are considered ambiguous and raise an exception. Use braces to disambiguate.
- $\$\frac\{x\}\{y\}\$$  can be used for displaying fractions.

- $\sqrt[3]{x}$  can be used to display the radical symbol with a root number and body.
- $\left(\frac{x}{y}\right)$  may be used to create parentheses and other delimiters that automatically resize to the height of their contents.
- Spacing around operators etc. is now generally more like TeX.
- Added support (and fonts) for boldface (bf) and sans-serif (sf) symbols.
- Log-like function name shortcuts are supported. For example,  $\sin(x)$  may be used instead of  $\{\rm sin}(x)$
- Limited use of kerning for the easy case (same font)

Behind the scenes, the `yparsing.py` module used for doing the math parsing was updated to the latest stable version (1.4.6). A lot of duplicate code was refactored out of the Font classes.

- MGD

2007-07-19 completed numpification of most trivial cases - NN

2007-07-19 converted non-numpy relicts throughout the code - NN

**2007-07-19 replaced the Python code in numerix/ by a minimal wrapper around** numpy that explicitly mentions all symbols that need to be addressed for further numpification - NN

**2007-07-18 make usetex respect changes to rcParams. texmanager used to** only configure itself when it was created, now it reconfigures when rcParams are changed. Thank you Alexander Schmolck for contributing a patch - DSD

2007-07-17 added validation to setting and changing rcParams - DSD

**2007-07-17 bugfix segfault in transforms module. Thanks Ben North for** the patch. - ADS

**2007-07-16 clean up some code in ticker.ScalarFormatter, use unicode to** render multiplication sign in offset ticklabel - DSD

**2007-07-16 fixed a formatting bug in ticker.ScalarFormatter's scientific** notation ( $10^0$  was being rendered as 10 in some cases) - DSD

**2007-07-13 Add MPL\_isfinite64() and MPL\_isinf64() for testing** doubles in (the now misnamed) `MPL_isnan.h`. - ADS

2007-07-13 The `matplotlib._isnan` module removed (use `numpy.isnan`) - ADS

2007-07-13 Some minor cleanups in `_transforms.cpp` - ADS

**2007-07-13 Removed the rest of the numerix extension code detritus,** numpified `axes.py`, and cleaned up the imports in `axes.py` - JDH

**2007-07-13 Added legend.loc as configurable option that could in** future default to 'best'. - NN

2007-07-12 Bugfixes in `mlab.py` to coerce inputs into numpy arrays. -ADS

2007-07-11 Added linespacing `kwargs` to `text.Text` - EF

2007-07-11 Added code to store font paths in SVG files. - MGD

2007-07-10 Store subset of TTF font as a Type 3 font in PDF files. - MGD

2007-07-09 Store subset of TTF font as a Type 3 font in PS files. - MGD

- 2007-07-09 Applied Paul's pick restructure pick and add pickers**, sourceforge patch 1749829 - JDH
- 2007-07-09 Applied Allan's draw\_lines agg optimization. JDH
- 2007-07-08 Applied Carl Worth's patch to fix cairo draw\_arc - SC
- 2007-07-07 fixed bug 1712099: xpdf distiller on windows - DSD
- 2007-06-30 Applied patches to tkagg, gtk, and wx backends to reduce** memory leakage. Patches supplied by Mike Droettboom; see tracker numbers 1745400, 1745406, 1745408. Also made unit/memleak\_gui.py more flexible with command-line options. - EF
- 2007-06-30 Split defaultParams into separate file rcdefaults (together with** validation code). Some heavy refactoring was necessary to do so, but the overall behavior should be the same as before. - NN
- 2007-06-27 Added MPLCONFIGDIR for the default location for mpl data** and configuration. useful for some apache installs where HOME is not writable. Tried to clean up the logic in \_get\_config\_dir to support non-writable HOME where are writable HOME/.matplotlib already exists - JDH
- 2007-06-27 Fixed locale bug reported at** [http://sourceforge.net/tracker/index.php?func=detail&aid=1744154&group\\_id=80706&atid=560720](http://sourceforge.net/tracker/index.php?func=detail&aid=1744154&group_id=80706&atid=560720) by adding a cbook.unicode\_safe function - JDH
- 2007-06-27 Applied Micheal's tk savefig bugfix described at** [http://sourceforge.net/tracker/index.php?func=detail&aid=1716732&group\\_id=80706&atid=560720](http://sourceforge.net/tracker/index.php?func=detail&aid=1716732&group_id=80706&atid=560720) Thanks Michael!
- 2007-06-27 Patch for get\_py2exe\_datafiles() to work with new directory** layout. (Thanks Tocer and also Werner Bruhin.) -ADS
- 2007-06-27 Added a scroll event to the mpl event handling system and** implemented it for backends GTK\* - other backend users/developers/maintainers, please add support for your backend. - JDH
- 2007-06-25 Changed default to clip=False in colors.Normalize;** modified Colorbar-Base for easier colormap display - EF
- 2007-06-13 Added maskedarray option to rc, numerix - EF
- 2007-06-11 Python 2.5 compatibility fix for mlab.py - EF
- 2007-06-10 In matplotlibrc file, use 'dashed' | 'solid' instead** of a pair of floats for contour.negative\_linestyle - EF
- 2007-06-08 Allow plot and fill fmt string to be any mpl string** colorspec - EF
- 2007-06-08 Added gnuplot file plotfile function to pylab - see** examples/plotfile\_demo.py - JDH
- 2007-06-07 Disable build of numarray and Numeric extensions for** internal MPL use and the numerix layer. - ADS
- 2007-06-07 Added csv2rec to matplotlib.mlab to support automatically** converting csv files to record arrays using type introspection, and turned on native datetime support using the new units support in matplotlib.dates. See examples/loadrec.py ! JDH
- 2007-06-07 Simplified internal code of \_auto\_legend\_data - NN
- 2007-06-04 Added labeldistance arg to Axes.pie to control the raidal** distance of the wedge labels - JDH

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**2007-06-03 Turned mathtext in SVG into single `<text>` with multiple `<tspan>` objects** (easier to edit in inkscape). - NN

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2007-06-02 Released 0.90.1 at revision 3352

**2007-06-02 Display only meaningful labels when calling `legend()`** without args. - NN

**2007-06-02 Have errorbar follow the color cycle even if line is not plotted.** Suppress plotting of errorbar caps for `capsize=0`. - NN

2007-06-02 Set markers to same alpha value as line. - NN

2007-06-02 Fix mathtext position in svg backend. - NN

**2007-06-01 Deprecate Numeric and numarray for use as numerix. Props to Travis** - job well done. - ADS

**2007-05-18 Added LaTeX unicode support. Enable with the `'text.latex.unicode'`** rc-Param. This requires the ucs and inputenc LaTeX packages. - ADS

**2007-04-23 Fixed some problems with polar - added general polygon** clipping to clip the lines and grids to the polar axes. Added support for `set_rmax` to easily change the maximum radial grid. Added support for polar legend - JDH

**2007-04-16 Added `Figure.autofmt_xdate` to handle adjusting the bottom** and rotating the tick labels for date plots when the ticks often overlap - JDH

2007-04-09 Beginnings of usetex support for pdf backend. -JKS

**2007-04-07 Fixed legend/LineCollection bug. Added label support** to collections. - EF

**2007-04-06 Removed deprecated support for a float value as a gray-scale;** now it must be a string, like `'0.5'`. Added `alpha kwarg` to `ColorConverter.to_rgba_list`. - EF

**2007-04-06 Fixed rotation of ellipses in pdf backend** (sf bug #1690559) -JKS

**2007-04-04 More matshow tweaks; documentation updates; new method** `set_bounds()` for formatters and locators. - EF

**2007-04-02 Fixed problem with imshow and matshow of integer arrays;** fixed problems with changes to color autoscaling. - EF

**2007-04-01 Made image color autoscaling work correctly with a tracking colorbar;** `norm.autoscale` now scales unconditionally, while `norm.autoscale_None` changes only None-valued `vmin`, `vmax`. - EF

2007-03-31 Added a qt-based subplot-adjustment dialog - DSD

2007-03-30 Fixed a bug in `backend_qt4`, reported on mpl-dev - DSD

**2007-03-26 Removed `colorbar_classic` from `figure.py`; fixed bug in `Figure.clf()`** in which `_axobservers` was not getting cleared. Modernization and cleanups. - EF

**2007-03-26 Refactored some of the units support - units now live in** the respective x and y Axis instances. See also `API_CHANGES` for some alterations to the conversion interface. JDH

**2007-03-25 Fix masked array handling in `quiver.py` for numpy.** (Numeric and numarray support for masked arrays is broken in other ways when using quiver. I didn't pursue that.) - ADS

2007-03-23 Made `font_manager.py` close opened files. - JKS

2007-03-22 Made `imshow` default extent match `matshow` - EF

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**2007-03-22 Some more niceties for xcorr - a maxlags option, normed** now works for xcorr as well as axorr, usevlines is supported, and a zero correlation hline is added. See examples/xcorr\_demo.py. Thanks Sameer for the patch. - JDH

**2007-03-21 Axes.vlines and Axes.hlines now create and returns a** LineCollection, not a list of lines. This is much faster. The kwarg signature has changed, so consult the docs. Modified Axes.errorbar which uses vlines and hlines. See API\_CHANGES; the return signature for these three functions is now different

2007-03-20 Refactored units support and added new examples - JDH

2007-03-19 Added Mike's units patch - JDH

**2007-03-18 Matshow as an Axes method; test version matshow1()** in pylab; added 'integer' Boolean kwarg to MaxNLocator initializer to force ticks at integer locations. - EF

2007-03-17 Preliminary support for clipping to paths agg - JDH

2007-03-17 Text.set\_text() accepts anything convertible with '%s' - EF

2007-03-14 Add masked-array support to hist. - EF

**2007-03-03 Change barh to take a kwargs dict and pass it to bar.** Fixes sf bug #1669506.

**2007-03-02 Add rc parameter pdf.inheritcolor, which disables all** color-setting operations in the pdf backend. The idea is that you include the resulting file in another program and set the colors (both stroke and fill color) there, so you can use the same pdf file for e.g., a paper and a presentation and have them in the surrounding color. You will probably not want to draw figure and axis frames in that case, since they would be filled in the same color. - JKS

2007-02-26 Prevent building \_wxagg.so with broken Mac OS X wxPython. - ADS

2007-02-23 Require setuptools for Python 2.3 - ADS

**2007-02-22 WXAgg accelerator updates - KM** WXAgg's C++ accelerator has been fixed to use the correct wxBitmap constructor.

The backend has been updated to use new wxPython functionality to provide fast blit() animation without the C++ accelerator. This requires wxPython 2.8 or later. Previous versions of wxPython can use the C++ accelerator or the old pure Python routines.

setup.py no longer builds the C++ accelerator when wxPython  $\geq$  2.8 is present.

The blit() method is now faster regardless of which agg/wxPython conversion routines are used.

**2007-02-21 Applied the PDF backend patch by Nicolas Grilly.** This impacts several files and directories in matplotlib:

- Created the directory lib/matplotlib/mpl-data/fonts/pdfcorefonts, holding AFM files for the 14 PDF core fonts. These fonts are embedded in every PDF viewing application.
- setup.py: Added the directory pdfcorefonts to package\_data.
- lib/matplotlib/\_\_init\_\_.py: Added the default parameter 'pdf.use14corefonts'. When True, the PDF backend uses only the 14 PDF core fonts.
- lib/matplotlib/afm.py: Added some keywords found in recent AFM files. Added a little workaround to handle Euro symbol.

- `lib/matplotlib/fontmanager.py`: Added support for the 14 PDF core fonts. These fonts have a dedicated cache (file `pdfcorefont.cache`), not the same as for other AFM files (file `.afmfont.cache`). Also cleaned comments to conform to CODING\_GUIDE.
- `lib/matplotlib/backends/backend_pdf.py`: Added support for 14 PDF core fonts. Fixed some issues with incorrect character widths and encodings (works only for the most common encoding, `WinAnsiEncoding`, defined by the official PDF Reference). Removed parameter `'dpi'` because it causes alignment issues.

-JKS (patch by Nicolas Grilly)

**2007-02-17 Changed `ft2font.get_charmap`, and updated all the files where `get_charmap` is mentioned** - ES

2007-02-13 Added barcode demo - JDH

2007-02-13 Added binary colormap to `cm` - JDH

2007-02-13 Added `twiny` to `pylab` - JDH

**2007-02-12 Moved data files into `lib/matplotlib` so that `setuptools'` `develop` mode works.** Re-organized the `mpl-data` layout so that this source structure is maintained in the installation. (i.e., the `'fonts'` and `'images'` sub-directories are maintained in site-packages.) Suggest removing `site-packages/matplotlib/mpl-data` and `~/matplotlib/ttffont.cache` before installing - ADS

**2007-02-07 Committed Rob Hetland's patch for qt4: remove references to `text()/latin1()`, plus some improvements to the toolbar layout** - DSD

2007-02-06 Released 0.90.0 at revision 3003

**2007-01-22 Extended the new picker API to `text`, `patches` and `patch` collections.** Added support for user customizable pick hit testing and attribute tagging of the `PickEvent` - Details and examples in `examples/pick_event_demo.py` - JDH

**2007-01-16 Begun work on a new pick API using the `mpl event handling` framework.** Artists will define their own pick method with a configurable epsilon tolerance and return pick attrs. All artists that meet the tolerance threshold will fire a `PickEvent` with artist dependent attrs; e.g., a `Line2D` can set the `indices` attribute that shows the indices into the line that are within epsilon of the pick point. See `examples/pick_event_demo.py`. The implementation of pick for the remaining Artists remains to be done, but the core infrastructure at the level of event handling is in place with a proof-of-concept implementation for `Line2D` - JDH

**2007-01-16 `src/_image.cpp`: update to use `Py_ssize_t` (for 64-bit systems).** Use return value of `fread()` to prevent warning messages - SC

**2007-01-15 `src/_image.cpp`: combine `buffer_argb32()` and `buffer_bgra32()` into a new method `color_conv(format)`** - SC

**2007-01-14 `backend_cairo.py`: update `draw_arc()` so that `examples/arctest.py` looks correct** - SC

**2007-01-12 `backend_cairo.py`: enable clipping. Update `draw_image()` so that `examples/contour_demo.py` looks correct** - SC

**2007-01-12 `backend_cairo.py`: fix `draw_image()` so that `examples/image_demo.py` now looks correct** - SC

- 2007-01-11 Added Axes.xcorr and Axes.acorr to plot the cross** correlation of x vs y or the autocorrelation of x. pylab wrappers also provided. See examples/xcorr\_demo.py - JDH
- 2007-01-10 Added "Subplot.label\_outer" method. It will set the** visibility of the ticklabels so that yticklabels are only visible in the first column and xticklabels are only visible in the last row - JDH
- 2007-01-02 Added additional kwarg documentation - JDH
- 2006-12-28 Improved error message for nonpositive input to log** transform; added log kwarg to bar, barh, and hist, and modified bar method to behave sensibly by default when the ordinate has a log scale. (This only works if the log scale is set before or by the call to bar, hence the utility of the log kwarg.) - EF
- 2006-12-27 backend\_cairo.py: update draw\_image() and \_draw\_mathtext() to work** with numpy - SC
- 2006-12-20 Fixed xpdf dependency check, which was failing on windows.** Removed ps2eps dependency check. - DSD
- 2006-12-19 Added Tim Leslie's spectral patch - JDH
- 2006-12-17 Added rc param 'axes.formatter.limits' to control** the default threshold for switching to scientific notation. Added convenience method Axes.ticklabel\_format() for turning scientific notation on or off on either or both axes. - EF
- 2006-12-16 Added ability to turn control scientific notation** in ScalarFormatter - EF
- 2006-12-16 Enhanced boxplot to handle more flexible inputs - EF
- 2006-12-13 Replaced calls to where() in colors.py with much faster** clip() and putmask() calls; removed inappropriate uses of getmaskorNone (which should be needed only very rarely); all in response to profiling by David Cournapeau. Also fixed bugs in my 2-D array support from 12-09. - EF
- 2006-12-09 Replaced spy and spy2 with the new spy that combines** marker and image capabilities - EF
- 2006-12-09 Added support for plotting 2-D arrays with plot:** columns are plotted as in Matlab - EF
- 2006-12-09 Added linewidth kwarg to bar and barh; fixed arg** checking bugs - EF
- 2006-12-07 Made pcolormesh argument handling match pcolor;** fixed kwarg handling problem noted by Pierre GM - EF
- 2006-12-06 Made pcolor support vector X and/or Y instead of** requiring 2-D arrays - EF
- 2006-12-05 Made the default Artist.\_transform None (rather than** invoking identity\_transform for each artist only to have it overridden later). Use artist.get\_transform() rather than artist.\_transform, even in derived classes, so that the default transform will be created lazily as needed - JDH
- 2006-12-03 Added LogNorm to colors.py as illustrated by** examples/pcolor\_log.py, based on suggestion by Jim McDonald. Colorbar modified to handle LogNorm. Norms have additional "inverse" method. - EF
- 2006-12-02 Changed class names in colors.py to match convention:** normalize -> Normalize, no\_norm -> NoNorm. Old names are still available. Changed \_\_init\_\_.py rc defaults to match those in matplotlibrc - EF

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- 2006-11-22 Fixed bug in `set_*lim` that I had introduced on 11-15 - EF
- 2006-11-22 Added `examples/clippedline.py`, which shows how to clip line** data based on view limits - it also changes the marker style when zoomed in - JDH
- 2006-11-21 Some spy bug-fixes and added precision arg per Robert C's** suggestion - JDH
- 2006-11-19 Added semi-automatic docstring generation detailing all the** kwargs that functions take using the artist introspection tools; e.g., 'help text now details the scatter kwargs that control the Text properties - JDH
- 2006-11-17 Removed obsolete `scatter_classic`, leaving a stub to** raise `NotImplementedError`; same for `pcolor_classic` - EF
- 2006-11-15 Removed obsolete `pcolor_classic` - EF
- 2006-11-15 Fixed 1588908 reported by Russel Owen; factored** `nonsingular` method out of `ticker.py`, put it into `transforms.py` as a function, and used it in `set_xlim` and `set_ylim`. - EF
- 2006-11-14 Applied patch 1591716 by Ulf Larsen to fix a bug in** `apply_aspect`. Modified and applied patch 1594894 by mdehoon to fix bugs and improve formatting in `lines.py`. Applied patch 1573008 by Greg Willden to make `psd` etc. plot full frequency range for complex inputs. - EF
- 2006-11-14 Improved the ability of the colorbar to track** changes in corresponding image, `pcolor`, or `contourf`. - EF
- 2006-11-11 Fixed bug that broke Numeric compatibility;** added support for alpha to `colorbar`. The alpha information is taken from the mappable object, not specified as a kwarg. - EF
- 2006-11-05 Added `broken_barh` function for making a sequence of** horizontal bars broken by gaps - see `examples/broken_barh.py`
- 2006-11-05 Removed `lineprops` and `markerprops` from the Annotation code** and replaced them with an arrow configurable with kwarg `arrowprops`. See `examples/annotation_demo.py` - JDH
- 2006-11-02 Fixed a pylab subplot bug that was causing axes to be** deleted with `hspace` or `wspace` equals zero in `subplots_adjust` - JDH
- 2006-10-31 Applied axes3d patch 1587359** [http://sourceforge.net/tracker/index.php?func=detail&aid=1587359&group\\_id=80706&atid=560722](http://sourceforge.net/tracker/index.php?func=detail&aid=1587359&group_id=80706&atid=560722) JDH
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- 2006-10-26 Released 0.87.7 at revision 2835
- 2006-10-25 Made "tiny" kwarg in `Locator.nonsingular` much smaller - EF
- 2006-10-17 Closed sf bug 1562496 update line props `dash/solid/cap/join`** styles - JDH
- 2006-10-17 Complete overhaul of the annotations API and example code** - See `matplotlib.text.Annotation` and `examples/annotation_demo.py` JDH
- 2006-10-12 Committed Manuel Metz's StarPolygon code and** `examples/scatter_star_poly.py` - JDH
- 2006-10-11 commented out all default values in `matplotlibrc.template`** Default values should generally be taken from `defaultParam` in `__init__.py` - the file `matplotlib` should only contain those values that the user wants to explicitly change from the default. (see thread "marker color handling" on `matplotlib-devel`)
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2006-10-10 Changed default comment character for load to '#' - JDH

**2006-10-10 deactivated rcfile-configurability of markerfacecolor** and `markeredge-color`. Both are now hardcoded to the special value 'auto' to follow the line color. Configurability at run-time (using function arguments) remains functional. - NN

**2006-10-07 introduced dummy argument magnification=1.0 to** `FigImage.make_image` to satisfy unit test `figimage_demo.py` The argument is not yet handled correctly, which should only show up when using non-standard DPI settings in PS backend, introduced by patch #1562394. - NN

2006-10-06 add backend-agnostic example: `simple3d.py` - NN

2006-09-29 fix line-breaking for SVG-inline images (purely cosmetic) - NN

**2006-09-29 reworked set\_linestyle and set\_marker** `markeredgecolor` and `markerface-color` now default to a special value "auto" that keeps the color in sync with the line color further, the intelligence of `axes.plot` is cleaned up, improved and simplified. Complete compatibility cannot be guaranteed, but the new behavior should be much more predictable (see patch #1104615 for details) - NN

**2006-09-29 changed implementation of clip-path in SVG to work around a** limitation in inkscape - NN

**2006-09-29 added two options to matplotlibrc:** `svg.image_inline` `svg.image_noscale` see patch #1533010 for details - NN

2006-09-29 `axes.py`: cleaned up kwargs checking - NN

2006-09-29 `setup.py`: cleaned up setup logic - NN

2006-09-29 `setup.py`: check for required pygtk versions, fixes bug #1460783 - SC

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2006-09-27 Released 0.87.6 at revision 2783

**2006-09-24 Added line pointers to the Annotation code, and a pylab** interface. See `matplotlib.text.Annotation`, `examples/annotation_demo.py` and `examples/annotation_demo_pylab.py` - JDH

**2006-09-18 mathtext2.py: The SVG backend now supports the same things that** the AGG backend does. Fixed some bugs with rendering, and out of bounds errors in the AGG backend - ES. Changed the return values of `math_parse_s_ft2font_svg` to support lines (fractions etc.)

**2006-09-17 Added an Annotation class to facilitate annotating objects** and an examples file `examples/annotation_demo.py`. I want to add dash support as in `TextWithDash`, but haven't decided yet whether inheriting from `TextWithDash` is the right base class or if another approach is needed - JDH

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2006-09-05 Released 0.87.5 at revision 2761

**2006-09-04 Added nxutils for some numeric add-on extension code** - specifically a better/more efficient inside polygon tester (see `unit/inside_poly_*.py`) - JDH

2006-09-04 Made bitstream fonts the rc default - JDH

**2006-08-31 Fixed alpha-handling bug in ColorConverter, affecting** collections in general and `contour/contourf` in particular. - EF

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- 2006-08-30 ft2font.cpp: Added draw\_rect\_filled method (now used by mathtext2** to draw the fraction bar) to FT2Font - ES
- 2006-08-29 setupext.py: wrap calls to tk.getvar() with str().** On some systems, getvar returns a Tcl\_Obj instead of a string - DSD
- 2006-08-28 mathtext2.py: Sub/superscripts can now be complex (i.e. fractions etc.).** The demo is also updated - ES
- 2006-08-28 font\_manager.py: Added /usr/local/share/fonts to list of X11 font directories** - DSD
- 2006-08-28 mahtext2.py: Initial support for complex fractions. Also,** rendering is now completely separated from parsing. The sub/superscripts now work better. Updated the mathtext2\_demo.py - ES
- 2006-08-27 qt backends: don't create a QApplication when backend is imported,** do it when the FigureCanvasQt is created. Simplifies applications where mpl is embedded in qt. Updated embedding\_in\_qt\* examples - DSD
- 2006-08-27 mahtext2.py: Now the fonts are searched in the OS font dir and in the** mpl-data dir. Also env is not a dict anymore. - ES
- 2006-08-26 minor changes to \_\_init\_\_.py, mathtex2\_demo.py. Added matplotlibrc** key "mathtext.mathtext2" (removed the key "mathtext2") - ES
- 2006-08-21 mathtext2.py: Initial support for fractions** Updated the math-text2\_demo.py \_mathtext\_data.py: removed "" from the unicode dicts mathtext.py: Minor modification (because of \_mathtext\_data.py)- ES
- 2006-08-20 Added mathtext2.py: Replacement for mathtext.py. Supports  $\wedge$ , rm,** cal etc., sin, cos etc., unicode, recursive nestings, inline math mode. The only backend currently supported is Agg `__init__.py`: added new rc params for mathtext2 added mathtext2\_demo.py example - ES
- 2006-08-19 Added embedding\_in\_qt4.py example - DSD
- 2006-08-11 Added scale free Ellipse patch for Agg - CM
- 2006-08-10 Added converters to and from julian dates to matplotlib.dates** (num2julian and julian2num) - JDH
- 2006-08-08 Fixed widget locking so multiple widgets could share the** event handling - JDH
- 2006-08-07 Added scale free Ellipse patch to SVG and PS - CM
- 2006-08-05 Re-organized imports in numerix for numpy 1.0b2 - TEO
- 2006-08-04 Added draw\_markers to PDF backend. - JKS
- 2006-08-01 Fixed a bug in postscript's rendering of dashed lines - DSD
- 2006-08-01 figure.py: savefig() update docstring to add support for 'format'** argument. backend\_cairo.py: print\_figure() add support 'format' argument. - SC
- 2006-07-31 Don't let postscript's xpdf distiller compress images - DSD
- 2006-07-31 Added shallowcopy() methods to all Transformations;** removed copy\_bbox\_transform and copy\_bbox\_transform\_shallow from transforms.py; added offset\_copy() function to transforms.py to facilitate positioning artists with offsets. See examples/transoffset.py. - EF
- 2006-07-31 Don't let postscript's xpdf distiller compress images - DSD

**2006-07-29 Fixed numerix polygon bug reported by Nick Fotopoulos.** Added `inverse_numerix_xy()` transform method. Made `autoscale_view()` preserve axis direction (e.g., increasing down).- EF

**2006-07-28 Added shallow bbox copy routine for transforms - mainly** useful for copying transforms to apply offset to. - JDH

**2006-07-28 Added resize method to FigureManager class** for Qt and Gtk backend - CM

2006-07-28 Added `subplots_adjust` button to Qt backend - CM

**2006-07-26 Use numerix more in collections.** Quiver now handles masked arrays. - EF

2006-07-22 Fixed bug #1209354 - DSD

**2006-07-22 make scatter() work with the kwarg "color". Closes bug** 1285750 - DSD

**2006-07-20 backend\_cairo.py: require pycairo 1.2.0.** `print_figure()` update to output SVG using cairo.

2006-07-19 Added blitting for Qt4Agg - CM

2006-07-19 Added lasso widget and example `examples/lasso_demo.py` - JDH

2006-07-18 Added blitting for QtAgg backend - CM

2006-07-17 Fixed bug #1523585: skip nans in semilog plots - DSD

**2006-07-12 Add support to render the scientific notation label** over the right-side y-axis - DSD

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2006-07-11 Released 0.87.4 at revision 2558

2006-07-07 Fixed a `usetex` bug with older versions of latex - DSD

2006-07-07 Add compatibility for NumPy 1.0 - TEO

2006-06-29 Added a Qt4Agg backend. Thank you James Amundson - DSD

**2006-06-26 Fixed a usetex bug. On windows, usetex will process** postscript output in the current directory rather than in a temp directory. This is due to the use of spaces and tildes in windows paths, which cause problems with latex. The `subprocess` module is no longer used. - DSD

**2006-06-22 Various changes to bar(), barh(), and hist().** Added `'edgecolor'` keyword arg to `bar()` and `barh()`. The `x` and `y` args in `barh()` have been renamed to `width` and `bottom` respectively, and their order has been swapped to maintain a (position, value) order ala matlab. `left`, `height`, `width` and `bottom` args can now all be scalars or sequences. `barh()` now defaults to edge alignment instead of center alignment. Added a keyword arg `'align'` to `bar()`, `barh()` and `hist()` that controls between edge or center bar alignment. Fixed ignoring the `rcParams['patch.facecolor']` for bar color in `bar()` and `barh()`. Fixed ignoring the `rcParams['lines.color']` for error bar color in `bar()` and `barh()`. Fixed a bug where patches would be cleared when error bars were plotted if `rcParams['axes.hold']` was `False`. - MAS

**2006-06-22 Added support for numerix 2-D arrays as alternatives to** a sequence of (x,y) tuples for specifying paths in collections, quiver, contour, pcolor, transforms. Fixed contour bug involving setting limits for color mapping. Added numpy-style `all()` to numerix. - EF

**2006-06-20 Added custom FigureClass hook to pylab interface - see** `examples/custom_figure_class.py`

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- 2006-06-16 Added colormaps from gist (gist\_earth, gist\_stern, gist\_rainbow, gist\_gray, gist\_yarg, gist\_heat, gist\_ncar)** - JW
- 2006-06-16 Added a pointer to parent in figure canvas so you can** access the container with `fig.canvas.manager`. Useful if you want to set the window title, e.g., in `gtk fig.canvas.manager.window.set_title`, though a GUI neutral method would be preferable  
JDH
- 2006-06-16 Fixed colorbar.py to handle indexed colors (i.e., norm = no\_norm())** by centering each colored region on its index. - EF
- 2006-06-15 Added scalex and scaley to Axes.autoscale\_view to support** selective autoscaling just the x or y axis, and supported these command in `plot` so you can say `plot(something, scaley=False)` and just the x axis will be autoscaled. Modified `axvline` and `axhline` to support this, so for example `axvline` will no longer autoscale the y axis.  
JDH
- 2006-06-13 Fix so numpy updates are backward compatible - TEO
- 2006-06-12 Updated numerix to handle numpy restructuring of oldnumeric** - TEO
- 2006-06-12 Updated numerix.fft to handle numpy restructuring** Added `ImportError` to `numerix.linear_algebra` for numpy -TEO
- 2006-06-11 Added quiverkey command to pylab and Axes, using** `QuiverKey` class in `quiver.py`. Changed `pylab` and `Axes` to use `quiver2` if possible, but drop back to the newly-renamed `quiver_classic` if necessary. Modified `examples/quiver_demo.py` to illustrate the new `quiver` and `quiverkey`. Changed `LineCollection` implementation slightly to improve compatibility with `PolyCollection`. - EF
- 2006-06-11 Fixed a usetex bug for windows, running latex on files** with spaces in their names or paths was failing - DSD
- 2006-06-09 Made additions to numerix, changes to quiver to make it work** with all numeric flavors. - EF
- 2006-06-09 Added quiver2 function to pylab and method to axes,** with implementation via a `Quiver` class in `quiver.py`. `quiver2` will replace `quiver` before the next release; it is placed alongside it initially to facilitate testing and transition. See also `examples/quiver2_demo.py`. - EF
- 2006-06-08 Minor bug fix to make ticker.py draw proper minus signs** with `usetex` - DSD
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- 2006-06-06 Released 0.87.3 at revision 2432
- 2006-05-30 More partial support for polygons with outline or fill,** but not both. Made `LineCollection` inherit from `ScalarMappable`. - EF
- 2006-05-29 Yet another revision of aspect-ratio handling. - EF
- 2006-05-27 Committed a patch to prevent stroking zero-width lines in** the `svg` backend - DSD
- 2006-05-24 Fixed colorbar positioning bug identified by Helge** Avlesen, and improved the algorithm; added a `'pad'` kwarg to control the spacing between colorbar and parent axes. - EF
- 2006-05-23 Changed color handling so that collection initializers** can take any `mpl` color arg or sequence of args; deprecated `float` as `grayscale`, replaced by string representation of `float`. - EF

- 2006-05-19 Fixed bug: plot failed if all points were masked - EF
- 2006-05-19 Added custom symbol option to scatter - JDH
- 2006-05-18 New example, multi\_image.py; colorbar fixed to show** offset text when the ScalarFormatter is used; FixedFormatter augmented to accept and display offset text. - EF
- 2006-05-14 New colorbar; old one is renamed to colorbar\_classic.** New colorbar code is in colorbar.py, with wrappers in figure.py and pylab.py. Fixed aspect-handling bug reported by Michael Mossey. Made backend\_bases.draw\_quad\_mesh() run.- EF
- 2006-05-08 Changed handling of end ranges in contourf: replaced** "clip-ends" kwarg with "extend". See docstring for details. -EF
- 2006-05-08 Added axisbelow to rc - JDH
- 2006-05-08 If using PyGTK require version 2.2+ - SC
- 2006-04-19 Added compression support to PDF backend, controlled by** new pdf.compression rc setting. - JKS
- 2006-04-19 Added Jouni's PDF backend
- 2006-04-18 Fixed a bug that caused agg to not render long lines
- 2006-04-16 Masked array support for pcolormesh; made pcolormesh support the** same combinations of X,Y,C dimensions as pcolor does; improved (I hope) description of grid used in pcolor, pcolormesh. - EF
- 2006-04-14 Reorganized axes.py - EF
- 2006-04-13 Fixed a bug Ryan found using usetex with sans-serif fonts and** exponential tick labels - DSD
- 2006-04-11 Refactored backend\_ps and backend\_agg to prevent module-level** texmanager imports. Now these imports only occur if text.usetex rc setting is true - DSD
- 2006-04-10 Committed changes required for building mpl on win32** platforms with visual studio. This allows wxpython blitting for fast animations. - CM
- 2006-04-10 Fixed an off-by-one bug in Axes.change\_geometry.
- 2006-04-10 Fixed bug in pie charts where wedge wouldn't have label in** legend. Submitted by Simon Hildebrandt. - ADS
- 2006-05-06 Usetex makes temporary latex and dvi files in a temporary** directory, rather than in the user's current working directory - DSD
- 2006-04-05 Applied Ken's wx deprecation warning patch closing sf patch** #1465371 - JDH
- 2006-04-05 Added support for the new API in the postscript backend.** Allows values to be masked using nan's, and faster file creation - DSD
- 2006-04-05 Use python's subprocess module for usetex calls to** external programs. subprocess catches when they exit abnormally so an error can be raised. - DSD
- 2006-04-03 Fixed the bug in which widgets would not respond to** events. This regressed the twinx functionality, so I also updated subplots\_adjust to update axes that share an x or y with a subplot instance. - CM
- 2006-04-02 Moved PBox class to transforms and deleted pbox.py;** made pylab axis command a thin wrapper for Axes.axis; more tweaks to aspect-ratio handling; fixed

- Axes.specgram to account for the new imshow default of unit aspect ratio; made contour set the Axes.dataLim. - EF
- 2006-03-31 Fixed the Qt "Underlying C/C++ object deleted" bug. - JRE
- 2006-03-31 Applied Vasily Sulatskov's Qt Navigation Toolbar enhancement. - JRE
- 2006-03-31 Ported Norbert's rewriting of Halldor's stineman\_interp** algorithm to make it numerix compatible and added code to matplotlib.mlab. See examples/interp\_demo.py - JDH
- 2006-03-30 Fixed a bug in aspect ratio handling; blocked potential** crashes when panning with button 3; added axis('image') support. - EF
- 2006-03-28 More changes to aspect ratio handling; new PBox class** in new file pbox.py to facilitate resizing and repositioning axes; made PolarAxes maintain unit aspect ratio. - EF
- 2006-03-23 Refactored TextWithDash class to inherit from, rather than** delegate to, the Text class. Improves object inspection and closes bug # 1357969 - DSD
- 2006-03-22 Improved aspect ratio handling, including pylab interface.** Interactive resizing, pan, zoom of images and plots (including panels with a shared axis) should work. Additions and possible refactoring are still likely. - EF
- 2006-03-21 Added another colorbrewer colormap (RdYlBu) - JSWHIT
- 2006-03-21 Fixed tickmarks for logscale plots over very large ranges.** Closes bug # 1232920 - DSD
- 2006-03-21 Added Rob Knight's arrow code; see examples/arrow\_demo.py - JDH
- 2006-03-20 Added support for masking values with nan's, using ADS's isnan** module and the new API. Works for \*Agg backends - DSD
- 2006-03-20 Added contour.negative\_linestyle rcParam - ADS
- 2006-03-20 Added \_isnan extension module to test for nan with Numeric**
- ADS
- 2006-03-17 Added Paul and Alex's support for faceting with quadmesh** in sf patch 1411223 - JDH
- 2006-03-17 Added Charle Twardy's pie patch to support colors=None.** Closes sf patch 1387861 - JDH
- 2006-03-17 Applied sophana's patch to support overlapping axes with** toolbar navigation by toggling activation with the 'a' key. Closes sf patch 1432252 - JDH
- 2006-03-17 Applied Aarre's linestyle patch for backend EMF; closes sf** patch 1449279 - JDH
- 2006-03-17 Applied Jordan Dawe's patch to support kwarg properties** for grid lines in the grid command. Closes sf patch 1451661 - JDH
- 2006-03-17 Center postscript output on page when using usetex - DSD
- 2006-03-17 subprocess module built if Python <2.4 even if subprocess** can be imported from an egg - ADS
- 2006-03-17 Added \_subprocess.c from Python upstream and hopefully** enabled building (without breaking) on Windows, although not tested. - ADS

**2006-03-17 Updated subprocess.py to latest Python upstream and** reverted name  
back to subprocess.py - ADS

2006-03-16 Added John Porter's 3D handling code

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2006-03-16 Released 0.87.2 at revision 2150

**2006-03-15 Fixed bug in MaxNLocator revealed by daigos@infinito.it.** The main  
change is that Locator.nonsingular now adjusts vmin and vmax if they are nearly the  
same, not just if they are equal. A new kwarg, "tiny", sets the threshold. - EF

**2006-03-14 Added import of compatibility library for newer numpy** linear\_algebra -  
TEO

**2006-03-12 Extended "load" function to support individual columns and** moved  
"load" and "save" into matplotlib.mlab so they can be used outside of pylab - see  
examples/load\_converter.py - JDH

**2006-03-12 Added AutoDateFormatter and AutoDateLocator submitted** by James  
Evans. Try the load\_converter.py example for a demo. - ADS

2006-03-11 Added subprocess module from python-2.4 - DSD

**2006-03-11 Fixed landscape orientation support with the usetex** option. The back-  
end\_ps print\_figure method was getting complicated, I added a \_print\_figure\_tex method  
to maintain some degree of sanity - DSD

**2006-03-11 Added "papertype" savefig kwarg for setting** postscript papersizes. paper-  
type and ps.papersize rc setting can also be set to "auto" to autoscale pagesizes - DSD

**2006-03-09 Apply P-J's patch to make pstoepts work on windows** patch report #  
1445612 - DSD

2006-03-09 Make backend rc parameter case-insensitive - DSD

**2006-03-07 Fixed bug in backend\_ps related to C0-C6 papersizes,** which were caus-  
ing problems with postscript viewers. Supported page sizes include letter, legal, ledger,  
A0-A10, and B0-B10 - DSD

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2006-03-07 Released 0.87.1

**2006-03-04 backend\_cairo.py:** fix get\_rgb() bug reported by Keith Briggs. Require pycairo  
1.0.2. Support saving png to file-like objects. - SC

2006-03-03 Fixed pcolor handling of vmin, vmax - EF

**2006-03-02 improve page sizing with usetex with the latex** geometry package. Closes  
bug # 1441629 - DSD

**2006-03-02 Fixed dpi problem with usetex png output. Accepted a** modified version  
of patch # 1441809 - DSD

2006-03-01 Fixed axis('scaled') to deal with case xmax < xmin - JSWHIT

2006-03-01 Added reversed colormaps (with '\_r' appended to name) - JSWHIT

2006-02-27 Improved eps bounding boxes with usetex - DSD

2006-02-27 Test svn commit, again!

**2006-02-27 Fixed two dependency checking bugs related to usetex** on Windows - DSD

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**2006-02-27 Made the rc deprecation warnings a little more human** readable.

**2006-02-26 Update the previous `gtk.main_quit()` bug fix to use `gtk.main_level()`**

- SC

2006-02-24 Implemented alpha support in contour and contourf - EF

**2006-02-22 Fixed `gtk main quit` bug when quit was called before mainloop.** - JDH

**2006-02-22 Small change to `colors.py` to workaround apparent** bug in numpy masked array module - JSWHIT

**2006-02-22 Fixed bug in `ScalarMappable.to_rgba()` reported by** Ray Jones, and fixed incorrect fix found by Jeff Whitaker - EF

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2006-02-22 Released 0.87

2006-02-21 Fixed portrait/landscape orientation in postscript backend - DSD

2006-02-21 Fix bug introduced in yesterday's bug fix - SC

**2006-02-20 `backend_gtk.py` `FigureCanvasGTK.draw()`: fix bug reported by** David Tremouilles - SC

**2006-02-20 Remove the "`pygtk.require('2.4')`" error from** `examples/embedding_in_gtk2.py` - SC

**2006-02-18 `backend_gtk.py` `FigureCanvasGTK.draw()`: simplify to use (rather than** duplicate) the `expose_event()` drawing code - SC

**2006-02-12 Added stagger or waterfall plot capability to `LineCollection`;** illustrated in `examples/collections.py`. - EF

**2006-02-11 Massive cleanup of the `usetex` code in the postscript backend. Possibly** fixed the clipping issue users were reporting with older versions of ghostscript - DSD

**2006-02-11 Added `autolim kwarg` to `axes.add_collection`. Changed** `collection` `get_verts()` methods accordingly. - EF

**2006-02-09 added a temporary rc parameter `text.dvipnghack`, to allow Mac users to get nice** results with the `usetex` option. - DSD

2006-02-09 Fixed a bug related to setting font sizes with the `usetex` option. - DSD

2006-02-09 Fixed a bug related to `usetex`'s latex code. - DSD

**2006-02-09 Modified behavior of `font.size` rc setting. You should define `font.size` in pts,** which will set the "medium" or default fontsize. Special text sizes like axis labels or tick labels can be given relative font sizes like small, large, x-large, etc. and will scale accordingly. - DSD

**2006-02-08 Added `py2exe` specific `datapath` check again. Also added new `py2exe`** helper function `get_py2exe_datafiles` for use in `py2exe` `setup.py` scripts. - CM

2006-02-02 Added `box` function to `pylab`

**2006-02-02 Fixed a problem in `setupext.py`, tk library formatted in unicode** caused build problems - DSD

2006-02-01 Dropped TeX engine support in `usetex` to focus on LaTeX. - DSD

**2006-01-29 Improved usetex option to respect the serif, sans-serif, monospace,** and cursive rc settings. Removed the font.latex.package rc setting, it is no longer required - DSD

2006-01-29 Fixed tex's caching to include font.family rc information - DSD

**2006-01-29 Fixed subpixel rendering bug in \*Agg that was causing** uneven gridlines - JDH

**2006-01-28 Added fontcmd to backend\_ps's RendererPS.draw\_tex, to support other** font families in eps output - DSD

**2006-01-28 Added MaxNLocator to ticker.py, and changed contour.py to** use it by default. - EF

**2006-01-28 Added fontcmd to backend\_ps's RendererPS.draw\_tex, to support other** font families in eps output - DSD

**2006-01-27 Buffered reading of matplotlibrc parameters in order to allow** 'verbose' settings to be processed first (allows verbose.report during rc validation process) - DSD

**2006-01-27 Removed setuptools support from setup.py and created a** separate setup-pegg.py file to replace it. - CM

**2006-01-26 Replaced the ugly datapath logic with a cleaner approach from** <http://wiki.python.org/moin/DistutilsInstallDataScattered>. Overrides the install\_data command. - CM

**2006-01-24 Don't use character typecodes in cntr.c — changed to use** defined type-numbers instead. - TEO

2006-01-24 Fixed some bugs in usetex's and ps.usedistiller's dependency

2006-01-24 Added masked array support to scatter - EF

**2006-01-24 Fixed some bugs in usetex's and ps.usedistiller's** dependency checking - DSD

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2006-01-24 Released 0.86.2

**2006-01-20 Added a converters dict to pylab load to convert selected** coloumns to float - especially useful for files with date strings, uses a datestr2num converter - JDH

**2006-01-20 Added datestr2num to matplotlib dates to convert a string** or sequence of strings to a matplotlib datenum

**2006-01-18 Added quadrilateral pcolormesh patch 1409190 by Alex Mont** and Paul Kienzle - this is \*Agg only for now. See examples/quadmesh\_demo.py - JDH

2006-01-18 Added Jouni's boxplot patch - JDH

2006-01-18 Added comma delimiter for pylab save - JDH

2006-01-12 Added Ryan's legend patch - JDH

2006-1-12 Fixed numpy / numeric to use .dtype.char to keep in SYNC with numpy SVN

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2006-1-11 Released 0.86.1

2006-1-11 Fixed setup.py for win32 build and added rc template to the MANIFEST.in

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**2006-1-10 Added xpdf distiller option. matplotlibrc ps.usedistiller can now be** none, false, ghostscript, or xpdf. Validation checks for dependencies. This needs testing, but the xpdf option should produce the highest-quality output and small file sizes - DSD

**2006-01-10 For the usetex option, backend\_ps now does all the LaTeX work in the** os's temp directory - DSD

2006-1-10 Added checks for usetex dependencies. - DSD

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2006-1-9 Released 0.86

2006-1-4 Changed to support numpy (new name for scipy\_core) - TEO

2006-1-4 Added Mark's scaled axes patch for shared axis

2005-12-28 Added Chris Barker's build\_wxagg patch - JDH

**2005-12-27 Altered numerix/scipy to support new scipy package** structure - TEO

2005-12-20 Fixed Jame's Boyles date tick reversal problem - JDH

**2005-12-20 Added Jouni's rc patch to support lists of keys to set on** - JDH

**2005-12-12 Updated pyparsing and mathtext for some speed enhancements** (Thanks Paul McGuire) and minor fixes to scipy numerix and setuptools

**2005-12-12 Matplotlib data is now installed as package\_data** in the matplotlib module. This gets rid of checking the many possibilities in matplotlib.\_get\_data\_path() - CM

**2005-12-11 Support for setuptools/pkg\_resources to build and use** matplotlib as an egg. Still allows matplotlib to exist using a traditional distutils install. - ADS

**2005-12-03 Modified setup to build matplotlibrc based on compile time** findings. It will set numerix in the order of scipy, numarray, Numeric depending on which are founds, and backend as in preference order GTKAgg, WXAgg, TkAgg, GTK, Agg, PS

**2005-12-03 Modified scipy patch to support Numeric, scipy and numarray** Some work remains to be done because some of the scipy imports are broken if only the core is installed. e.g., apparently we need from scipy.basic.fftpack import \* rather than from scipy.fftpack import \*

**2005-12-03 Applied some fixes to Nicholas Young's nonuniform image** patch

2005-12-01 Applied Alex Gontmakher hatch patch - PS only for now

2005-11-30 Added Rob McMullen's EMF patch

2005-11-30 Added Daishi's patch for scipy

2005-11-30 Fixed out of bounds draw markers segfault in agg

2005-11-28 Got TkAgg blitting working 100% (cross fingers) correctly. - CM

**2005-11-27 Multiple changes in cm.py, colors.py, figure.py, image.py,** contour.py, contour\_demo.py; new \_cm.py, examples/image\_masked.py. 1) Separated the color table data from cm.py out into a new file, \_cm.py, to make it easier to find the actual code in cm.py and to add new colormaps. Also added some line breaks to the color data dictionaries. Everything from \_cm.py is imported by cm.py, so the split should be transparent. 2) Enabled automatic generation of a colormap from a list of colors in contour; see modified examples/contour\_demo.py. 3) Support for imshow of a masked array, with the ability to specify colors (or no color at all) for masked regions, and for regions that are above or below the normally mapped region. See examples/image\_masked.py.

4) In support of the above, added two new classes, ListedColormap, and no\_norm, to colors.py, and modified the Colormap class to include common functionality. Added a clip kwarg to the normalize class. Reworked color handling in contour.py, especially in the ContourLabeller mixin. - EF

2005-11-25 Changed text.py to ensure color is hashable. EF

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2005-11-16 Released 0.85

2005-11-16 Changed the default default linewidth in rc to 1.0

**2005-11-16 Replaced agg\_to\_gtk\_drawable with pure pygtk pixbuf code in backend\_gtkagg.** When the equivalent is done for blit, the agg extension code will no longer be needed

**2005-11-16 Added a maxdict item to cbook to prevent caches from growing** w/o bounds

**2005-11-15 Fixed a colorup/colordown reversal bug in finance.py** - Thanks Gilles

**2005-11-15 Applied Jouni K Steppanen's boxplot patch SF patch#1349997**

• JDH

**2005-11-09 added axisbelow attr for Axes to determine whether ticks and such** are above or below the actors

2005-11-08 Added Nicolas' irregularly spaced image patch

**2005-11-08 Deprecated HorizontalSpanSelector and replaced with SpanSelection** that takes a third arg, direction. The new SpanSelector supports horizontal and vertical span selection, and the appropriate min/max is returned. - CM

2005-11-08 Added lineprops dialog for gtk

**2005-11-03 Added FIFOBuffer class to mlab to support real time feeds** and examples/fifo\_buffer.py

**2005-11-01 Contributed Nickolas Young's patch for afm mathtext** to support math-text based upon the standard postscript Symbol font when ps.usetex = True.

2005-10-26 Added support for scatter legends - thanks John Gill

**2005-10-20 Fixed image clipping bug that made some tex labels disappear.** JDH

2005-10-14 Removed sqrt from dvipng 1.6 alpha channel mask.

2005-10-14 Added width kwarg to hist function

2005-10-10 Replaced all instances of os.rename with shutil.move

2005-10-05 Added Michael Brady's ydate patch

2005-10-04 Added rkern's texmanager patch

**2005-09-25 contour.py modified to use a single ContourSet class** that handles filled contours, line contours, and labels; added keyword arg (clip\_ends) to contourf. Colorbar modified to work with new ContourSet object; if the ContourSet has lines rather than polygons, the colorbar will follow suit. Fixed a bug introduced in 0.84, in which contourf(...,colors=...) was broken - EF

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2005-09-19 Released 0.84

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- 2005-09-14 Added a new 'resize\_event' which triggers a callback with a** backend\_bases.ResizeEvent object - JDH
- 2005-09-14 font\_manager.py: removed chkfontpath from x11FontDirectory() - SC
- 2005-09-14 Factored out auto date locator/formatter factory code into** matplotlib.date.date\_ticker\_factory; applies John Bryne's quiver patch.
- 2005-09-13 Added Mark's axes positions history patch #1286915
- 2005-09-09 Added support for auto canvas resizing with** fig.set\_figsize\_inches(9,5,forward=True) # inches OR fig.resize(400,300) # pixels
- 2005-09-07 figure.py: update Figure.draw() to use the updated** renderer.draw\_image() so that examples/figimage\_demo.py works again. examples/stock\_demo.py: remove data\_clipping (which no longer exists) - SC
- 2005-09-06 Added Eric's tick.direction patch: in or out in rc
- 2005-09-06 Added Martin's rectangle selector widget
- 2005-09-04 Fixed a logic err in text.py that was preventing rgxsuper** from matching - JDH
- 2005-08-29 Committed Ken's wx blit patch #1275002
- 2005-08-26 colorbar modifications - now uses contourf instead of imshow** so that colors used by contourf are displayed correctly. Added two new keyword args (cspacing and clabels) that are only relevant for ContourMappable images - JSWHIT
- 2005-08-24 Fixed a PS image bug reported by Darren - JDH
- 2005-08-23 colors.py: change hex2color() to accept unicode strings as well as** normal strings. Use isinstance() instead of types.IntType etc - SC
- 2005-08-16 removed data\_clipping line and rc property - JDH
- 2005-08-22 backend\_svg.py: Remove redundant "x=0.0 y=0.0" from svg element.** Increase svg version from 1.0 to 1.1. Add viewBox attribute to svg element to allow SVG documents to scale-to-fit into an arbitrary viewport - SC
- 2005-08-16 Added Eric's dot marker patch - JDH
- 2005-08-08 Added blitting/animation for TkAgg - CM
- 2005-08-05 Fixed duplicate tickline bug - JDH
- 2005-08-05 Fixed a GTK animation bug that cropped up when doing** animations in gtk/gtkagg canvases that had widgets packed above them
- 2005-08-05 Added Clovis Goldemberg patch to the tk save dialog
- 2005-08-04 Removed origin kwarg from backend.draw\_image. origin is** handled entirely by the frontend now.
- 2005-07-03 Fixed a bug related to TeX commands in backend\_ps
- 2005-08-03 Fixed SVG images to respect upper and lower origins.
- 2005-08-03 Added flipud method to image and removed it from to\_str.
- 2005-07-29 Modified figure.figsaspect to take an array or number;** modified backend\_svg to write utf-8 - JDH
- 2005-07-30 backend\_svg.py: embed png image files in svg rather than linking** to a separate png file, fixes bug #1245306 (thanks to Norbert Nemecek for the patch) - SC

2005-07-29 Released 0.83.2

**2005-07-27 Applied SF patch 1242648: minor rounding error in** `IndexDateFormatter` in `dates.py`

**2005-07-27 Applied sf patch 1244732: Scale axis such that circle** looks like circle - JDH

2005-07-29 Improved message reporting in `texmanager` and `backend_ps` - DSD

**2005-07-28 backend\_gtk.py: update `FigureCanvasGTK.draw()` (needed due to the** recent `expose_event()` change) so that `examples/anim.py` works in the usual way - SC

**2005-07-26 Added new widgets `Cursor` and `HorizontalSpanSelector` to** `matplotlib.widgets`. See `examples/widgets/cursor.py` and `examples/widgets/span_selector.py` - JDH

**2005-07-26 added draw event to mpl event hierarchy - triggered on** `figure.draw`

2005-07-26 `backend_gtk.py`: allow 'f' key to toggle window fullscreen mode

**2005-07-26 backend\_svg.py: write "<.../>" elements all on one line and remove** surplus spaces - SC

**2005-07-25 backend\_svg.py: simplify code by deleting `GraphicsContextSVG` and** `RendererSVG.new_gc()`, and moving the `gc.get_capstyle()` code into `RendererSVG.get_gc_props_svg()` - SC

**2005-07-24 backend\_gtk.py: call `FigureCanvasBase.motion_notify_event()` on** all motion-notify-events, not just ones where a modifier key or button has been pressed (fixes bug report from Niklas Volbers) - SC

**2005-07-24 backend\_gtk.py: modify `print_figure()` use own pixmap, fixing** problems where `print_figure()` overwrites the display pixmap. return False from all button/key etc events - to allow the event to propagate further - SC

**2005-07-23 backend\_gtk.py: change `expose_event` from using `set_back_pixmap();`** `clear()` to `draw_drawable()` - SC

**2005-07-23 backend\_gtk.py: removed `pygtk.require()`** `matplotlib/_init_.py`: delete 'FROZEN' and 'McPLError' which are no longer used - SC

2005-07-22 `backend_gdk.py`: removed `pygtk.require()` - SC

**2005-07-21 backend\_svg.py: Remove unused imports. Remove methods doc strings** which just duplicate the docs from `backend_bases.py`. Rename `draw_mathtext` to `_draw_mathtext`. - SC

**2005-07-17 examples/embedding\_in\_gtk3.py: new example demonstrating placing** a `FigureCanvas` in a `gtk.ScrolledWindow` - SC

2005-07-14 Fixed a Windows related bug (#1238412) in `texmanager` - DSD

**2005-07-11 Fixed color kwarg bug, setting `color=1` or `0` caused an** exception - DSD

2005-07-07 Added Eric's MA `set_xdata` `Line2D` fix - JDH

**2005-07-06 Made `HOME/.matplotlib` the new config dir where the** `matplotlibrc` file, the `ttf.cache`, and the `tex.cache` live. The new default filenames in `.matplotlib` have no leading dot and are not hidden. e.g., the new names are `matplotlibrc` `tex.cache` `ttffont.cache`. This is how `ipython` does it so it must be right. If old files are found, a warning is issued and they are moved to the new location. Also fixed `texmanager` to put

all files, including temp files in `~/matplotlib/tex.cache`, which allows you to use `usetex` in non-writable dirs.

**2005-07-05 Fixed bug #1231611 in subplots adjust layout. The problem** was that the text caching mechanism was not using the transformation affine in the key. - JDH

**2005-07-05 Fixed default backend import problem when using API (SF bug # 1209354** - see `API_CHANGES` for more info - JDH

2005-07-04 `backend_gtk.py`: require PyGTK version 2.0.0 or higher - SC

**2005-06-30 `setupext.py`: added `numarray_inc_dirs` for building against `numarray`** when not installed in standard location - ADS

**2005-06-27 `backend_svg.py`: write figure width, height as int, not float.** Update to fix some of the pychecker warnings - SC

**2005-06-23 Updated `examples/agg_test.py` to demonstrate curved paths and fills** - JDH

**2005-06-21 Moved some `texmanager` and `backend_agg` tex caching to class level** rather than instance level - JDH

**2005-06-20 `setupext.py`: fix problem where `_nc_backend_gdk` is installed to the** wrong directory - SC

2005-06-19 Added 10.4 support for `CocoaAgg`. - CM

**2005-06-18 Move `Figure.get_width_height()` to `FigureCanvasBase` and return int** instead of float. - SC

**2005-06-18 Applied Ted Drain's QtAgg patch: 1) Changed the toolbar to** be a horizontal bar of push buttons instead of a `QToolBar` and updated the layout algorithms in the main window accordingly. This eliminates the ability to drag and drop the toolbar and detach it from the window. 2) Updated the resize algorithm in the main window to show the correct size for the plot widget as requested. This works almost correctly right now. It looks to me like the final size of the widget is off by the border of the main window but I haven't figured out a way to get that information yet. We could just add a small margin to the new size but that seems a little hacky. 3) Changed the x/y location label to be in the toolbar like the Tk backend instead of as a status line at the bottom of the widget. 4) Changed the toolbar pixmaps to use the ppm files instead of the png files. I noticed that the Tk backend buttons looked much nicer and it uses the ppm files so I switched them.

**2005-06-17 Modified the `gtk` backend to not queue mouse motion events.** This allows for live updates when dragging a slider. - CM

**2005-06-17 Added starter `CocoaAgg` backend. Only works on OS 10.3 for now** and requires `PyObjC`. (10.4 is high priority) - CM

**2005-06-17 Upgraded `pyparsing` and applied Paul McGuire's suggestions** for speeding things up. This more than doubles the speed of `mathtext` in my simple tests. JDH

2005-06-16 Applied David Cooke's subplot `make_key` patch

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2005-06-15 0.82 released

**2005-06-15 Added subplot config tool to GTK\* backends - note you must now** import the `NavigationToolbar2` from your backend of choice rather than from `backend_gtk` because it needs to know about the backend specific canvas

- see examples/embedding\_in\_gtk2.py. Ditto for wx backend - see examples/embedding\_in\_wxagg.py

2005-06-15 backend\_cairo.py: updated to use pycairo 0.5.0 - SC

**2005-06-14 Wrote some GUI neutral widgets (Button, Slider, RadioButtons, CheckButtons) in matplotlib.widgets.** See examples/widgets/\*.py - JDH

**2005-06-14 Exposed subplot parameters as rc vars and as the fig SubplotParams instance subplotpars.** See figure.SubplotParams, figure.Figure.subplots\_adjust and the pylab method.subplots\_adjust and examples/subplots\_adjust.py . Also added a GUI neutral widget for adjusting subplots, see examples/subplot\_toolbar.py - JDH

**2005-06-13 Exposed cap and join style for lines with new rc params and**

line properties

```
lines.dash_joinstyle : miter # miter|round|bevel lines.dash_capstyle : butt
# butt|round|projecting lines.solid_joinstyle : miter # miter|round|bevel
lines.solid_capstyle : projecting # butt|round|projecting
```

2005-06-13 Added kwargs to Axes init

2005-06-13 Applied Baptiste's tick patch - JDH

**2005-06-13 Fixed rc alias 'l' bug reported by Fernando by removing** aliases for main-level rc options. - JDH

2005-06-10 Fixed bug #1217637 in ticker.py - DSD

2005-06-07 Fixed a bug in texmanager.py: .aux files not being removed - DSD

2005-06-08 Added Sean Richard's hist binning fix - see API\_CHANGES - JDH

**2005-06-07 Fixed a bug in texmanager.py: .aux files not being removed**

- DSD

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2005-06-07 matplotlib-0.81 released

2005-06-06 Added autoscale\_on prop to axes

2005-06-06 Added Nick's picker "among" patch - JDH

2005-06-05 Fixed a TeX/LaTeX font discrepancy in backend\_ps. - DSD

**2005-06-05 Added a ps.distill option in rc settings. If True, postscript** output will be distilled using ghostscript, which should trim the file size and allow it to load more quickly. Hopefully this will address the issue of large ps files due to font definitions. Tested with gnu-ghostscript-8.16. - DSD

2005-06-03 Improved support for tex handling of text in backend\_ps. - DSD

**2005-06-03 Added rc options to render text with tex or latex, and to select the latex** font package. - DSD

2005-06-03 Fixed a bug in ticker.py causing a ZeroDivisionError

**2005-06-02 backend\_gtk.py remove DBL\_BUFFER, add line to expose\_event to** try to fix pygtk 2.6 redraw problem - SC

**2005-06-01 The default behavior of ScalarFormatter now renders scientific** notation and large numerical offsets in a label at the end of the axis. - DSD

- 2005-06-01 Added Nicholas' frombyte image patch - JDH
- 2005-05-31 Added vertical TeX support for agg - JDH
- 2005-05-31 Applied Eric's cntr patch - JDH
- 2005-05-27 Finally found the pesky agg bug (which Maxim was kind enough to fix within hours) that was causing a segfault in the win32 cached marker drawing. Now windows users can get the enormous performance benefits of caced markers w/o those occasional pesy screenshots. - JDH**
- 2005-05-27 Got win32 build system working again, using a more recent version of gtk and pygtk in the win32 build, gtk 2.6 from <http://www.gimp.org/~tml/gimp/win32/downloads.html> (you will also need libpng12.dll to use these). I haven't tested whether this binary build of mpl for win32 will work with older gtk runtimes, so you may need to upgrade.**
- 2005-05-27 Fixed bug where 2nd wxapp could be started if using wxagg backend. - ADS**
- 2005-05-26 Added Daishi text with dash patch - see examples/dashtick.py
- 2005-05-26 Moved backend\_latex functionality into backend\_ps. If text.usetex=True, the PostScript backend will use LaTeX to generate the .ps or .eps file. Ghostscript is required for eps output. - DSD**
- 2005-05-24 Fixed alignment and color issues in latex backend. - DSD
- 2005-05-21 Fixed raster problem for small rasters with dvipng - looks like it was a premultiplied alpha problem - JDH**
- 2005-05-20 Added linewidth and faceted kwarg to scatter to control edgewidth and color. Also added autolegend patch to inspect line segments.**
- 2005-05-18 Added Orsay and JPL qt fixes - JDH
- 2005-05-17 Added a psfrag latex backend - some alignment issues need to be worked out. Run with -dLaTeX and a .tex file and \*.eps file are generated. latex and dvips the generated latex file to get ps output. Note xdvi \*does not work, you must generate ps.- JDH**
- 2005-05-13 Added Florent Rougon's Axis set\_label1 patch**
- 2005-05-17 pcolor optimization, fixed bug in previous pcolor patch - JSWHIT
- 2005-05-16 Added support for masked arrays in pcolor - JSWHIT
- 2005-05-12 Started work on TeX text for antigrain using pngdvi - see examples/tex\_demo.py and the new module matplotlib.texmanager. Rotated text not supported and rendering small glyphs is not working right yet. BUt large font sizes and/or high dpi saved figs work great.**
- 2005-05-10 New image resize options interpolation options. New values for the interp kwarg are**
- 'nearest', 'bilinear', 'bicubic', 'spline16', 'spline36', 'hanning', 'hamming', 'hermite', 'kaiser', 'quadric', 'catrom', 'gaussian', 'bessel', 'mitchell', 'sinc', 'lanczos', 'blackman'
- See help(imshow) for details, particularly the interpolation, filternorm and filterrad kwargs
- 2005-05-10 Applied Eric's contour mem leak fixes - JDH

**2005-05-10 Extended python agg wrapper and started implementing** backend\_agg2, an agg renderer based on the python wrapper. This will be more flexible and easier to extend than the current backend\_agg. See also examples/agg\_test.py - JDH

**2005-05-09 Added Marcin's no legend patch to exclude lines from the** autolegend builder

```
plot(x, y, label='nolegend')
```

2005-05-05 Upgraded to agg23

2005-05-05 Added newscalarformatter\_demo.py to examples. -DSD

**2005-05-04 Added NewScalarFormatter. Improved formatting of ticklabels,** scientific notation, and the ability to plot large large numbers with small ranges, by determining a numerical offset. See ticker.NewScalarFormatter for more details. -DSD

2005-05-03 Added the option to specify a delimiter in pylab.load -DSD

2005-04-28 Added Darren's line collection example

2005-04-28 Fixed aa property in agg - JDH

2005-04-27 Set postscript page size in .matplotlibrc - DSD

2005-04-26 Added embedding in qt example. - JDH

**2005-04-14 Applied Michael Brady's qt backend patch: 1) fix a bug** where keyboard input was grabbed by the figure and not released 2) turn on cursor changes 3) clean up a typo and commented-out print statement. - JDH

**2005-04-14 Applied Eric Firing's masked data lines patch and contour** patch. Support for masked arrays has been added to the plot command and to the Line2D object. Only the valid points are plotted. A "valid\_only" kwarg was added to the get\_xdata() and get\_ydata() methods of Line2D; by default it is False, so that the original data arrays are returned. Setting it to True returns the plottable points. - see examples/masked\_demo.py - JDH

2005-04-13 Applied Tim Leslie's arrow key event handling patch - JDH

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0.80 released

**2005-04-11 Applied a variant of rick's xlim/ylim/axis patch. These** functions now take kwargs to let you selectively alter only the min or max if desired. e.g., xlim(xmin=2) or axis(ymax=3). They always return the new lim. - JDH

**2005-04-11 Incorporated Werner's wx patch - wx backend should be** compatible with wxpython2.4 and recent versions of 2.5. Some early versions of wxpython 2.5 will not work because there was a temporary change in the dc API that was rolled back to make it 2.4 compliant

**2005-04-11 modified tkagg show so that new figure window pops up on** call to figure

2005-04-11 fixed wxapp init bug

**2005-04-02 updated backend\_ps.draw\_lines, draw\_markers for use with the** new API - DSD

2005-04-01 Added editable polygon example

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2005-03-31 0.74 released

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**2005-03-30 Fixed and added checks for floating point inaccuracy in** `ticker.Base` - DSD

**2005-03-30 updated /ellipse definition in backend\_ps.py to address bug #1122041** - DSD

2005-03-29 Added unicode support for Agg and PS - JDH

2005-03-28 Added Jarrod's svg patch for text - JDH

2005-03-28 Added Ludal's arrow and quiver patch - JDH

**2005-03-28 Added label kwarg to Axes to facilitate forcing the** creation of new Axes with otherwise identical attributes

2005-03-28 Applied boxplot and OSX font search patches

2005-03-27 Added ft2font NULL check to fix Japanese font bug - JDH

**2005-03-27 Added sprint legend patch plus John Gill's tests and fix** - see `examples/legend_auto.py` - JDH

2005-03-19 0.73.1 released

2005-03-19 Reverted wxapp handling because it crashed win32 - JDH

2005-03-18 Add `.number` attribute to figure objects returned by `figure()` - FP

2005-03-18 0.73 released

2005-03-16 Fixed `labeledsep` bug

2005-03-16 Applied Darren's ticker fix for small ranges - JDH

2005-03-16 Fixed tick on horiz colorbar - JDH

2005-03-16 Added Japanese winreg patch - JDH

**2005-03-15 backend\_gtkagg.py: changed to use double buffering, this fixes** the problem reported Joachim Berdal Haga - "Parts of plot lagging from previous frame in animation". Tested with `anim.py` and it makes no noticeable difference to performance (23.7 before, 23.6 after) - SC

**2005-03-14 add src/backend\_gdk.c extension to provide a substitute function** for `pixbuf.get_pixels_array()`. Currently `pixbuf.get_pixels_array()` only works with Numeric, and then only works if pygtk has been compiled with Numeric support. The change provides a function `pixbuf_get_pixels_array()` which works with Numeric and `numarray` and is always available. It means that `backend_gtk` should be able to display images and `mathtext` in all circumstances. - SC

2005-03-11 Upgraded CXX to 5.3.1

**2005-03-10 remove `GraphicsContextPS.set_linestyle()` and `GraphicsContextSVG.set_linestyle()`** since they do no more than the base class `GraphicsContext.set_linestyle()` - SC

2005-03-09 Refactored contour functionality into dedicated module

2005-03-09 Added Eric's contourf updates and Nadia's `clabel` functionality

**2005-03-09 Moved colorbar to `figure.Figure` to expose it for API developers**

- JDH

2005-03-09 backend\_cairo.py: implemented draw\_markers() - SC

**2005-03-09 cbook.py: only use enumerate() (the python version) if the builtin**

**version is not available.** Add new function 'izip' which is set to itertools.izip if available and the python equivalent if not available. - SC

**2005-03-07 backend\_gdk.py: remove PIXELS\_PER\_INCH from points\_to\_pixels(), but**

**still use it to adjust font sizes. This allows the GTK version of line\_styles.py** to more closely match GTKAgg, previously the markers were being drawn too large. - SC

2005-03-01 Added Eric's contourf routines

**2005-03-01 Added start of proper agg SWIG wrapper. I would like to** expose agg functionality directly at the user level and this module will serve that purpose eventually, and will hopefully take over most of the functionality of the current \_image and \_backend\_agg modules. - JDH

**2005-02-28 Fixed polyfit / polyval to convert input args to float** arrays - JDH

**2005-02-25 Add experimental feature to backend\_gtk.py to enable/disable** double buffering (DBL\_BUFFER=True/False) - SC

**2005-02-24 colors.py change ColorConverter.to\_rgb() so it always returns rgb** (and not rgba), allow cnames keys to be cached, change the exception raised from RuntimeError to ValueError (like hex2color()) hex2color() use a regular expression to check the color string is valid - SC

**2005-02-23 Added rc param ps.useafm so backend ps can use native afm** fonts or truetype. afme breaks mathtext but causes much smaller font sizes and may result in images that display better in some contexts (e.g., pdfs incorporated into latex docs viewed in acrobat reader). I would like to extend this approach to allow the user to use truetype only for mathtext, which should be easy.

**2005-02-23 Used sequence protocol rather than tuple in agg collection** drawing routines for greater flexibility - JDH

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2005-02-22 0.72.1 released

**2005-02-21 fixed linestyle for collections - contour now dashes for** levels <0

2005-02-21 fixed ps color bug - JDH

2005-02-15 fixed missing qt file

**2005-02-15 banished error\_msg and report\_error. Internal backend** methods like error\_msg\_gtk are preserved. backend writers, check your backends, and diff against 0.72 to make sure I did the right thing! - JDH

2005-02-14 Added enthought traits to matplotlib tree - JDH

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2005-02-14 0.72 released

2005-02-14 fix bug in cbook alltrue() and onetrue() - SC

2005-02-11 updated qtagg backend from Ted - JDH

- 2005-02-11 matshow fixes for figure numbering, return value and docs - FP
- 2005-02-09 new zorder example for fine control in zorder\_demo.py - FP
- 2005-02-09 backend renderer draw\_lines now has transform in backend**, as in draw\_markers; use numerix in \_backend\_agg, added small line optimization to agg
- 2005-02-09 subplot now deletes axes that it overlaps
- 2005-02-08 Added transparent support for gzipped files in load/save - Fernando Perez** (FP from now on).
- 2005-02-08 Small optimizations in PS backend. They may have a big impact for large plots, otherwise they don't hurt** - FP
- 2005-02-08 Added transparent support for gzipped files in load/save - Fernando Perez** (FP from now on).
- 2005-02-07 Added newstyle path drawing for markers - only implemented in agg currently** - JDH
- 2005-02-05 Some superscript text optimizations for ticking log plots
- 2005-02-05 Added some default key press events to pylab figures: 'g' toggles grid** - JDH
- 2005-02-05 Added some support for handling log switching for lines** that have non-pos data - JDH
- 2005-02-04 Added Nadia's contour patch - contour now has matlab compatible syntax**; this also fixed an unequal sized contour array bug - JDH
- 2005-02-04 Modified GTK backends to allow the FigureCanvas to be resized** smaller than its original size - SC
- 2005-02-02 Fixed a bug in dates mx2num - JDH
- 2005-02-02 Incorporated Fernando's matshow - JDH
- 2005-02-01 Added Fernando's figure num patch, including experimental support for pylab backend switching, LineCollection.color warns, savefig now a figure method, fixed a close(fig) bug** - JDH
- 2005-01-31 updated datalim in contour - JDH
- 2005-01-30 Added backend\_qtagg.py provided by Sigve Tjora - SC
- 2005-01-28 Added tk.inspect rc param to .matplotlibrc. IDLE users should set tk.pythoninspect:True and interactive:True and backend:TkAgg**
- 2005-01-28 Replaced examples/interactive.py with an updated script from Fernando Perez** - SC
- 2005-01-27 Added support for shared x or y axes. See examples/shared\_axis\_demo.py and examples/ganged\_plots.py**
- 2005-01-27 Added Lee's patch for missing symbols leq and LEFTbracket** to \_math-text\_data - JDH
- 2005-01-26 Added Baptiste's two scales patch - see help(twinx) in the pylab interface** for more info. See also examples/two\_scales.py
- 2005-01-24 Fixed a mathtext parser bug that prevented font changes in sub/superscripts** - JDH

**2005-01-24 Fixed contour to work w/ interactive changes in colormaps, clim, etc** - JDH

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2005-01-21 matplotlib-0.71 released

2005-01-21 Refactored numerix to solve vexing namespace issues - JDH

2005-01-21 Applied Nadia's contour bug fix - JDH

**2005-01-20 Made some changes to the contour routine - particularly region=1** seems to fix a lot of the zigzag strangeness. Added colormaps as default for contour - JDH

**2005-01-19 Restored builtin names which were overridden (min, max, abs, round, and sum) in pylab.** This is a potentially significant change for those who were relying on an array version of those functions that previously overrode builtin function names. - ADS

**2005-01-18 Added accents to mathtext: hat, breve, grave, bar, acute, tilde, vec, dot, ddot.** All of them have the same syntax, e.g., to make an overbar you do `bar{o}` or to make an o umlaut you do `ddot{o}`. The shortcuts are also provided, e.g., "o 'e 'e ~n .x ^y - JDH

2005-01-18 Plugged image resize memory leaks - JDH

2005-01-18 Fixed some mathtext parser problems relating to superscripts

**2005-01-17 Fixed a yticklabel problem for colorbars under change of clim** - JDH

**2005-01-17 Cleaned up Destroy handling in wx reducing memleak/fig from approx 800k to approx 6k** - JDH

2005-01-17 Added kappa to latex\_to\_bakoma - JDH

2005-01-15 Support arbitrary colorbar axes and horizontal colorbars - JDH

**2005-01-15 Fixed colormap number of colors bug so that the colorbar** has the same discretization as the image - JDH

2005-01-15 Added Nadia's x,y contour fix - JDH

**2005-01-15 backend\_cairo: added PDF support which requires pycairo 0.1.4.** Its not usable yet, but is ready for when the Cairo PDF backend matures - SC

2005-01-15 Added Nadia's x,y contour fix

2005-01-12 Fixed set clip\_on bug in artist - JDH

2005-01-11 Reverted pythoninspect in tkagg - JDH

**2005-01-09 Fixed a backend\_bases event bug caused when an event is** triggered when location is None - JDH

**2005-01-07 Add patch from Stephen Walton to fix bug in pylab.load()** when the % character is included in a comment. - ADS

**2005-01-07 Added markerscale attribute to Legend class. This allows** the marker size in the legend to be adjusted relative to that in the plot. - ADS

**2005-01-06 Add patch from Ben Vanhaeren to make the FigureManagerGTK vbox** a public attribute - SC

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2004-12-30 Release 0.70

**2004-12-28 Added coord location to key press and added a** examples/picker\_demo.py

2004-12-28 Fixed coords notification in wx toolbar - JDH

**2004-12-28 Moved connection and disconnection event handling to the**

FigureCanvasBase. Backends now only need to connect one time for each of the button press, button release and key press/release functions. The base class deals with callbacks and multiple connections. This fixes flakiness on some backends (tk, wx) in the presence of multiple connections and/or disconnect - JDH

**2004-12-27 Fixed PS mathtext bug where color was not set - Jochen** please verify correct - JDH

**2004-12-27 Added Shadow class and added shadow kwarg to legend and pie** for shadow effect - JDH

2004-12-27 Added pie charts and new example/pie\_demo.py

**2004-12-23 Fixed an agg text rotation alignment bug, fixed some text** kwarg processing bugs, and added examples/text\_rotation.py to explain and demonstrate how text rotations and alignment work in matplotlib. - JDH

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2004-12-22 0.65.1 released - JDH

**2004-12-22 Fixed colorbar bug which caused colorbar not to respond to** changes in colormap in some instances - JDH

**2004-12-22 Refactored NavigationToolbar in tkagg to support app** embedding, init now takes (canvas, window) rather than (canvas, figman) - JDH

**2004-12-21 Refactored axes and subplot management - removed** add\_subplot and add\_axes from the FigureManager. classic toolbar updates are done via an observer pattern on the figure using add\_axobserver. Figure now maintains the axes stack (for gca) and supports axes deletion. Ported changes to GTK, Tk, Wx, and FLTK. Please test! Added delaxes - JDH

**2004-12-21 Lots of image optimizations - 4x performance boost over** 0.65 JDH

**2004-12-20 Fixed a figimage bug where the axes is shown and modified** tkagg to move the destroy binding into the show method.

**2004-12-18 Minor refactoring of NavigationToolbar2 to support** embedding in an application - JDH

2004-12-14 Added linestyle to collections (currently broken) - JDH

**2004-12-14 Applied Nadia's setupext patch to fix libstdc++ link** problem with contour and solaris -JDH

**2004-12-14 A number of pychecker inspired fixes, including removal of** True and False from cbook which I erroneously thought was needed for python2.2 - JDH

**2004-12-14 Finished porting doc strings for set introspection.** Used silent\_list for many get funcs that return lists. JDH

2004-12-13 dates.py: removed all timezone() calls, except for UTC - SC

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2004-12-13 0.65 released - JDH

**2004-12-13 colors.py: rgb2hex(), hex2color() made simpler (and faster), also**  
rgb2hex() - added round() instead of integer truncation hex2color() - changed 256.0  
divisor to 255.0, so now '#ffffff' becomes (1.0,1.0,1.0) not (0.996,0.996,0.996) - SC

2004-12-11 Added ion and ioff to pylab interface - JDH

**2004-12-11 backend\_template.py: delete FigureCanvasTemplate.realize() - most**  
backends don't use it and its no longer needed

backend\_ps.py, backend\_svg.py: delete show() and draw\_if\_interactive() - they are not  
needed for image backends

backend\_svg.py: write direct to file instead of StringIO - SC

**2004-12-10 Added zorder to artists to control drawing order of lines, patches and**  
text in axes. See examples/zoder\_demo.py - JDH

2004-12-10 Fixed colorbar bug with scatter - JDH

2004-12-10 Added Nadia Dencheva <dencheva@stsci.edu> contour code - JDH

2004-12-10 backend\_cairo.py: got mathtext working - SC

2004-12-09 Added Norm Peterson's svg clipping patch

2004-12-09 Added Matthew Newville's wx printing patch

2004-12-09 Migrated matlab to pylab - JDH

**2004-12-09 backend\_gtk.py: split into two parts**

- backend\_gdk.py - an image backend
- backend\_gtk.py - A GUI backend that uses GDK - SC

**2004-12-08 backend\_gtk.py: remove quit\_after\_print\_xvfb(\*args), show\_xvfb(),**  
Dialog\_MeasureTool(gtk.Dialog) one month after sending mail to matplotlib-users  
asking if anyone still uses these functions - SC

**2004-12-02 backend\_bases.py, backend\_template.py: updated some of the method**  
documentation to make them consistent with each other - SC

**2004-12-04 Fixed multiple bindings per event for TkAgg mpl\_connect and**  
mpl\_disconnect. Added a "test\_disconnect" command line parameter to coords\_demo.py  
JTM

2004-12-04 Fixed some legend bugs JDH

**2004-11-30 Added over command for oneoff over plots. e.g., over(plot, x, y, lw=2).**  
Works with any plot function.

2004-11-30 Added bbox property to text - JDH

**2004-11-29 Zoom to rect now respect reversed axes limits (for both linear and log**  
axes). - GL

**2004-11-29 Added the over command to the matlab interface. over** allows you to add  
an overlay plot regardless of hold state. - JDH

**2004-11-25 Added Printf to mplutils for printf style format string** formatting in C++  
(should help write better exceptions)

**2004-11-24 IMAGE\_FORMAT: remove from agg and gtkagg backends as its no longer**  
used - SC

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- 2004-11-23 Added matplotlib compatible set and get introspection.** See `set_and_get.py`
- 2004-11-23 applied Norbert's patched and exposed legend configuration** to `kwargs` - JDH
- 2004-11-23 `backend_gtk.py`: added a default exception handler - SC
- 2004-11-18 backend\_gtk.py: change so that the backend knows about all image formats** and does not need to use `IMAGE_FORMAT` in other backends - SC
- 2004-11-18 Fixed some report\_error bugs in string interpolation as** reported on SF bug tracker- JDH
- 2004-11-17 backend\_gtkcairo.py: change so all print\_figure() calls render using Cairo** and get saved using `backend_gtk.print_figure()` - SC
- 2004-11-13 backend\_cairo.py: Discovered the magic number (96) required for Cairo PS plots** to come out the right size. Restored Cairo PS output and added support for landscape mode - SC
- 2004-11-13 Added `ishold` - JDH
- 2004-11-12 Added many new matlab colormaps - autumn bone cool copper** `flag gray hot hsv jet pink prism spring summer winter` - PG
- 2004-11-11 greatly simplify the emitted postscript code - JV
- 2004-11-12 Added new plotting functions spy, spy2 for sparse matrix** visualization - JDH
- 2004-11-11 Added rgrids, thetragrids for customizing the grid** locations and labels for polar plots - JDH
- 2004-11-11 make the Gtk backends build without an X-server connection - JV
- 2004-11-10 matplotlib/\_init\_.py: Added FROZEN to signal we are running under py2exe** (or similar) - is used by `backend_gtk.py` - SC
- 2004-11-09 backend\_gtk.py: Made fix suggested by maffew@cat.org.au** to prevent problems when `py2exe` calls `pygtk.require()`. - SC
- 2004-11-09 backend\_cairo.py: Added support for printing to a fileobject.** Disabled cairo PS output which is not working correctly. - SC
- 
- 2004-11-08 `matplotlib-0.64` released
- 2004-11-04 Changed -dbackend processing to only use known backends,** so we don't clobber other non-matplotlib uses of `-d`, like `-debug`.
- 2004-11-04 backend\_agg.py: added IMAGE\_FORMAT to list the formats that the backend can save to.** `backend_gtkagg.py`: added support for saving JPG files by using the GTK backend - SC
- 2004-10-31 backend\_cairo.py: now produces png and ps files (although the figure sizing needs some work).** `pycairo` did not wrap all the necessary functions, so I wrapped them myself, they are included in the `backend_cairo.py` doc string. - SC
- 2004-10-31 backend\_ps.py: clean up the generated PostScript code,** use the PostScript stack to hold intermediate values instead of storing them in the dictionary. - JV
-

**2004-10-30 backend\_ps.py, ft2font.cpp, ft2font.h: fix the position of text** in the PostScript output. The new FT2Font method `get_descent` gives the distance between the lower edge of the bounding box and the baseline of a string. In `backend_ps` the text is shifted upwards by this amount. - JV

**2004-10-30 backend\_ps.py: clean up the code a lot. Change the** PostScript output to be more DSC compliant. All definitions for the generated PostScript are now in a PostScript dictionary `'mpldict'`. Moved the long comment about drawing ellipses from the PostScript output into a Python comment. - JV

**2004-10-30 backend\_gtk.py: removed FigureCanvasGTK.realize() as its no longer** needed. Merged `ColorManager` into `GraphicsContext` `backend_bases.py`: For `set_capstyle/joinstyle()` only set cap or joinstyle if there is no error. - SC

**2004-10-30 backend\_gtk.py: tidied up print\_figure() and removed some of the** dependency on widget events - SC

**2004-10-28 backend\_cairo.py: The renderer is complete except for mathtext,** `draw_image()` and clipping. `gtkcairo` works reasonably well. `cairo` does not yet create any files since I can't figure how to set the 'target surface', I don't think `pycairo` wraps the required functions - SC

**2004-10-28 backend\_gtk.py: Improved the save dialog (GTK 2.4 only) so it** presents the user with a menu of supported image formats - SC

**2004-10-28 backend\_svg.py: change print\_figure() to restore original face/edge** color `backend_ps.py` : change `print_figure()` to ensure original face/edge colors are restored even if there's an `IOError` - SC

2004-10-27 Applied Norbert's errorbar patch to support `barsabove` kwarg

2004-10-27 Applied Norbert's legend patch to support `None` handles

**2004-10-27 Added two more backends: backend\_cairo.py, backend\_gtkcairo.py**  
They are not complete yet, currently `backend_gtkcairo` just renders polygons, rectangles and lines - SC

2004-10-21 Added polar axes and plots - JDH

**2004-10-20 Fixed corrcoef bug exposed by corrcoef(X) where X is matrix**

- JDH

**2004-10-19 Added kwarg support to xticks and yticks to set ticklabel** text properties - thanks to T. Edward Whalen for the suggestion

2004-10-19 Added support for PIL images in `imshow()`, `image.py` - ADS

**2004-10-19 Re-worked exception handling in \_image.py and \_transforms.py** to avoid masking problems with shared libraries. - JTM

**2004-10-16 Streamlined the matlab interface wrapper, removed the** `noplot` option to `hist` - just use `mlab.hist` instead.

**2004-09-30 Added Andrew Dalke's strftime code to extend the range of** dates supported by the `DateFormatter` - JDH

2004-09-30 Added `barh` - JDH

**2004-09-30 Removed fallback to alternate array package from numerix** so that `ImportErrors` are easier to debug. JTM

2004-09-30 Add `GTK+ 2.4` support for the message in the toolbar. SC

**2004-09-30 Made some changes to support python22 - lots of doc fixes.** - JDH

2004-09-29 Added a Verbose class for reporting - JDH

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2004-09-28 Released 0.63.0

**2004-09-28 Added save to file object for agg - see** examples/print\_stdout.py

2004-09-24 Reorganized all py code to lib subdir

**2004-09-24 Fixed axes resize image edge effects on interpolation -** required upgrade to agg22 which fixed an agg bug related to this problem

2004-09-20 Added toolbar2 message display for backend\_tkagg. JTM

**2004-09-17 Added coords formatter attributes. These must be callable,**

and return a string for the x or y data. These will be used to format the x and y data for the coords box. Default is the axis major formatter. e.g.:

```
# format the coords message box
def price(x): return '$%1.2f'%x
ax.format_xdata = DateFormatter('%Y-%m-%d')
ax.format_ydata = price
```

**2004-09-17 Total rewrite of dates handling to use python datetime with** num2date, date2num and drange. pytz for timezone handling, dateutils for sophisticated ticking. date ranges from 0001-9999 are supported. rrules allow arbitrary date ticking. examples/date\_demo\*.py converted to show new usage. new example examples/date\_demo\_rrule.py shows how to use rrules in date plots. The date locators are much more general and almost all of them have different constructors. See matplotlib.dates for more info.

**2004-09-15 Applied Fernando's backend \_init\_ patch to support easier** backend maintenance. Added his numutils to mlab. JDH

**2004-09-16 Re-designated all files in matplotlib/images as binary and** w/o keyword substitution using "cvs admin -kb \*.svg ...". See binary files in "info cvs" under Linux. This was messing up builds from CVS on windows since CVS was doing lf -> cr/lf and keyword substitution on the bitmaps. - JTM

**2004-09-15 Modified setup to build array-package-specific extensions** for those extensions which are array-aware. Setup builds extensions automatically for either Numeric, numarray, or both, depending on what you have installed. Python proxy modules for the array-aware extensions import the version optimized for numarray or Numeric determined by numerix. - JTM

**2004-09-15 Moved definitions of infinity from mlab to numerix to avoid** divide by zero warnings for numarray - JTM

2004-09-09 Added axhline, axvline, axhspan and axvspan

---

2004-08-30 matplotlib 0.62.4 released

**2004-08-30 Fixed a multiple images with different extent bug,** Fixed markerfacecolor as RGB tuple

**2004-08-27 Mathtext now more than 5x faster. Thanks to Paul McGuire** for fixes both to pyparsing and to the matplotlib grammar! mathtext broken on python2.2

**2004-08-25 Exposed Darren's and Greg's log ticking and formatting** options to semilogx and friends

2004-08-23 Fixed grid w/o args to toggle grid state - JDH

2004-08-11 Added Gregory's log patches for major and minor ticking

2004-08-18 Some pixel edge effects fixes for images

2004-08-18 Fixed TTF files reads in backend\_ps on win32.

**2004-08-18 Added base and subs properties for logscale plots, user** modifiable using `set_[x,y]scale('log',base=b,subs=[mt1,mt2,...])` - GL

**2004-08-18 fixed a bug exposed by trying to find the HOME dir on win32** thanks to Alan Issac for pointing to the light - JDH

2004-08-18 fixed errorbar bug in setting ecolord - JDH

2004-08-12 Added Darren Dale's exponential ticking patch

2004-08-11 Added Gregory's fltkagg backend

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2004-08-09 matplotlib-0.61.0 released

**2004-08-08 backend\_gtk.py: get rid of the final PyGTK deprecation warning by** replacing `gtkOptionMenu` with `gtkMenu` in the 2.4 version of the classic toolbar.

**2004-08-06 Added Tk zoom to rect rectangle, proper idle drawing, and** keybinding - JDH

2004-08-05 Updated installing.html and INSTALL - JDH

2004-08-01 backend\_gtk.py: move all drawing code into the `expose_event()`

2004-07-28 Added Greg's toolbar2 and backend\_\*agg patches - JDH

**2004-07-28 Added image.imread with support for loading png into** numerix arrays

**2004-07-28 Added key modifiers to events - implemented dynamic updates** and rubber banding for interactive pan/zoom - JDH

**2004-07-27 did a readthrough of SVG, replacing all the string** additions with string interps for efficiency, fixed some layout problems, added font and image support (through external pngs) - JDH

**2004-07-25 backend\_gtk.py: modify toolbar2 to make it easier to support GTK+** 2.4. Add GTK+ 2.4 toolbar support. - SC

2004-07-24 backend\_gtk.py: Simplified classic toolbar creation - SC

**2004-07-24 Added images/matplotlib.svg to be used when GTK+ windows are** minimised - SC

**2004-07-22 Added right mouse click zoom for NavigationToolbar2 panning** mode. - JTM

**2004-07-22 Added NavigationToolbar2 support to backend\_tkagg.** Minor tweak to backend\_bases. - JTM

**2004-07-22 Incorporated Gergory's renderer cache and buffer object** cache - JDH

**2004-07-22 Backend\_gtk.py: Added support for GtkFileChooser, changed** FileSelection/FileChooser so that only one instance pops up, and made them both modal. - SC

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**2004-07-21 Applied backend\_agg memory leak patch from hayden - jocallo@online.no.** Found and fixed a leak in binary operations on transforms. Moral of the story: never incref where you meant to decref! Fixed several leaks in ft2font: moral of story: almost always return Py::asObject over Py::Object - JDH

**2004-07-21 Fixed a to string memory allocation bug in agg and image modules - JDH**

**2004-07-21 Added mpl\_connect and mpl\_disconnect to matlab interface - JDH**

2004-07-21 Added beginnings of users\_guide to CVS - JDH

2004-07-20 ported toolbar2 to wx

2004-07-20 upgraded to agg21 - JDH

2004-07-20 Added new icons for toolbar2 - JDH

**2004-07-19 Added vertical mathtext for \*Agg and GTK - thanks Jim Benson! - JDH**

2004-07-16 Added ps/eps/svg savefig options to wx and gtk JDH

2004-07-15 Fixed python framework tk finder in setupest.py - JDH

**2004-07-14 Fixed layer images demo which was broken by the 07/12 image extent fixes - JDH**

**2004-07-13 Modified line collections to handle arbitrary length segments for each line segment. - JDH**

**2004-07-13 Fixed problems with image extent and origin - set\_image\_extent deprecated. Use imshow(blah, blah, extent=(xmin, xmax, ymin, ymax) instead - JDH**

**2004-07-12 Added prototype for new nav bar with codified event handling.** Use mpl\_connect rather than connect for matplotlib event handling. toolbar style determined by rc toolbar param. backend status: gtk: prototype, wx: in progress, tk: not started - JDH

**2004-07-11 backend\_gtk.py: use builtin round() instead of redefining it.**

- SC

2004-07-10 Added embedding\_in\_wx3 example - ADS

2004-07-09 Added dynamic\_image\_wxagg to examples - ADS

2004-07-09 added support for embedding TrueType fonts in PS files - PEB

2004-07-09 fixed a sfnt bug exposed if font cache is not built

**2004-07-09 added default arg None to matplotlib.matlab grid command to toggle current grid state**

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2004-07-08 0.60.2 released

2004-07-08 fixed a mathtext bug for '6'

2004-07-08 added some numarray bug workarounds

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2004-07-07 0.60 released

2004-07-07 Fixed a bug in dynamic\_demo\_wx

**2004-07-07 backend\_gtk.py: raise SystemExit immediately if 'import pygtk' fails - SC**

- 2004-07-05 Added new `mathtext` commands `over{sym1}{sym2}` and `under{sym1}{sym2}`**
- 2004-07-05 Unified image and patch collections `colormapping` and scaling args.** Updated docstrings for all - JDH
- 2004-07-05 Fixed a figure legend bug and added `examples/figlegend_demo.py`** - JDH
- 2004-07-01 Fixed a memory leak in image and agg to string methods
- 2004-06-25 Fixed `fonts_demo` spacing problems and added a `kwargs` version of the `fonts_demo` `fonts_demo_kw.py`** - JDH
- 2004-06-25 `finance.py`: handle case when `urlopen()` fails - SC
- 2004-06-24 Support for multiple images on axes and figure, with blending.** Support for upper and lower image origins. `clim`, `jet` and `gray` functions in matlab interface operate on current image - JDH
- 2004-06-23 ported code to Perry's new colormap and norm scheme. Added new rc attributes `image.aspect`, `image.interpolation`, `image.cmap`, `image.lut`, `image.origin`**
- 2004-06-20 `backend_gtk.py`: replace `gtk.TRUE/FALSE` with `True/False`.** simplified `_make_axis_menu()`. - SC
- 2004-06-19 `anim_tk.py`: Updated to use TkAgg by default (not GTK)**  
`backend_gtk.py`: Added `'_'` in front of private widget creation functions - SC
- 2004-06-17 `backend_gtk.py`: Create a GC once in `realise()`, not every time `draw()` is called.** - SC
- 2004-06-16 Added new py2exe FAQ entry and added frozen support in `get_data_path`** for py2exe - JDH
- 2004-06-16 Removed GTKGD, which was always just a proof-of-concept backend** - JDH
- 2004-06-16 `backend_gtk.py` updates to replace deprecated functions**  
**`gtk.mainquit()`, `gtk.mainloop()`.** Update `NavigationToolbar` to use the new `GtkToolBar` API - SC
- 2004-06-15 removed `set_default_font` from `font_manager` to unify font customization** using the new function `rc`. See `API_CHANGES` for more info. The examples `fonts_demo.py` and `fonts_demo_kw.py` are ported to the new API - JDH
- 2004-06-15 Improved (yet again!) axis scaling to properly handle singleton plots** - JDH
- 2004-06-15 Restored the old `FigureCanvasGTK.draw()` - SC
- 2004-06-11 More memory leak fixes in transforms and `ft2font` - JDH
- 2004-06-11 Eliminated numerix .numerix file and environment variable `NUMERIX`.** Fixed bug which prevented command line overrides: `-numarray` or `-numeric`. - JTM
- 2004-06-10 Added rc configuration function `rc`; deferred all rc param setting until** object creation time; added new rc attrs: `lines.markerfacecolor`, `lines.markeredgewidth`, `lines.markeredgewidth`, `patch.linewidth`, `patch.facecolor`, `patch.edgecolor`, `patch.antialiased`; see `examples/customize_rc.py` for usage - JDH

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2004-06-09 0.54.2 released

- 
- 2004-06-08 Rewrote ft2font using CXX as part of general memory leak** fixes; also fixed transform memory leaks - JDH
  - 2004-06-07 Fixed several problems with log ticks and scaling - JDH
  - 2004-06-07 Fixed width/height issues for images - JDH
  - 2004-06-03 Fixed draw\_if\_interactive bug for semilogx;
  - 2004-06-02 Fixed text clipping to clip to axes - JDH
  - 2004-06-02 Fixed leading newline text and multiple newline text - JDH
  - 2004-06-02 Fixed plot\_date to return lines - JDH
  - 2004-06-01 Fixed plot to work with x or y having shape N,1 or 1,N - JDH
  - 2004-05-31 Added renderer markeredgewidth attribute of Line2D. - ADS
  - 2004-05-29 Fixed tick label clipping to work with navigation.
  - 2004-05-28 Added renderer grouping commands to support groups in SVG/PS.** - JDH
  - 2004-05-28 Fixed, this time I really mean it, the singleton plot** plot([0]) scaling bug; Fixed Flavio's shape = N,1 bug - JDH
  - 2004-05-28 added colorbar - JDH
  - 2004-05-28 Made some changes to the matplotlib.colors.Colormap** to properly support clim - JDH
- 

2004-05-27 0.54.1 released

- 2004-05-27 Lots of small bug fixes: rotated text at negative angles,** errorbar capsize and autoscaling, right tick label position, gtkagg on win98, alpha of figure background, singleton plots - JDH
  - 2004-05-26 Added Gary's errorbar stuff and made some fixes for length** one plots and constant data plots - JDH
  - 2004-05-25 Tweaked TkAgg backend so that canvas.draw() works** more like the other backends. Fixed a bug resulting in 2 draws per figure mangager show(). - JTM
- 

2004-05-19 0.54 released

- 2004-05-18 Added newline separated text with rotations to text.Text** layout - JDH
  - 2004-05-16 Added fast pcolor using PolyCollections. - JDH
  - 2004-05-14 Added fast polygon collections - changed scatter to use** them. Added multiple symbols to scatter. 10x speedup on large scatters using \*Agg and 5X speedup for ps. - JDH
  - 2004-05-14 On second thought... created an "nx" namespace in** numerix which maps type names onto typecodes the same way for both numarray and Numeric. This undoes my previous change immediately below. To get a typename for Int16 useable in a Numeric extension: say nx.Int16. - JTM
  - 2004-05-15 Rewrote transformation class in extension code, simplified** all the artist constructors - JDH
-

**2004-05-14 Modified the type definitions in the numarray side of numerix** so that they are Numeric typecodes and can be used with Numeric complex extensions. The original numarray types were renamed to type<old\_name>. - JTM

**2004-05-06 Gary Ruben sent me a bevy of new plot symbols and markers.** See matplotlib.matlab.plot - JDH

**2004-05-06 Total rewrite of mathtext - factored ft2font stuff out of layout engine** and defined abstract class for font handling to lay groundwork for ps mathtext. Rewrote parser and made layout engine much more precise. Fixed all the layout hacks. Added spacing commands / and hspace. Added composite chars and defined angstrom. - JDH

**2004-05-05 Refactored text instances out of backend; aligned text** with arbitrary rotations is now supported - JDH

2004-05-05 Added a Matrix capability for numarray to numerix. JTM

**2004-05-04 Updated whats\_new.html.template to use dictionary and template loop,** added anchors for all versions and items; updated goals.txt to use those for links. PG

**2004-05-04 Added fonts\_demo.py to backend\_driver, and AFM and TTF font caches** to font\_manager.py - PEB

**2004-05-03 Redid goals.html.template to use a goals.txt file that has a pseudo re-**structured text organization. PG

**2004-05-03 Removed the close buttons on all GUIs and added the python #!** bang line to the examples following Steve Chaplin's advice on matplotlib dev

**2004-04-29 Added CXX and rewrote backend\_agg using it; tracked down and fixed** agg memory leak - JDH

2004-04-29 Added stem plot command - JDH

2004-04-28 Fixed PS scaling and centering bug - JDH

2004-04-26 Fixed errorbar autoscale problem - JDH

**2004-04-22 Fixed copy tick attribute bug, fixed singular datalim ticker bug;** fixed mathtext fontsize interactive bug. - JDH

**2004-04-21 Added calls to draw\_if\_interactive to axes(), legend(), and pcolor().** Deleted duplicate pcolor(). - JTM

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2004-04-21 matplotlib 0.53 release

2004-04-19 Fixed vertical alignment bug in PS backend - JDH

**2004-04-17 Added support for two scales on the "same axes" with tick** different ticking and labeling left right or top bottom. See examples/two\_scales.py - JDH

**2004-04-17 Added default dirs as list rather than single dir in setuext.py** - JDH

**2004-04-16 Fixed wx exception swallowing bug (and there was much rejoicing!)** - JDH

**2004-04-16 Added new ticker locator a formatter, fixed default font return** - JDH

**2004-04-16 Added get\_name method to FontProperties class. Fixed font lookup** in GTK and WX backends. - PEB

- 2004-04-16 Added get- and set\_fontstyle mmethods. - PEB
- 2004-04-10 Mathtext fixes: scaling with dpi, - JDH
- 2004-04-09 Improved font detection algorithm. - PEB
- 2004-04-09 Move deprecation warnings from text.py to \_\_init\_\_.py - PEB
- 2004-04-09 Added default font customization - JDH
- 2004-04-08 Fixed viewlim set problem on axes and axis. - JDH
- 2004-04-07 Added validate\_comma\_sep\_str and font properties paramaters to \_\_init\_\_.** Removed font families and added rcParams to FontProperties \_\_init\_\_ arguments in font\_manager. Added default font property parameters to .matplotlibrc file with descriptions. Added deprecation warnings to the get\_ - and set\_fontXXX methods of the Text object. - PEB
- 2004-04-06 Added load and save commands for ASCII data - JDH
- 2004-04-05 Improved font caching by not reading AFM fonts until needed.** Added better documentation. Changed the behaviour of the get\_family, set\_family, and set\_name methods of FontProperties. - PEB
- 2004-04-05 Added WXAgg backend - JDH
- 2004-04-04 Improved font caching in backend\_agg with changes to font\_manager** - JDH
- 2004-03-29 Fixed fontdicts and kwargs to work with new font manager** - JDH

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This is the Old, stale, never used changelog

**2002-12-10 - Added a TODO file and CHANGELOG. Lots to do - get**

crackin'!

- Fixed y zoom tool bug
- Adopted a compromise fix for the y data clipping problem. The problem was that for solid lines, the y data clipping (as opposed to the gc clipping) caused artifactual horizontal solid lines near the ylim boundaries. I did a 5% offset hack in Axes set\_ylim functions which helped, but didn't cure the problem for very high gain y zooms. So I disabled y data clipping for connected lines . If you need extensive y clipping, either plot(y,x) because x data clipping is always enabled, or change the \_set\_clip code to 'if 1' as indicated in the lines.py src. See \_set\_clip in lines.py and set\_ylim in figure.py for more information.

**2002-12-11 - Added a measurement dialog to the figure window to**

measure axes position and the delta x delta y with a left mouse drag. These defaults can be overridden by deriving from Figure and overriding button\_press\_event, button\_release\_event, and motion\_notify\_event, and \_dialog\_measure\_tool.

- fixed the navigation dialog so you can check the axes the navigation buttons apply to.

2003-04-23 Released matplotlib v0.1

**2003-04-24 Added a new line style PixelLine2D which is the plots the markers as pixels (as small as possible) with format symbol ','**

Added a new class Patch with derived classes Rectangle, RegularPolygon and Circle

2003-04-25 Implemented new functions errorbar, scatter and hist

Added a new line type '|' which is a vline. syntax is plot(x, Y, '|') where y.shape = len(x),2 and each row gives the ymin,ymax for the respective values of x. Previously I had implemented vlins as a list of lines, but I needed the efficiency of the numeric clipping for large numbers of vlins outside the viewport, so I wrote a dedicated class Vline2D which derives from Line2D

2003-05-01

Fixed ytick bug where grid and tick show outside axis viewport with gc clip

2003-05-14

Added new ways to specify colors 1) matlab format string 2) html-style hex string, 3) rgb tuple. See examples/color\_demo.py

2003-05-28

Changed figure rendering to draw from a pixmap to reduce flicker. See examples/system\_monitor.py for an example where the plot is continuously updated w/o flicker. This example is meant to simulate a system monitor that shows free CPU, RAM, etc...

2003-08-04

Added Jon Anderson's GTK shell, which doesn't require pygtk to have threading built-in and looks nice!

2003-08-25

Fixed deprecation warnings for python2.3 and pygtk-1.99.18

2003-08-26

Added figure text with new example examples/figtext.py

2003-08-27

Fixed bugs i figure text with font override dictionaries and fig text that was placed outside the window bounding box

2003-09-1 thru 2003-09-15

Added a postscript and a GD module backend

2003-09-16

Fixed font scaling and point scaling so circles, squares, etc on lines will scale with DPI as will fonts. Font scaling is not fully implemented on the gtk backend because I have not figured out how to scale fonts to arbitrary sizes with GTK

2003-09-17

Fixed figure text bug which crashed X windows on long figure text extending beyond display area. This was, I believe, due to the vestigial erase functionality that was no longer needed since I began rendering to a pixmap

2003-09-30 Added legend

**2003-10-01 Fixed bug when colors are specified with rgb tuple or hex string.**

**2003-10-21 Andrew Straw provided some legend code which I modified** and incorporated. Thanks Andrew!

**2003-10-27 Fixed a bug in axis.get\_view\_distance that affected zoom in** versus out with interactive scrolling, and a bug in the axis text reset system that prevented the text from being redrawn on a interactive gtk view lim set with the widget

Fixed a bug in that prevented the manual setting of ticklabel strings from working properly

**2003-11-02 - Do a nearest neighbor color pick on GD when** allocate fails

**2003-11-02**

- Added pcolor plot
- Added MRI example
- Fixed bug that screwed up label position if xticks or yticks were empty
- added nearest neighbor color picker when GD max colors exceeded
- fixed figure background color bug in GD backend

**2003-11-10 - 2003-11-11**

- major refactoring.
  - Ticks (with labels, lines and grid) handled by dedicated class
  - Artist now know bounding box and dpi
  - Bounding boxes and transforms handled by dedicated classes
  - legend in dedicated class. Does a better job of alignment and bordering. Can be initialized with specific line instances. See examples/legend\_demo2.py

2003-11-14 Fixed legend positioning bug and added new position args

2003-11-16 Finsihed porting GD to new axes API

2003-11-20 - add TM for matlab on website and in docs

2003-11-20 - make a nice errorbar and scatter screenshot

**2003-11-20 - auto line style cycling for multiple line types** broken

2003-11-18 (using inkrect) :logical rect too big on gtk backend

**2003-11-18 ticks don't reach edge of axes in gtk mode** - rounding error?

2003-11-20 - port Gary's errorbar code to new API before 0.40

**2003-11-20 - problem with stale \_set\_font. legend axes box** doesn't resize on save in GTK backend - see htdocs legend\_demo.py

2003-11-21 - make a dash-dot dict for the GC

2003-12-15 - fix install path bug

## 7.2 New in matplotlib 0.98.4

### Table of Contents

- *New in matplotlib 0.98.4*

- Legend enhancements
- Fancy annotations and arrows
- Native OS X backend
- psd amplitude scaling
- Fill between
- Lots more

It's been four months since the last matplotlib release, and there are a lot of new features and bug-fixes.

Thanks to Charlie Moad for testing and preparing the source release, including binaries for OS X and Windows for python 2.4 and 2.5 (2.6 and 3.0 will not be available until numpy is available on those releases). Thanks to the many developers who contributed to this release, with contributions from Jae-Joon Lee, Michael Droettboom, Ryan May, Eric Firing, Manuel Metz, Jouni K. Seppänen, Jeff Whitaker, Darren Dale, David Kaplan, Michiel de Hoon and many others who submitted patches

### 7.2.1 Legend enhancements

Jae-Joon has rewritten the legend class, and added support for multiple columns and rows, as well as fancy box drawing. See `legend()` and `matplotlib.legend.Legend`.

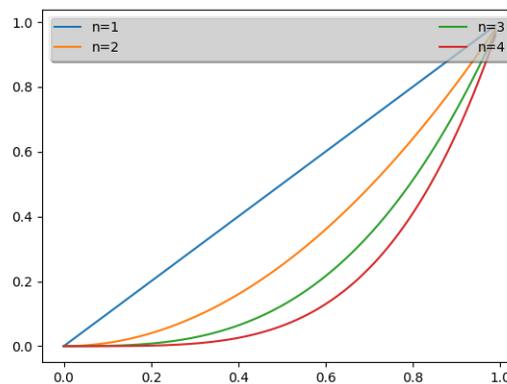


Fig. 1: Whats New 98 4 Legend

### 7.2.2 Fancy annotations and arrows

Jae-Joon has added lots of support to annotations for drawing fancy boxes and connectors in annotations. See `annotate()` and `BoxStyle`, `ArrowStyle`, and `ConnectionStyle`.

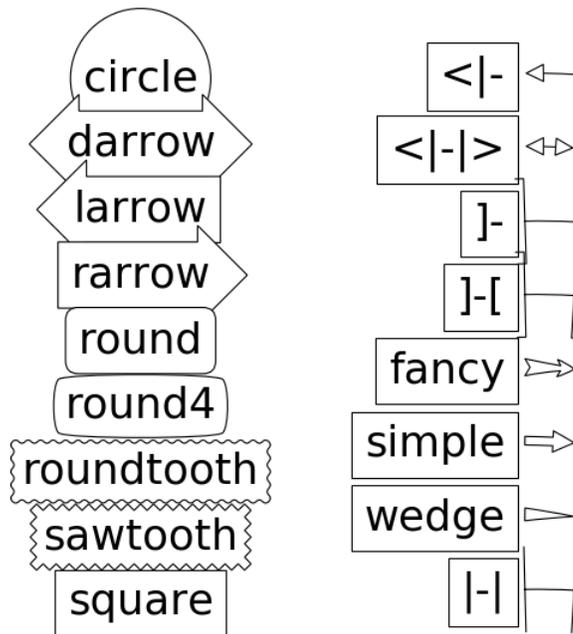


Fig. 2: Whats New 98 4 Fancy

### 7.2.3 Native OS X backend

Michiel de Hoon has provided a native Mac OSX backend that is almost completely implemented in C. The backend can therefore use Quartz directly and, depending on the application, can be orders of magnitude faster than the existing backends. In addition, no third-party libraries are needed other than Python and NumPy. The backend is interactive from the usual terminal application on Mac using regular Python. It hasn't been tested with ipython yet, but in principle it should to work there as well. Set 'backend : macosx' in your matplotlibrc file, or run your script with:

```
> python myfile.py -dmacosx
```

### 7.2.4 psd amplitude scaling

Ryan May did a lot of work to rationalize the amplitude scaling of `psd()` and friends. See [/gallery/lines\\_bars\\_and\\_markers/psd\\_demo](#). The changes should increase MATLAB compatibility and increase scaling options.

### 7.2.5 Fill between

Added a `fill_between()` function to make it easier to do shaded region plots in the presence of masked data. You can pass an `x` array and a `ylower` and `yupper` array to fill between, and an optional `where` argument which is a logical mask where you want to do the filling.

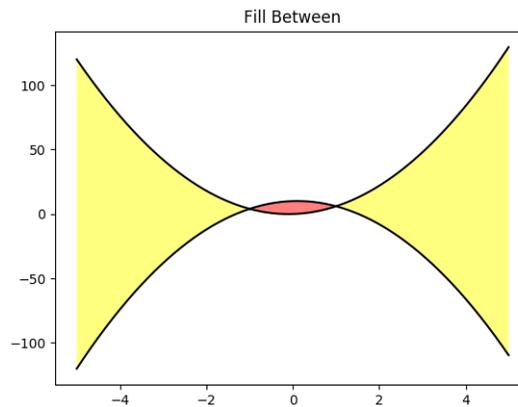


Fig. 3: Whats New 98 4 Fill Between

## 7.2.6 Lots more

Here are the 0.98.4 notes from the CHANGELOG:

Added mdehoon's native macosx backend from sf patch 2179017 - JDH

Removed the prints in the set\_\*style commands. Return the list of pretty-printed strings instead - JDH

Some of the changes Michael made to improve the output of the property tables in the rest docs broke or made difficult to use some of the interactive doc helpers, e.g., setp and getp. Having all the rest markup in the ipython shell also confused the docstrings. I added a new rc param docstring.harcopy, to format the docstrings differently for hardcopy and other use. The ArtistInspector could use a little refactoring now since there is duplication of effort between the rest output and the non-rest output - JDH

Updated spectral methods (psd, csd, etc.) to scale one-sided densities by a factor of 2 and, optionally, scale all densities by the sampling frequency. This gives better MATLAB compatibility. -RM

Fixed alignment of ticks in colorbars. -MGD

drop the deprecated "new" keyword of np.histogram() for numpy 1.2 or later. -JJL

Fixed a bug in svg backend that new\_figure\_manager() ignores keywords arguments such as figsize, etc. -JJL

Fixed a bug that the handlelength of the new legend class set too short when numpoints=1 -JJL

Added support for data with units (e.g., dates) to

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Axes.fill\_between. -RM

Added fancybox keyword to legend. Also applied some changes for better look, including baseline adjustment of the multiline texts so that it is center aligned. -JLL

The transmuter classes in the patches.py are reorganized as subclasses of the Style classes. A few more box and arrow styles are added. -JLL

Fixed a bug in the new legend class that didn't allowed a tuple of coordinate values as loc. -JLL

Improve checks for external dependencies, using subprocess (instead of deprecated popen\*) and distutils (for version checking) - DSD

Reimplementation of the legend which supports baseline alignment, multi-column, and expand mode. - JLL

Fixed histogram autoscaling bug when bins or range are given explicitly (fixes Debian bug 503148) - MM

Added rcParam axes.unicode\_minus which allows plain hyphen for minus when False - JDH

Added scatterpoints support in Legend. patch by Erik Tollerud - JLL

Fix crash in log ticking. - MGD

Added static helper method BrokenHBarCollection.span\_where and Axes/pyplot method fill\_between. See examples/pylab/fill\_between.py - JDH

Add x\_isdata and y\_isdata attributes to Artist instances, and use them to determine whether either or both coordinates are used when updating dataLim. This is used to fix autoscaling problems that had been triggered by axhline, axhspan, axvline, axvspan. - EF

Update the psd(), csd(), cohere(), and specgram() methods of Axes and the csd() cohere(), and specgram() functions in mlab to be in sync with the changes to psd(). In fact, under the hood, these all call the same core to do computations. - RM

Add 'pad\_to' and 'sides' parameters to mlab.psd() to allow controlling of zero padding and returning of negative frequency components, respectively. These are added in a way that does not change the API. - RM

Fix handling of c kwarg by scatter; generalize is\_string\_like to accept numpy and numpy.ma string array scalars. - RM and EF

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Fix a possible EINTR problem **in** `dviread`, which might help when saving pdf files **from** `the qt` backend. - JKS

Fix bug **with** `zoom to rectangle` **and** `twin axes` - MGD

Added Jae Joon's **fancy arrow, box and annotation enhancements** -- see `examples/pylab_examples/annotation_demo2.py`

Autoscaling **is** now supported **with** `shared axes` - EF

Fixed exception **in** `dviread` that happened **with** `Minion` - JKS

`set_xlim, ylim` now **return** a copy of the `viewlim` array to avoid modify inplace surprises

Added image thumbnail generating function `matplotlib.image.thumbnail`. See `examples/misc/image_thumbnail.py` - JDH

Applied `scatleg` patch based on ideas **and** work by Erik Tollerud **and** Jae-Joon Lee. - MM

Fixed bug **in** pdf backend: **if** you **pass** a file **object for** output instead of a filename, e.g., **in** a web app, we now flush the **object** at the end. - JKS

Add path simplification support to `paths` **with** `gaps`. - EF

Fix problem **with** AFM files that don't **specify the font's** full name **or** family name. - JKS

Added `'scilimits'` kwarg to `Axes.ticklabel_format()` method, **for** easy access to the `set_powerlimits` method of the major `ScalarFormatter`. - EF

Experimental new kwarg `borderpad` to replace `pad` **in** legend, based on suggestion by Jae-Joon Lee. - EF

Allow `spy` to ignore zero values **in** sparse arrays, based on patch by Tony Yu. Also fixed `plot` to handle empty data arrays, **and** fixed handling of markers **in** `figlegend`. - EF

Introduce drawstyles **for** lines. Transparently split linestyles like `'steps--'` into drawstyle `'steps'` **and** linestyle `'--'`. Legends always use drawstyle `'default'`. - MM

Fixed `quiver` **and** `quiverkey` bugs (failure to scale properly when resizing) **and** added additional methods **for** determining the arrow angles - EF

Fix polar interpolation to handle negative values of `theta` - MGD

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Reorganized cbook **and** mlab methods related to numerical calculations that have little to do **with** the goals of those two modules into a separate module `numerical_methods.py`. Also, added ability to select points **and** stop point selection **with** keyboard **in** `ginput` **and** manual contour labeling code. Finally, fixed contour labeling bug. - DMK

Fix backtick **in** Postscript output. - MGD

[ 2089958 ] Path simplification **for** vector output backends  
Leverage the simplification code exposed through `path_to_polygons` to simplify certain well-behaved paths **in** the vector backends (PDF, PS **and** SVG). "`path.simplify`" must be **set** to **True** **in** `matplotlibrc` **for** this to work. - MGD

Add "`filled`" kwarg to `Path.intersects_path` **and** `Path.intersects_bbox`. - MGD

Changed full arrows slightly to avoid an xpdf rendering problem reported by Friedrich Hagedorn. - JKS

Fix conversion of quadratic to cubic Bezier curves **in** PDF **and** PS backends. Patch by Jae-Joon Lee. - JKS

Added 5-point star marker to plot command `q-` EF

Fix hatching **in** PS backend - MGD

Fix log **with** base 2 - MGD

Added support **for** bilinear interpolation **in** `NonUniformImage`; patch by Gregory Lielens. - EF

Added support **for** multiple histograms **with** data of different length - MM

Fix step plots **with** log scale - MGD

Fix masked arrays **with** markers **in** non-Agg backends - MGD

Fix `clip_on` kwarg so it actually works correctly - MGD

Fix locale problems **in** SVG backend - MGD

fix quiver so masked values are **not** plotted - JSW

improve interactive pan/zoom **in** qt4 backend on windows - DSD

Fix more bugs **in** NaN/inf handling. In particular, path simplification (which does **not** handle NaNs **or** infs) will be turned off automatically when infs **or** NaNs are present. Also masked

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arrays are now converted to arrays **with** NaNs **for** consistent handling of masks **and** NaNs - MGD **and** EF

Added support **for** arbitrary rasterization resolutions to the SVG backend. - MW

## 7.3 New in matplotlib 0.99

### Table of Contents

- *New in matplotlib 0.99*
  - *New documentation*
  - *mplot3d*
  - *axes grid toolkit*
  - *Axis spine placement*

### 7.3.1 New documentation

Jae-Joon Lee has written two new guides *Legend guide* and *Advanced Annotation*. Michael Sarahan has written *Image tutorial*. John Hunter has written two new tutorials on working with paths and transformations: *Path Tutorial* and *Transformations Tutorial*.

### 7.3.2 mplot3d

Reinier Heeres has ported John Porter's mplot3d over to the new matplotlib transformations framework, and it is now available as a toolkit `mpl_toolkits.mplot3d` (which now comes standard with all mpl installs). See `mplot3d-examples-index` and *Getting started*

### 7.3.3 axes grid toolkit

Jae-Joon Lee has added a new toolkit to ease displaying multiple images in matplotlib, as well as some support for curvilinear grids to support the world coordinate system. The toolkit is included standard with all new mpl installs. See `axes_grid1-examples-index`, `axisartist-examples-index`, *What is axes\_grid1 toolkit?* and *axisartist*

### 7.3.4 Axis spine placement

Andrew Straw has added the ability to place "axis spines" - the lines that denote the data limits - in various arbitrary locations. No longer are your axis lines constrained to be a simple rectangle around the figure - you can turn on or off left, bottom, right and top, as well as "detach" the spine to offset it away from the data. See `/gallery/ticks_and_spines/spine_placement_demo` and `matplotlib.spines.Spine`.

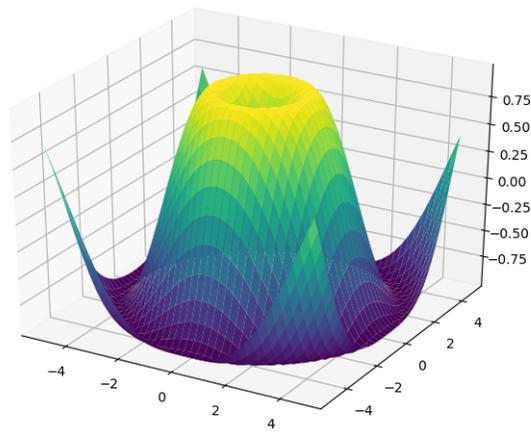


Fig. 4: Whats New 99 Mplot3d

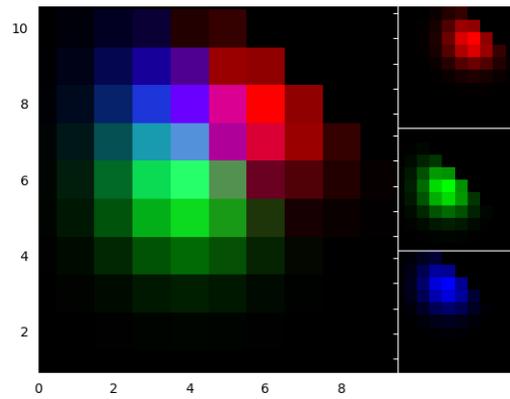


Fig. 5: Whats New 99 Axes Grid

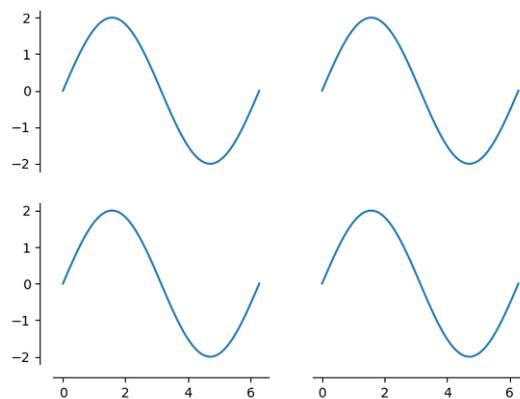


Fig. 6: Whats New 99 Spines

## 7.4 New in matplotlib 1.0

### Table of Contents

- *New in matplotlib 1.0*
  - *HTML5/Canvas backend*
  - *Sophisticated subplot grid layout*
  - *Easy pythonic subplots*
  - *Contour fixes and and triplot*
  - *multiple calls to show supported*
  - *mplot3d graphs can be embedded in arbitrary axes*
  - *tick\_params*
  - *Lots of performance and feature enhancements*
  - *Much improved software carpentry*
  - *Bugfix marathon*

### 7.4.1 HTML5/Canvas backend

Simon Ratcliffe and Ludwig Schwardt have released an [HTML5/Canvas](#) backend for matplotlib. The backend is almost feature complete, and they have done a lot of work comparing their html5 rendered images with our core renderer Agg. The backend features client/server interactive navigation of matplotlib figures in an html5 compliant browser.

### 7.4.2 Sophisticated subplot grid layout

Jae-Joon Lee has written *gridspec*, a new module for doing complex subplot layouts, featuring row and column spans and more. See *Customizing Figure Layouts Using GridSpec and Other Functions* for a tutorial overview.

### 7.4.3 Easy pythonic subplots

Fernando Perez got tired of all the boilerplate code needed to create a figure and multiple subplots when using the matplotlib API, and wrote a *subplots()* helper function. Basic usage allows you to create the figure and an array of subplots with numpy indexing (starts with 0). e.g.:

```
fig, axarr = plt.subplots(2, 2)
axarr[0,0].plot([1,2,3]) # upper, left
```

See [/gallery/subplots\\_axes\\_and\\_figures/subplot\\_demo](#) for several code examples.

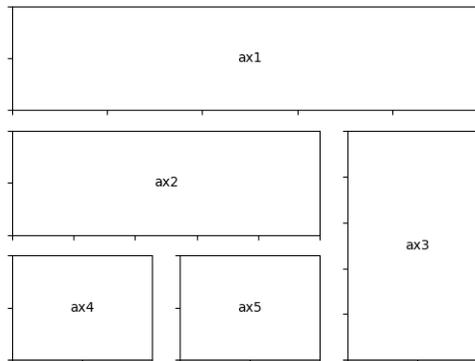


Fig. 7: Demo Gridspec01

#### 7.4.4 Contour fixes and and triplot

Ian Thomas has fixed a long-standing bug that has vexed our most talented developers for years. `contourf()` now handles interior masked regions, and the boundaries of line and filled contours coincide.

Additionally, he has contributed a new module `tri` and helper function `triplot()` for creating and plotting unstructured triangular grids.

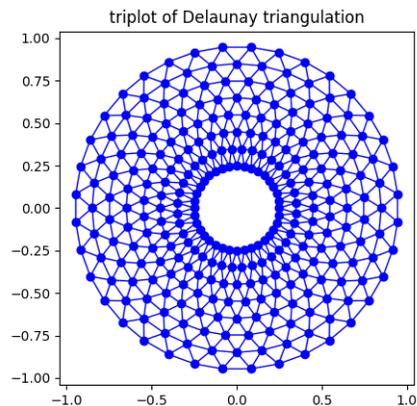


Fig. 8: Triplot Demo

#### 7.4.5 multiple calls to show supported

A long standing request is to support multiple calls to `show()`. This has been difficult because it is hard to get consistent behavior across operating systems, user interface toolkits and versions. Eric Firing has done a lot of work on rationalizing show across backends, with the desired behavior to make show raise all newly created figures and block execution until they are closed. Repeated calls to show should raise newly created figures since the last call. Eric has done a lot of testing on the user interface toolkits and versions and platforms he has

access to, but it is not possible to test them all, so please report problems to the [mailing list](#) and [bug tracker](#).

### 7.4.6 mplot3d graphs can be embedded in arbitrary axes

You can now place an mplot3d graph into an arbitrary axes location, supporting mixing of 2D and 3D graphs in the same figure, and/or multiple 3D graphs in a single figure, using the "projection" keyword argument to `add_axes` or `add_subplot`. Thanks Ben Root.

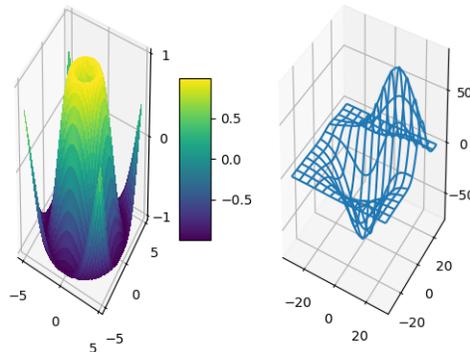


Fig. 9: Whats New 1 Subplot3d

### 7.4.7 tick\_params

Eric Firing wrote `tick_params`, a convenience method for changing the appearance of ticks and tick labels. See pyplot function `tick_params()` and associated Axes method `tick_params()`.

### 7.4.8 Lots of performance and feature enhancements

- Faster magnification of large images, and the ability to zoom in to a single pixel
- Local installs of documentation work better
- Improved "widgets" - mouse grabbing is supported
- More accurate snapping of lines to pixel boundaries
- More consistent handling of color, particularly the alpha channel, throughout the API

### 7.4.9 Much improved software carpentry

The matplotlib trunk is probably in as good a shape as it has ever been, thanks to improved [software carpentry](#). We now have a [buildbot](#) which runs a suite of [nose](#) regression tests on every svn commit, auto-generating a set of images and comparing them against a set of

known-goods, sending emails to developers on failures with a pixel-by-pixel image comparison. Releases and release bugfixes happen in branches, allowing active new feature development to happen in the trunk while keeping the release branches stable. Thanks to Andrew Straw, Michael Droettboom and other matplotlib developers for the heavy lifting.

#### 7.4.10 Bugfix marathon

Eric Firing went on a bug fixing and closing marathon, closing over 100 bugs on the [bug tracker](#) with help from Jae-Joon Lee, Michael Droettboom, Christoph Gohlke and Michiel de Hoon.

## 7.5 New in matplotlib 1.1

### Table of Contents

- *New in matplotlib 1.1*
  - *Sankey Diagrams*
  - *Animation*
  - *Tight Layout*
  - *PyQT4, PySide, and IPython*
  - *Legend*
  - *mplot3d*
  - *Numerix support removed*
  - *Markers*
  - *Other improvements*

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**Note:** matplotlib 1.1 supports Python 2.4 to 2.7

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#### 7.5.1 Sankey Diagrams

Kevin Davies has extended Yannick Copin's original Sankey example into a module (*sankey*) and provided new examples ([/gallery/specialty\\_plots/sankey\\_basics](#), [/gallery/specialty\\_plots/sankey\\_links](#), [/gallery/specialty\\_plots/sankey\\_rankine](#)).

#### 7.5.2 Animation

Ryan May has written a backend-independent framework for creating animated figures. The *animation* module is intended to replace the backend-specific examples formerly in the

Rankine Power Cycle: Example 8.6 from Moran and Shapiro  
 "Fundamentals of Engineering Thermodynamics", 6th ed., 2008

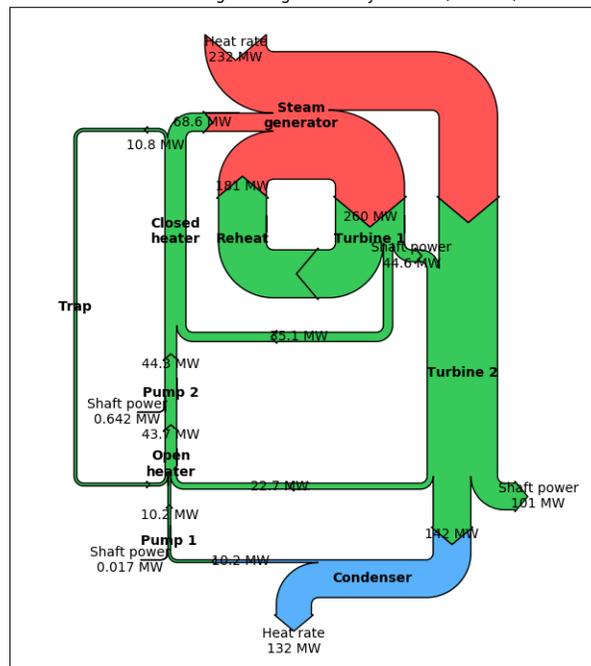


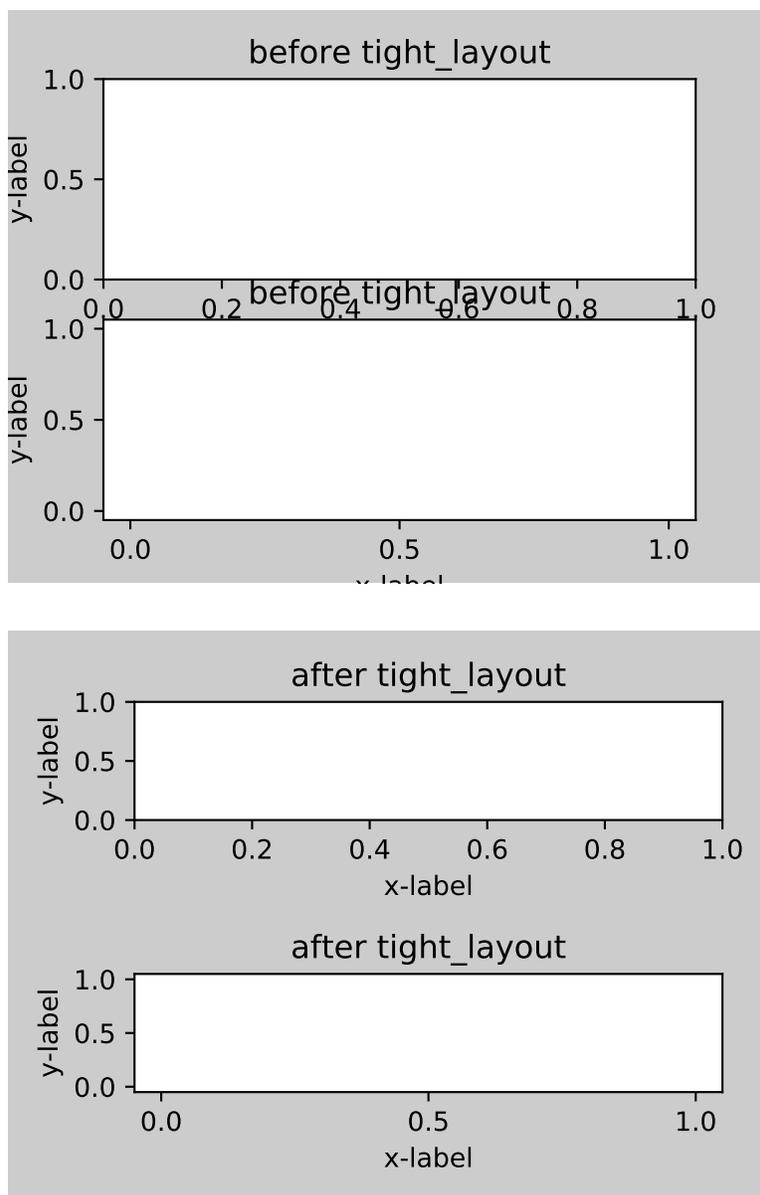
Fig. 10: Sankey Rankine

examples-index listings. Examples using the new framework are in animation-examples-index; see the entrancing double pendulum <gallery/animation/double\_pendulum\_sgskip.py> which uses `matplotlib.animation.Animation.save()` to create the movie below.

This should be considered as a beta release of the framework; please try it and provide feedback.

### 7.5.3 Tight Layout

A frequent issue raised by users of matplotlib is the lack of a layout engine to nicely space out elements of the plots. While matplotlib still adheres to the philosophy of giving users complete control over the placement of plot elements, Jae-Joon Lee created the `tight_layout` module and introduced a new command `tight_layout()` to address the most common layout issues.



The usage of this functionality can be as simple as

```
plt.tight_layout()
```

and it will adjust the spacing between subplots so that the axis labels do not overlap with neighboring subplots. A *Tight Layout guide* has been created to show how to use this new tool.

### 7.5.4 PyQT4, PySide, and IPython

Gerald Storer made the Qt4 backend compatible with PySide as well as PyQT4. At present, however, PySide does not support the `PyOS_InputHook` mechanism for handling gui events while waiting for text input, so it cannot be used with the new version 0.11 of `IPython`. Until this feature appears in PySide, IPython users should use the PyQT4 wrapper for QT4, which remains the matplotlib default.

An `rcParam` entry, "backend.qt4", has been added to allow users to select PyQt4, PyQt4v2, or PySide. The latter two use the Version 2 Qt API. In most cases, users can ignore this `rcParam` variable; it is available to aid in testing, and to provide control for users who are embedding matplotlib in a PyQT4 or PySide app.

### 7.5.5 Legend

Jae-Joon Lee has improved plot legends. First, legends for complex plots such as `stem()` plots will now display correctly. Second, the 'best' placement of a legend has been improved in the presence of NaNs.

See the *Legend guide* for more detailed explanation and examples.

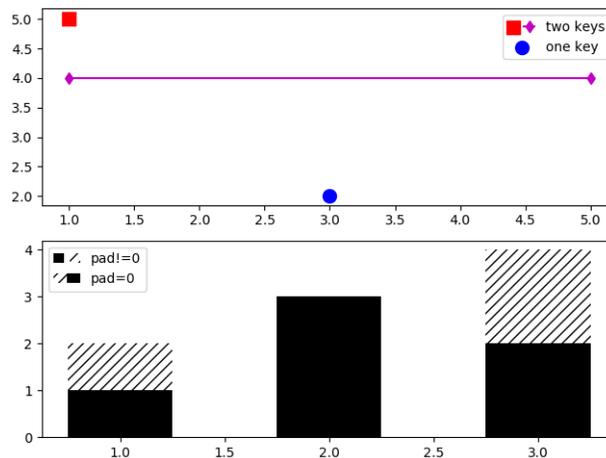


Fig. 11: Legend Demo4

### 7.5.6 mplot3d

In continuing the efforts to make 3D plotting in matplotlib just as easy as 2D plotting, Ben Root has made several improvements to the `mplot3d` module.

- *Axes3D* has been improved to bring the class towards feature-parity with regular Axes objects
- Documentation for *Getting started* was significantly expanded
- Axis labels and orientation improved
- Most 3D plotting functions now support empty inputs
- Ticker offset display added:

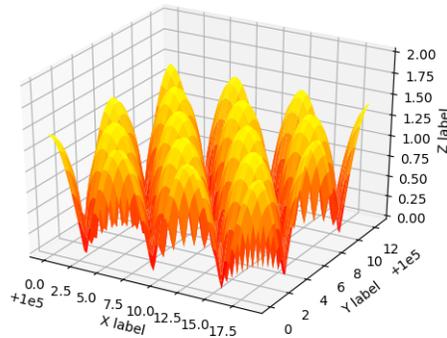


Fig. 12: Offset

- *contourf()* gains *zdir* and *offset* kwargs. You can now do this:

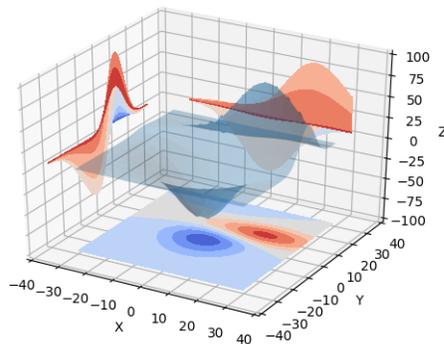


Fig. 13: Contourf3d 2

### 7.5.7 Numerix support removed

After more than two years of deprecation warnings, Numerix support has now been completely removed from matplotlib.

## 7.5.8 Markers

The list of available markers for `plot()` and `scatter()` has now been merged. While they were mostly similar, some markers existed for one function, but not the other. This merge did result in a conflict for the 'd' diamond marker. Now, 'd' will be interpreted to always mean "thin" diamond while 'D' will mean "regular" diamond.

Thanks to Michael Droettboom for this effort.

## 7.5.9 Other improvements

- Unit support for polar axes and `arrow()`
- `PolarAxes` gains getters and setters for "theta\_direction", and "theta\_offset" to allow for theta to go in either the clock-wise or counter-clockwise direction and to specify where zero degrees should be placed. `set_theta_zero_location()` is an added convenience function.
- Fixed error in argument handling for tri-functions such as `tricolor()`
- `axes.labelweight` parameter added to `rcParams`.
- For `imshow()`, `interpolation='nearest'` will now always perform an interpolation. A "none" option has been added to indicate no interpolation at all.
- An error in the Hammer projection has been fixed.
- `clabel` for `contour()` now accepts a callable. Thanks to Daniel Hyams for the original patch.
- Jae-Joon Lee added the `HBox` and `VBox` classes.
- Christoph Gohlke reduced memory usage in `imshow()`.
- `scatter()` now accepts empty inputs.
- The behavior for 'symlog' scale has been fixed, but this may result in some minor changes to existing plots. This work was refined by ssyr.
- Peter Butterworth added named figure support to `figure()`.
- Michiel de Hoon has modified the MacOSX backend to make its interactive behavior consistent with the other backends.
- Pim Schellart added a new colormap called "cubehelix". Sameer Grover also added a colormap called "coolwarm". See it and all other colormaps [here](#).
- Many bug fixes and documentation improvements.

## 7.6 New in matplotlib 1.2

### Table of Contents

- *New in matplotlib 1.2*
  - *Python 3.x support*

- *PGF/TikZ backend*
- *Locator interface*
- *Tri-Surface Plots*
- *Control the lengths of colorbar extensions*
- *Figures are picklable*
- *Set default bounding box in `matplotlibrc`*
- *New Boxplot Functionality*
- *New RC parameter functionality*
- *Streamplot*
- *New hist functionality*
- *Updated shipped dependencies*
- *Face-centred colors in tripcolor plots*
- *Hatching patterns in filled contour plots, with legends*
- *Known issues in the matplotlib 1.2 release*

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**Note:** matplotlib 1.2 supports Python 2.6, 2.7, and 3.1

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### 7.6.1 Python 3.x support

Matplotlib 1.2 is the first version to support Python 3.x, specifically Python 3.1 and 3.2. To make this happen in a reasonable way, we also had to drop support for Python versions earlier than 2.6.

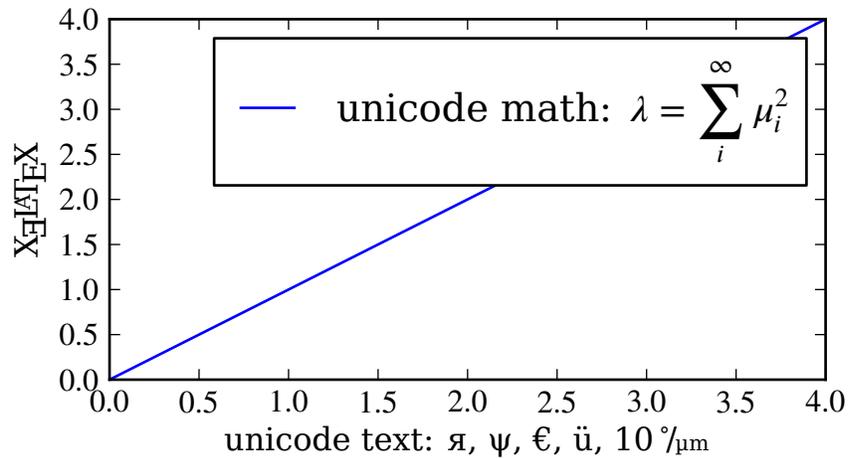
This work was done by Michael Droettboom, the Cape Town Python Users' Group, many others and supported financially in part by the SAGE project.

The following GUI backends work under Python 3.x: Gtk3Cairo, Qt4Agg, TkAgg and MacOSX. The other GUI backends do not yet have adequate bindings for Python 3.x, but continue to work on Python 2.6 and 2.7, particularly the Qt and QtAgg backends (which have been deprecated). The non-GUI backends, such as PDF, PS and SVG, work on both Python 2.x and 3.x.

Features that depend on the Python Imaging Library, such as JPEG handling, do not work, since the version of PIL for Python 3.x is not sufficiently mature.

### 7.6.2 PGF/TikZ backend

Peter Würtz wrote a backend that allows matplotlib to export figures as drawing commands for LaTeX. These can be processed by PdfLaTeX, XeLaTeX or LuaLaTeX using the PGF/TikZ package. Usage examples and documentation are found in *Typesetting With XeLaTeX/LuaLaTeX*.



### 7.6.3 Locator interface

Philip Elson exposed the intelligence behind the tick Locator classes with a simple interface. For instance, to get no more than 5 sensible steps which span the values 10 and 19.5:

```
>>> import matplotlib.ticker as mticker
>>> locator = mticker.MaxNLocator(nbins=5)
>>> print(locator.tick_values(10, 19.5))
[ 10.  12.  14.  16.  18.  20.]
```

### 7.6.4 Tri-Surface Plots

Damon McDougall added a new plotting method for the *mplot3d* toolkit called `plot_trisurf()`.

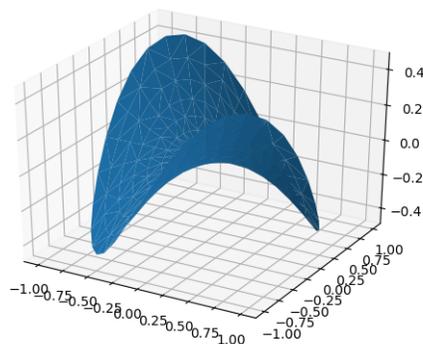
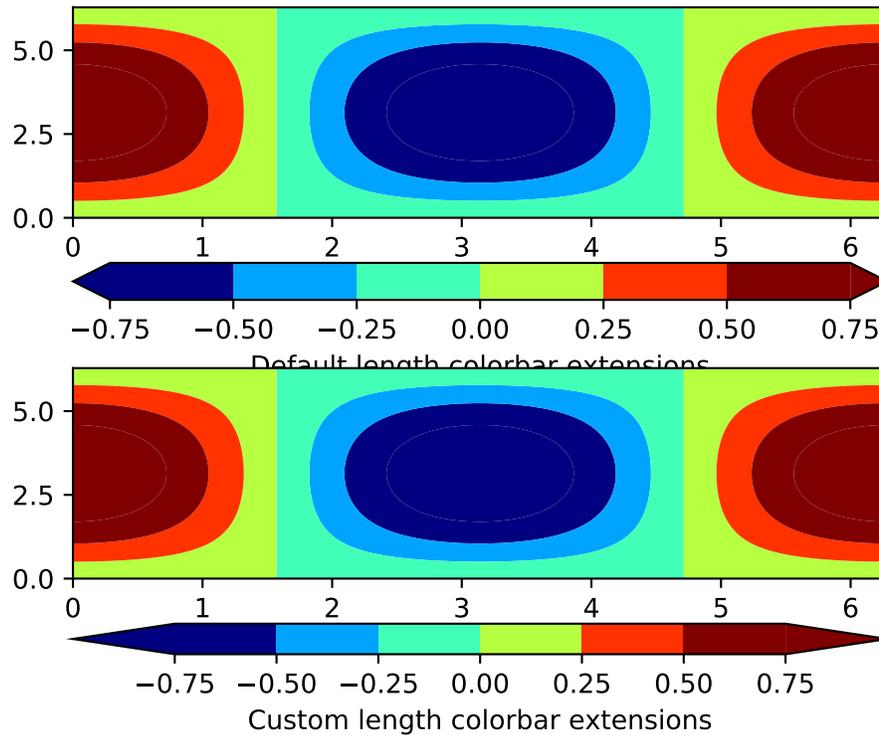


Fig. 14: Trisurf3d

### 7.6.5 Control the lengths of colorbar extensions

Andrew Dawson added a new keyword argument *extendfrac* to *colorbar()* to control the length of minimum and maximum colorbar extensions.



### 7.6.6 Figures are picklable

Philip Elson added an experimental feature to make figures picklable for quick and easy short-term storage of plots. Pickle files are not designed for long term storage, are unsupported when restoring a pickle saved in another matplotlib version and are insecure when restoring a pickle from an untrusted source. Having said this, they are useful for short term storage for later modification inside matplotlib.

### 7.6.7 Set default bounding box in matplotlibrc

Two new defaults are available in the *matplotlibrc* configuration file: *savefig.bbox*, which can be set to 'standard' or 'tight', and *savefig.pad\_inches*, which controls the bounding box padding.

## 7.6.8 New Boxplot Functionality

Users can now incorporate their own methods for computing the median and its confidence intervals into the `boxplot()` method. For every column of data passed to `boxplot`, the user can specify an accompanying median and confidence interval.

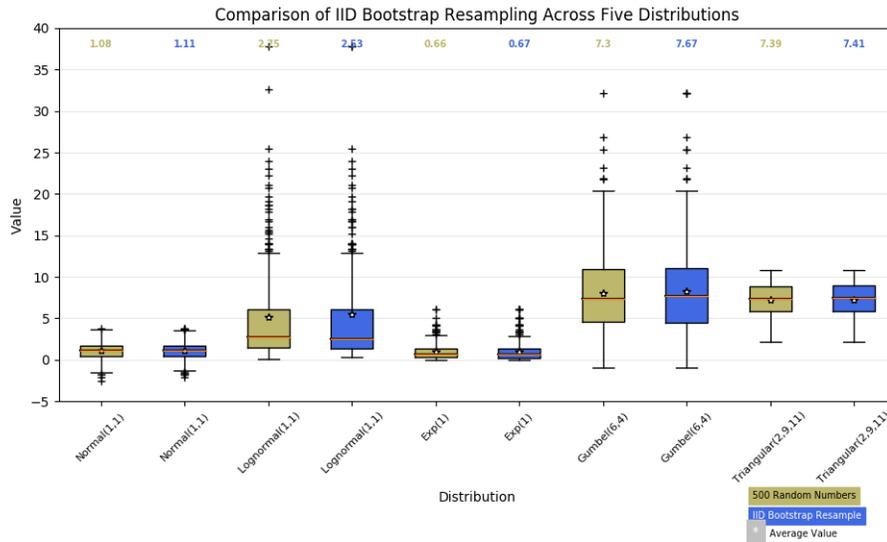


Fig. 15: Boxplot Demo3

## 7.6.9 New RC parameter functionality

Matthew Emmett added a function and a context manager to help manage RC parameters: `rc_file()` and `rc_context`. To load RC parameters from a file:

```
>>> mpl.rc_file('mpl.rc')
```

To temporarily use RC parameters:

```
>>> with mpl.rc_context(fname='mpl.rc', rc={'text.usetex': True}):
>>> ...
```

## 7.6.10 Streamplot

Tom Flanagan and Tony Yu have added a new `streamplot()` function to plot the streamlines of a vector field. This has been a long-requested feature and complements the existing `quiver()` function for plotting vector fields. In addition to simply plotting the streamlines of the vector field, `streamplot()` allows users to map the colors and/or line widths of the streamlines to a separate parameter, such as the speed or local intensity of the vector field.

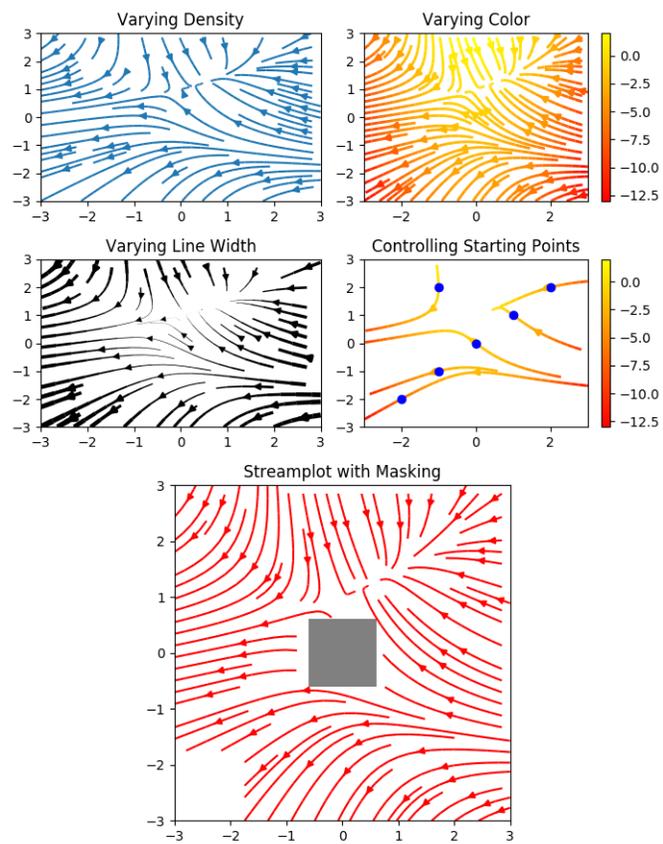


Fig. 16: Plot Streamplot

### 7.6.11 New hist functionality

Nic Eggert added a new `stacked` kwarg to `hist()` that allows creation of stacked histograms using any of the histogram types. Previously, this functionality was only available by using the `barstacked` histogram type. Now, when `stacked=True` is passed to the function, any of the histogram types can be stacked. The `barstacked` histogram type retains its previous functionality for backwards compatibility.

### 7.6.12 Updated shipped dependencies

The following dependencies that ship with matplotlib and are optionally installed alongside it have been updated:

- pytz 2012d
- dateutil 1.5 on Python 2.x, and 2.1 on Python 3.x

### 7.6.13 Face-centred colors in tripcolor plots

Ian Thomas extended `tripcolor()` to allow one color value to be specified for each triangular face rather than for each point in a triangulation.

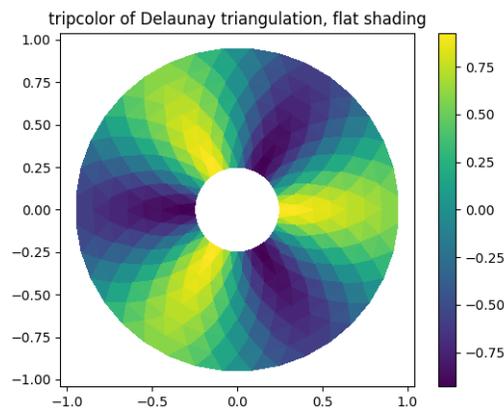


Fig. 17: Tripcolor Demo

### 7.6.14 Hatching patterns in filled contour plots, with legends

Phil Elson added support for hatching to `contourf()`, together with the ability to use a legend to identify contoured ranges.

### 7.6.15 Known issues in the matplotlib 1.2 release

- When using the Qt4Agg backend with IPython 0.11 or later, the save dialog will not display. This should be fixed in a future version of IPython.

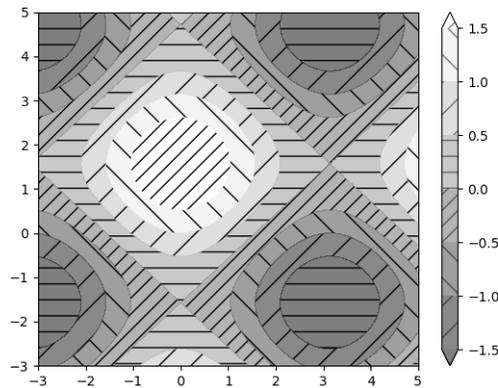


Fig. 18: Contourf Hatching

## 7.7 New in matplotlib 1.2.2

### Table of Contents

- *New in matplotlib 1.2.2*
  - *Improved collections*
  - *Multiple images on same axes are correctly transparent*

### 7.7.1 Improved collections

The individual items of a collection may now have different alpha values and be rendered correctly. This also fixes a bug where collections were always filled in the PDF backend.

### 7.7.2 Multiple images on same axes are correctly transparent

When putting multiple images onto the same axes, the background color of the axes will now show through correctly.

## 7.8 New in matplotlib 1.3

### Table of Contents

- *New in matplotlib 1.3*
  - *New in 1.3.1*
  - *New plotting features*

- *Updated Axes3D.contour methods*
- *Drawing*
- *Text*
- *Configuration (rcParams)*
- *Backends*
- *Documentation and examples*
- *Infrastructure*

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**Note:** matplotlib 1.3 supports Python 2.6, 2.7, 3.2, and 3.3

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### 7.8.1 New in 1.3.1

1.3.1 is a bugfix release, primarily dealing with improved setup and handling of dependencies, and correcting and enhancing the documentation.

The following changes were made in 1.3.1 since 1.3.0.

#### Enhancements

- Added a context manager for creating multi-page pdfs (see `matplotlib.backends.backend_pdf.PdfPages`).
- The WebAgg backend should now have lower latency over heterogeneous Internet connections.

#### Bug fixes

- Histogram plots now contain the endline.
- Fixes to the Molleweide projection.
- Handling recent fonts from Microsoft and Macintosh-style fonts with non-ascii metadata is improved.
- Hatching of fill between plots now works correctly in the PDF backend.
- Tight bounding box support now works in the PGF backend.
- Transparent figures now display correctly in the Qt4Agg backend.
- Drawing lines from one subplot to another now works.
- Unit handling on masked arrays has been improved.

#### Setup and dependencies

- Now works with any version of pyparsing 1.5.6 or later, without displaying hundreds of warnings.

- Now works with 64-bit versions of Ghostscript on MS-Windows.
- When installing from source into an environment without Numpy, Numpy will first be downloaded and built and then used to build matplotlib.
- Externally installed backends are now always imported using a fully-qualified path to the module.
- Works with newer version of wxPython.
- Can now build with a PyCXX installed globally on the system from source.
- Better detection of Gtk3 dependencies.

### Testing

- Tests should now work in non-English locales.
- PEP8 conformance tests now report on locations of issues.

## 7.8.2 New plotting features

### xkcd-style sketch plotting

To give your plots a sense of authority that they may be missing, Michael Droettboom (inspired by the work of many others in [PR #1329](#)) has added an `xkcd-style` sketch plotting mode. To use it, simply call `matplotlib.pyplot.xkcd()` before creating your plot. For really fine control, it is also possible to modify each artist's sketch parameters individually with `matplotlib.artist.Artist.set_sketch_params()`.

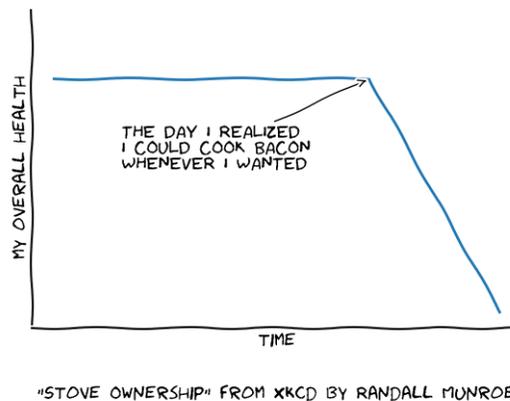


Fig. 19: xkcd

## 7.8.3 Updated Axes3D.contour methods

Damon McDougall updated the `tricontour()` and `tricontourf()` methods to allow 3D contour plots on arbitrary unstructured user-specified triangulations.

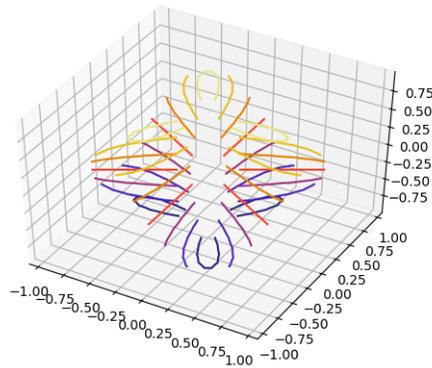


Fig. 20: Tricontour3d

### New eventplot plot type

Todd Jennings added a `eventplot()` function to create multiple rows or columns of identical line segments

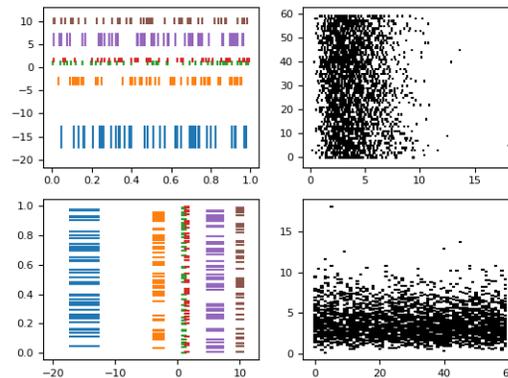


Fig. 21: Eventplot Demo

As part of this feature, there is a new `EventCollection` class that allows for plotting and manipulating rows or columns of identical line segments.

### Triangular grid interpolation

Geoffroy Billotey and Ian Thomas added classes to perform interpolation within triangular grids: (`LinearTriInterpolator` and `CubicTriInterpolator`) and a utility class to find the triangles in which points lie (`TrapezoidMapTriFinder`). A helper class to perform mesh refinement and smooth contouring was also added (`UniformTriRefiner`). Finally, a class implementing some basic tools for triangular mesh improvement was added (`TriAnalyzer`).

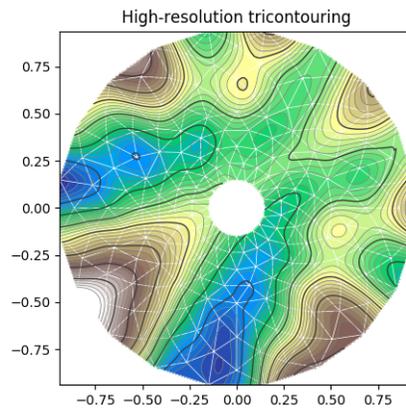


Fig. 22: Tricontour Smooth User

### Baselines for stackplot

Till Stensitzki added non-zero baselines to `stackplot()`. They may be symmetric or weighted.

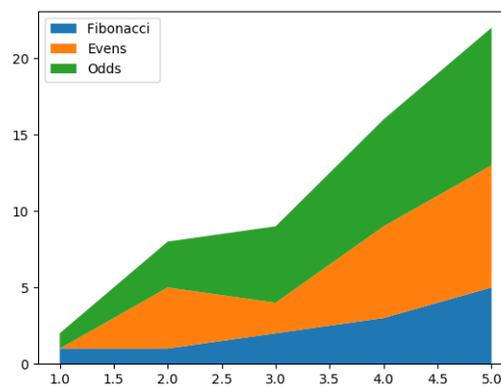


Fig. 23: Stackplot Demo2

### Rectangular colorbar extensions

Andrew Dawson added a new keyword argument `extendrect` to `colorbar()` to optionally make colorbar extensions rectangular instead of triangular.

### More robust boxplots

Paul Hobson provided a fix to the `boxplot()` method that prevent whiskers from being drawn inside the box for oddly distributed data sets.

### Calling `subplot()` without arguments

A call to `subplot()` without any arguments now acts the same as `subplot(111)` or `subplot(1,1,1)` - it creates one axes for the whole figure. This was already the behavior for both `axes()` and `subplots()`, and now this consistency is shared with `subplot()`.

## 7.8.4 Drawing

### Independent alpha values for face and edge colors

Wes Campaigne modified how `Patch` objects are drawn such that (for backends supporting transparency) you can set different alpha values for faces and edges, by specifying their colors in RGBA format. Note that if you set the alpha attribute for the patch object (e.g. using `set_alpha()` or the alpha keyword argument), that value will override the alpha components set in both the face and edge colors.

### Path effects on lines

Thanks to Jae-Joon Lee, path effects now also work on plot lines.

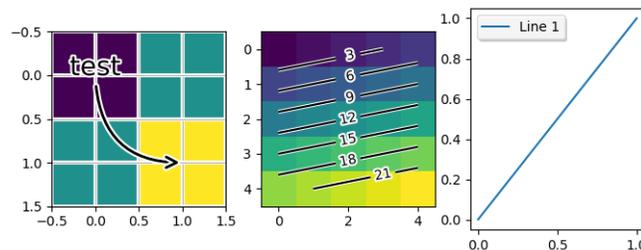


Fig. 24: Patheffect Demo

### Easier creation of colormap and normalizer for levels with colors

Phil Elson added the `matplotlib.colors.from_levels_and_colors()` function to easily create a colormap and normalizer for representation of discrete colors for plot types such as `matplotlib.pyplot.pcolormesh()`, with a similar interface to that of `contourf()`.

### Full control of the background color

Wes Campaigne and Phil Elson fixed the Agg backend such that PNGs are now saved with the correct background color when `fig.patch.get_alpha()` is not 1.

### Improved `bbox_inches="tight"` functionality

Passing `bbox_inches="tight"` through to `plt.save()` now takes into account *all* artists on a figure - this was previously not the case and led to several corner cases which did not function as expected.

### Initialize a rotated rectangle

Damon McDougall extended the *Rectangle* constructor to accept an `angle` kwarg, specifying the rotation of a rectangle in degrees.

## 7.8.5 Text

### Anchored text support

The `svg` and `pgf` backends are now able to save text alignment information to their output formats. This allows to edit text elements in saved figures, using Inkscape for example, while preserving their intended position. For `svg` please note that you'll have to disable the default text-to-path conversion (`mpl.rc('svg', fonttype='none')`).

### Better vertical text alignment and multi-line text

The vertical alignment of text is now consistent across backends. You may see small differences in text placement, particularly with rotated text.

If you are using a custom backend, note that the `draw_text` renderer method is now passed the location of the baseline, not the location of the bottom of the text bounding box.

Multi-line text will now leave enough room for the height of very tall or very low text, such as superscripts and subscripts.

### Left and right side axes titles

Andrew Dawson added the ability to add axes titles flush with the left and right sides of the top of the axes using a new keyword argument `loc` to `title()`.

### Improved manual contour plot label positioning

Brian Mattern modified the manual contour plot label positioning code to interpolate along line segments and find the actual closest point on a contour to the requested position. Previously, the closest path vertex was used, which, in the case of straight contours was sometimes quite distant from the requested location. Much more precise label positioning is now possible.

## 7.8.6 Configuration (rcParams)

### Quickly find rcParams

Phil Elson made it easier to search for rcParameters by passing a valid regular expression to `matplotlib.RcParams.find_all()`. `matplotlib.RcParams` now also has a pretty repr and str representation so that search results are printed prettily:

```
>>> import matplotlib
>>> print(matplotlib.rcParams.find_all('\.size'))
RcParams({'font.size': 12,
          'xtick.major.size': 4,
          'xtick.minor.size': 2,
          'ytick.major.size': 4,
          'ytick.minor.size': 2})
```

#### **axes.xmargin and axes.ymargin added to rcParams**

rcParam values (`axes.xmargin` and `axes.ymargin`) were added to configure the default margins used. Previously they were hard-coded to default to 0, default value of both rcParam values is 0.

#### **Changes to font rcParams**

The `font.*` rcParams now affect only text objects created after the rcParam has been set, and will not retroactively affect already existing text objects. This brings their behavior in line with most other rcParams.

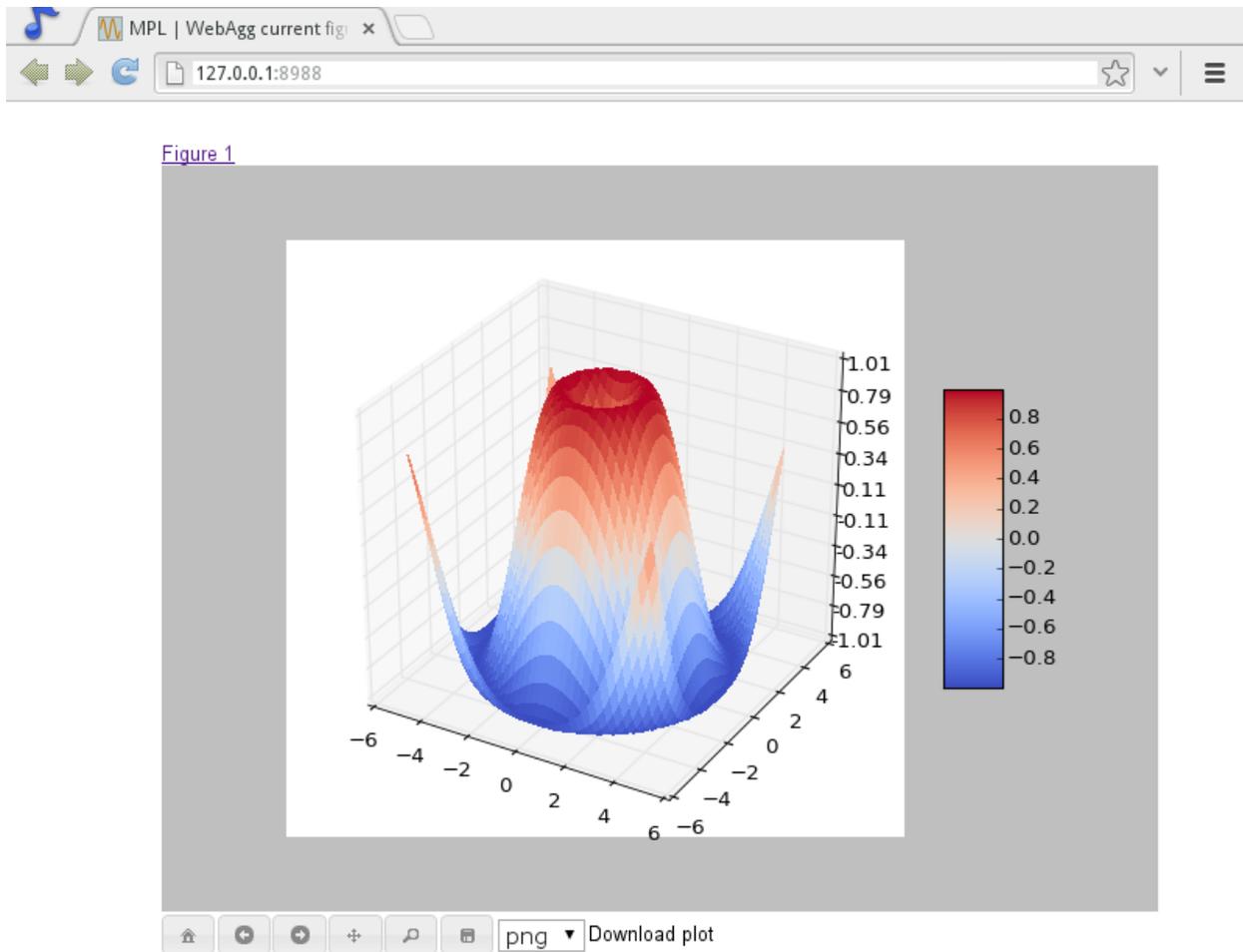
#### **savefig.jpeg\_quality added to rcParams**

rcParam value `savefig.jpeg_quality` was added so that the user can configure the default quality used when a figure is written as a JPEG. The default quality is 95; previously, the default quality was 75. This change minimizes the artifacting inherent in JPEG images, particularly with images that have sharp changes in color as plots often do.

## **7.8.7 Backends**

### **WebAgg backend**

Michael Droettboom, Phil Elson and others have developed a new backend, WebAgg, to display figures in a web browser. It works with animations as well as being fully interactive.



Future versions of matplotlib will integrate this backend with the IPython notebook for a fully web browser based plotting frontend.

### Remember save directory

Martin Spacek made the save figure dialog remember the last directory saved to. The default is configurable with the new `savefig.directory` rcParam in matplotlibrc.

## 7.8.8 Documentation and examples

### Numpydoc docstrings

Nelle Varoquaux has started an ongoing project to convert matplotlib's docstrings to numpydoc format. See [MEP10](#) for more information.

### Example reorganization

Tony Yu has begun work reorganizing the examples into more meaningful categories. The new gallery page is the fruit of this ongoing work. See [MEP12](#) for more information.

### Examples now use `subplots()`

For the sake of brevity and clarity, most of the examples now use the newer `subplots()`, which creates a figure and one (or multiple) axes object(s) in one call. The old way involved a call to `figure()`, followed by one (or multiple) `subplot()` calls.

## 7.8.9 Infrastructure

### Housecleaning

A number of features that were deprecated in 1.2 or earlier, or have not been in a working state for a long time have been removed. Highlights include removing the Qt version 3 backends, and the FltkAgg and Emf backends. See *Changes in 1.3.x* for a complete list.

### New setup script

matplotlib 1.3 includes an entirely rewritten setup script. We now ship fewer dependencies with the tarballs and installers themselves. Notably, `pytz`, `dateutil`, `yparsing` and `six` are no longer included with matplotlib. You can either install them manually first, or let pip install them as dependencies along with matplotlib. It is now possible to not include certain subcomponents, such as the unit test data, in the install. See `setup.cfg.template` for more information.

### XDG base directory support

On Linux, matplotlib now uses the XDG base directory specification to find the `matplotlibrc` configuration file. `matplotlibrc` should now be kept in `config/matplotlib`, rather than `matplotlib`. If your configuration is found in the old location, it will still be used, but a warning will be displayed.

### Catch opening too many figures using `pyplot`

Figures created through `pyplot.figure` are retained until they are explicitly closed. It is therefore common for new users of matplotlib to run out of memory when creating a large series of figures in a loop without closing them.

matplotlib will now display a `RuntimeWarning` when too many figures have been opened at once. By default, this is displayed for 20 or more figures, but the exact number may be controlled using the `figure.max_open_warning` rcParam.

## 7.9 New in matplotlib 1.4

Thomas A. Caswell served as the release manager for the 1.4 release.

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**Note:** matplotlib 1.4 supports Python 2.6, 2.7, 3.3, and 3.4

### 7.9.1 New colormap

In heatmaps, a green-to-red spectrum is often used to indicate intensity of activity, but this can be problematic for the red/green colorblind. A new, colorblind-friendly colormap is now available at [matplotlib.cm.wistia.com](http://matplotlib.cm.wistia.com). This colormap maintains the red/green symbolism while achieving deuteranopic legibility through brightness variations. See [here](#) for more information.

### 7.9.2 The nbagg backend

Phil Elson added a new backend, named "nbagg", which enables interactive figures in a live IPython notebook session. The backend makes use of the infrastructure developed for the webagg backend, which itself gives standalone server backed interactive figures in the browser, however nbagg does not require a dedicated matplotlib server as all communications are handled through the IPython Comm machinery.

As with other backends nbagg can be enabled inside the IPython notebook with:

```
import matplotlib
matplotlib.use('nbagg')
```

Once figures are created and then subsequently shown, they will be placed in an interactive widget inside the notebook allowing panning and zooming in the same way as any other matplotlib backend. Because figures require a connection to the IPython notebook server for their interactivity, once the notebook is saved, each figure will be rendered as a static image - thus allowing non-interactive viewing of figures on services such as [nbviewer](#).

### 7.9.3 New plotting features

#### Power-law normalization

Ben Gamari added a power-law normalization method, *PowerNorm*. This class maps a range of values to the interval [0,1] with power-law scaling with the exponent provided by the constructor's *gamma* argument. Power law normalization can be useful for, e.g., emphasizing small populations in a histogram.

#### Fully customizable boxplots

Paul Hobson overhauled the *boxplot()* method such that it is now completely customizable in terms of the styles and positions of the individual artists. Under the hood, *boxplot()* relies on a new function (*boxplot\_stats()*), which accepts any data structure currently compatible with *boxplot()*, and returns a list of dictionaries containing the positions for each element of the boxplots. Then a second method, *bxp()* is called to draw the boxplots based on the stats.

The *boxplot()* function can be used as before to generate boxplots from data in one step. But now the user has the flexibility to generate the statistics independently, or to modify the output of *boxplot\_stats()* prior to plotting with *bxp()*.

Lastly, each artist (e.g., the box, outliers, cap, notches) can now be toggled on or off and their styles can be passed in through individual kwargs. See the examples: [/gallery/statistics/boxplot](#) and [/gallery/statistics/bxp](#)

Added a bool kwarg, *manage\_xticks*, which if False disables the management of the ticks and limits on the x-axis by *bxp()*.

#### Support for datetime axes in 2d plots

Andrew Dawson added support for datetime axes to *contour()*, *contourf()*, *pcolormesh()* and *pcolor()*.

#### Support for additional spectrum types

Todd Jennings added support for new types of frequency spectrum plots: *magnitude\_spectrum()*, *phase\_spectrum()*, and *angle\_spectrum()*, as well as corresponding functions in *mlab*.

He also added these spectrum types to *specgram()*, as well as adding support for linear scaling there (in addition to the existing dB scaling). Support for additional spectrum types was also added to *specgram()*.

He also increased the performance for all of these functions and plot types.

#### Support for detrending and windowing 2D arrays in mlab

Todd Jennings added support for 2D arrays in the *detrend\_mean()*, *detrend\_none()*, and *detrend()*, as well as adding *apply\_window()* which support windowing 2D arrays.

### Support for strides in mlab

Todd Jennings added some functions to mlab to make it easier to use numpy strides to create memory-efficient 2D arrays. This includes `stride_repeat()`, which repeats an array to create a 2D array, and `stride_windows()`, which uses a moving window to create a 2D array from a 1D array.

### Formatter for new-style formatting strings

Added `FormatStrFormatterNewStyle` which does the same job as `FormatStrFormatter`, but accepts new-style formatting strings instead of printf-style formatting strings

### Consistent grid sizes in streamplots

`streamplot()` uses a base grid size of 30x30 for both `density=1` and `density=(1, 1)`. Previously a grid size of 30x30 was used for `density=1`, but a grid size of 25x25 was used for `density=(1, 1)`.

### Get a list of all tick labels (major and minor)

Added the kwarg 'which' to `get_xticklabels()`, `get_yticklabels()` and `get_ticklabels()`. 'which' can be 'major', 'minor', or 'both' select which ticks to return, like `set_ticks_position()`. If 'which' is `None` then the old behaviour (controlled by the bool `minor`).

### Separate horizontal/vertical axes padding support in ImageGrid

The kwarg 'axes\_pad' to `mpl_toolkits.axes_grid1.ImageGrid` can now be a tuple if separate horizontal/vertical padding is needed. This is supposed to be very helpful when you have a labelled legend next to every subplot and you need to make some space for legend's labels.

### Support for skewed transformations

The `Affine2D` gained additional methods `skew` and `skew_deg` to create skewed transformations. Additionally, matplotlib internals were cleaned up to support using such transforms in `Axes`. This transform is important for some plot types, specifically the Skew-T used in meteorology.

### Support for specifying properties of wedge and text in pie charts.

Added the kwargs 'wedgeprops' and 'textprops' to `pie()` to accept properties for wedge and text objects in a pie. For example, one can specify `wedgeprops = {'linewidth':3}` to specify the width of the borders of the wedges in the pie. For more properties that the user can specify, look at the docs for the wedge and text objects.

### Fixed the direction of errorbar upper/lower limits

Larry Bradley fixed the `errorbar()` method such that the upper and lower limits (`lolims`, `uplims`, `xlolims`, `xuplims`) now point in the correct direction.

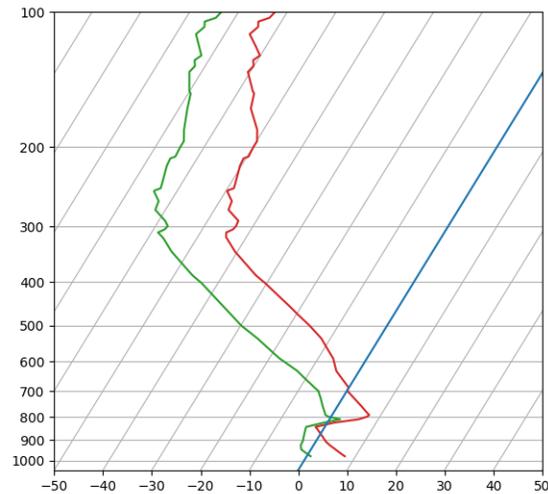


Fig. 25: Skewt

### More consistent add-object API for Axes

Added the Axes method `add_image` to put image handling on a par with artists, collections, containers, lines, patches, and tables.

### Violin Plots

Per Parker, Gregory Kelsie, Adam Ortiz, Kevin Chan, Geoffrey Lee, Deokjae Donald Seo, and Taesu Terry Lim added a basic implementation for violin plots. Violin plots can be used to represent the distribution of sample data. They are similar to box plots, but use a kernel density estimation function to present a smooth approximation of the data sample used. The added features are:

`violin()` - Renders a violin plot from a collection of statistics. `violin_stats()` - Produces a collection of statistics suitable for rendering a violin plot. `violinplot()` - Creates a violin plot from a set of sample data. This method makes use of `violin_stats()` to process the input data, and `violin_stats()` to do the actual rendering. Users are also free to modify or replace the output of `violin_stats()` in order to customize the violin plots to their liking.

This feature was implemented for a software engineering course at the University of Toronto, Scarborough, run in Winter 2014 by Anya Tafliovich.

### More `marker` options to show only a subset of markers

Rohan Walker extended the `marker` property in `Line2D`. You can now specify a subset of markers to show with an int, slice object, numpy fancy indexing, or float. Using a float shows markers at approximately equal display-coordinate-distances along the line.

### Added size related functions to specialized Collections

Added the `get_size` and `set_size` functions to control the size of elements of specialized collections (*AsteriskPolygonCollection BrokenBarHCollection CircleCollection PathCollection PolyCollection RegularPolyCollection StarPolygonCollection*).

### Fixed the mouse coordinates giving the wrong theta value in Polar graph

Added code to `transform_non_affine()` to ensure that the calculated theta value was between the range of 0 and  $2 * \pi$  since the problem was that the value can become negative after applying the direction and rotation to the theta calculation.

### Simple quiver plot for mplot3d toolkit

A team of students in an *Engineering Large Software Systems* course, taught by Prof. Anya Tafliovich at the University of Toronto, implemented a simple version of a quiver plot in 3D space for the mplot3d toolkit as one of their term project. This feature is documented in `quiver()`. The team members are: Ryan Steve D'Souza, Victor B, xbtsw, Yang Wang, David, Caradec Bisesar and Vlad Vassilovski.

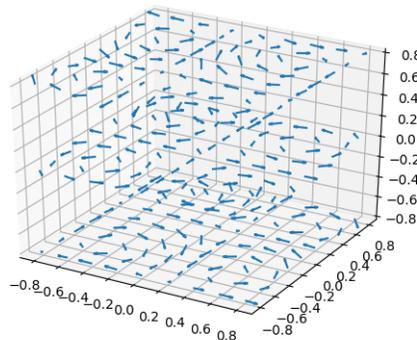


Fig. 26: Quiver3d

### polar-plot r-tick locations

Added the ability to control the angular position of the r-tick labels on a polar plot via `set_rlabel_position()`.

## 7.9.4 Date handling

### n-d array support for date conversion

Andrew Dawson added support for n-d array handling to `matplotlib.dates.num2date()`, `matplotlib.dates.date2num()` and `matplotlib.dates.datestr2num()`. Support is also added to the unit conversion interfaces `matplotlib.dates.DateConverter` and `matplotlib.units.Registry`.

## 7.9.5 Configuration (rcParams)

### `savefig.transparent` added

Controls whether figures are saved with a transparent background by default. Previously `savefig` always defaulted to a non-transparent background.

### `axes.titleweight`

Added rcParam to control the weight of the title

### `axes.formatter.useoffset` added

Controls the default value of `useOffset` in `ScalarFormatter`. If `True` and the data range is much smaller than the data average, then an offset will be determined such that the tick labels are meaningful. If `False` then the full number will be formatted in all conditions.

### `nbagg.transparent` added

Controls whether `nbagg` figures have a transparent background. `nbagg.transparent` is `True` by default.

## XDG compliance

Matplotlib now looks for configuration files (both `rcparams` and `style`) in XDG compliant locations.

## 7.9.6 `style` package added

You can now easily switch between different styles using the new `style` package:

```
>>> from matplotlib import style
>>> style.use('dark_background')
```

Subsequent plots will use updated colors, sizes, etc. To list all available styles, use:

```
>>> print style.available
```

You can add your own custom `<style name>.mplstyle` files to `~/.matplotlib/stylelib` or call `use` with a URL pointing to a file with `matplotlibrc` settings.

*Note that this is an experimental feature, and the interface may change as users test out this new feature.*

## 7.9.7 Backends

### Qt5 backend

Martin Fitzpatrick and Tom Badran implemented a Qt5 backend. The differences in namespace locations between Qt4 and Qt5 was dealt with by shimming Qt4 to look like Qt5, thus the Qt5 implementation is the primary implementation. Backwards compatibility for Qt4 is maintained by wrapping the Qt5 implementation.

The Qt5Agg backend currently does not work with IPython's %matplotlib magic.

The 1.4.0 release has a known bug where the toolbar is broken. This can be fixed by:

```
cd path/to/installed/matplotlib
wget https://github.com/matplotlib/matplotlib/pull/3322.diff
# unix2dos 3322.diff (if on windows to fix line endings)
patch -p2 < 3322.diff
```

### Qt4 backend

Rudolf Höfler changed the appearance of the subplottool. All sliders are vertically arranged now, buttons for tight layout and reset were added. Furthermore, the subplottool is now implemented as a modal dialog. It was previously a QMainWindow, leaving the SPT open if one closed the plot window.

In the figure options dialog one can now choose to (re-)generate a simple automatic legend. Any explicitly set legend entries will be lost, but changes to the curves' label, linestyle, et cetera will now be updated in the legend.

Interactive performance of the Qt4 backend has been dramatically improved under windows.

The mapping of key-signals from Qt to values matplotlib understands was greatly improved (For both Qt4 and Qt5).

### Cairo backends

The Cairo backends are now able to use the [cairocffi bindings](#) which are more actively maintained than the [pycairo bindings](#).

### Gtk3Agg backend

The Gtk3Agg backend now works on Python 3.x, if the [cairocffi bindings](#) are installed.

### PDF backend

Added context manager for saving to multi-page PDFs.

## 7.9.8 Text

### Text URLs supported by SVG backend

The `svg` backend will now render `Text` objects' `url` as a link in output SVGs. This allows one to make clickable text in saved figures using the `url` kwarg of the `Text` class.

### Anchored sizebar font

Added the `fontproperties` kwarg to `AnchoredSizeBar` to control the font properties.

## 7.9.9 Sphinx extensions

The `:context:` directive in the `plot_directive` Sphinx extension can now accept an optional `reset` setting, which will cause the context to be reset. This allows more than one distinct context to be present in documentation. To enable this option, use `:context: reset` instead of `:context: any` time you want to reset the context.

## 7.9.10 Legend and PathEffects documentation

The *Legend guide* and *Path effects guide* have both been updated to better reflect the full potential of each of these powerful features.

## 7.9.11 Widgets

### Span Selector

Added an option `span_stays` to the `SpanSelector` which makes the selector rectangle stay on the axes after you release the mouse.

## 7.9.12 GAE integration

Matplotlib will now run on google app engine.

## 7.10 New in matplotlib 1.5

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- *New in matplotlib 1.5*
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  - *Working with labeled data like pandas DataFrames*
  - *Added `axes.prop_cycle` key to `rcParams`*

- *New Colormaps*
- *Styles*
- *Backends*
- *Configuration (rcParams)*
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- *New plotting features*
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- *cbook.is\_sequence\_of\_strings recognizes string objects*
- *New close-figs argument for plot directive*
- *Support for URL string arguments to imread*
- *Display hook for animations in the IPython notebook*
- *Prefixed pkg-config for building*

---

**Note:** matplotlib 1.5 supports Python 2.7, 3.4, and 3.5

---

### 7.10.1 Interactive OO usage

All Artists now keep track of if their internal state has been changed but not reflected in the display ('stale') by a call to `draw`. It is thus possible to pragmatically determine if a given Figure needs to be re-drawn in an interactive session.

To facilitate interactive usage a `draw_all` method has been added to `pyplot` which will redraw all of the figures which are 'stale'.

To make this convenient for interactive use matplotlib now registers a function either with IPython's 'post\_execute' event or with the `displayhook` in the standard python REPL to automatically call `plt.draw_all` just before control is returned to the REPL. This ensures that the draw command is deferred and only called once.

The upshot of this is that for interactive backends (including `%matplotlib notebook`) in interactive mode (with `plt.ion()`)

```
import matplotlib.pyplot as plt
fig, ax = plt.subplots()
ln, = ax.plot([0, 1, 4, 9, 16])
plt.show()
ln.set_color('g')
```

will automatically update the plot to be green. Any subsequent modifications to the Artist objects will do likewise.

This is the first step of a larger consolidation and simplification of the pyplot internals.

## 7.10.2 Working with labeled data like pandas DataFrames

Plot methods which take arrays as inputs can now also work with labeled data and unpack such data.

This means that the following two examples produce the same plot:

Example

```
df = pandas.DataFrame({"var1": [1,2,3,4,5,6], "var2": [1,2,3,4,5,6]})
plt.plot(df["var1"], df["var2"])
```

Example

```
plt.plot("var1", "var2", data=df)
```

This works for most plotting methods, which expect arrays/sequences as inputs. `data` can be anything which supports `__getitem__` (dict, pandas.DataFrame, h5py, ...) to access array like values with string keys.

In addition to this, some other changes were made, which makes working with labeled data (ex pandas.Series) easier:

- For plotting methods with `label` keyword argument, one of the data inputs is designated as the label source. If the user does not supply a `label` that value object will be introspected for a label, currently by looking for a `name` attribute. If the value object does not have a `name` attribute but was specified by as a key into the data kwarg, then the key is used. In the above examples, this results in an implicit `label="var2"` for both cases.
- `plot()` now uses the index of a Series instead of `np.arange(len(y))`, if no `x` argument is supplied.

## 7.10.3 Added `axes.prop_cycle` key to `rcParams`

This is a more generic form of the now-deprecated `axes.color_cycle` param. Now, we can cycle more than just colors, but also linestyles, hatches, and just about any other artist property. Cycler notation is used for defining property cycles. Adding cyclers together will be like you are `zip()`-ing together two or more property cycles together:

```
axes.prop_cycle: cycler('color', 'rgb') + cycler('lw', [1, 2, 3])
```

You can even multiply cyclers, which is like using `itertools.product()` on two or more property cycles. Remember to use parentheses if writing a multi-line `prop_cycle` parameter.

## 7.10.4 New Colormaps

All four of the colormaps proposed as the new default are available as `'viridis'` (the new default in 2.0), `'magma'`, `'plasma'`, and `'inferno'`

## 7.10.5 Styles

Several new styles have been added, including many styles from the Seaborn project. Additionally, in order to prep for the upcoming 2.0 style-change release, a `'classic'` and `'default'`

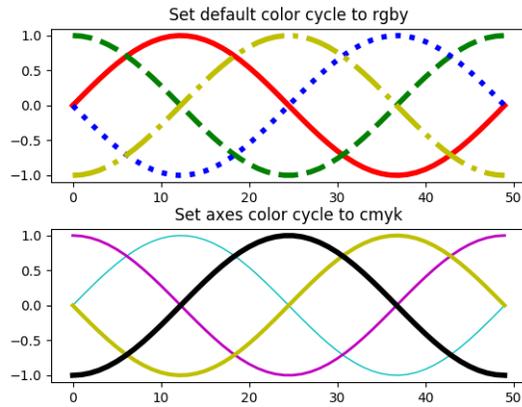
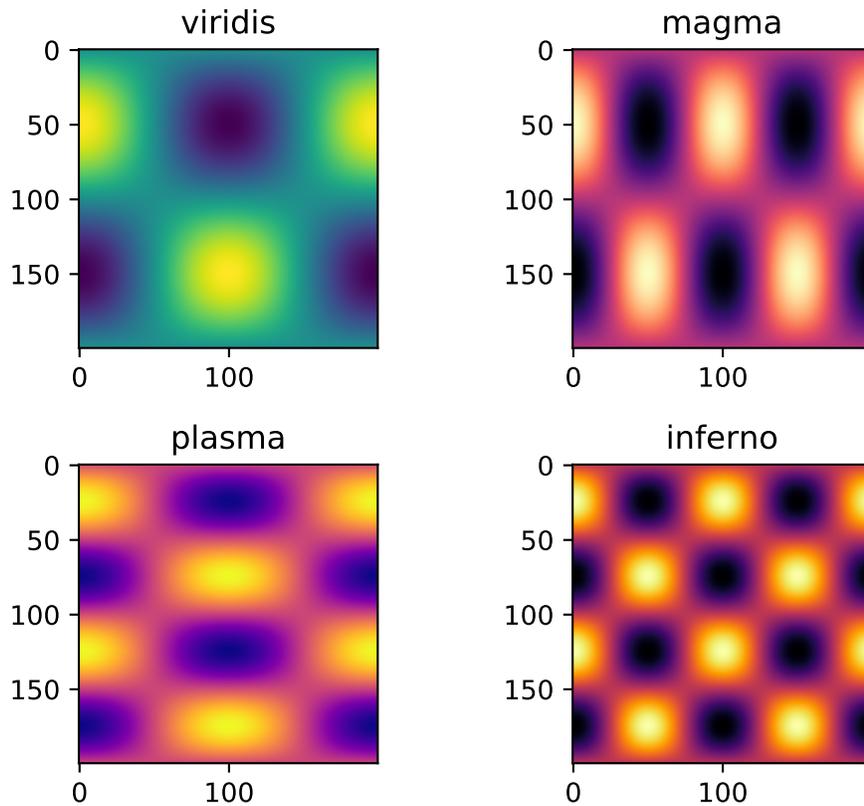


Fig. 27: Color Cycle



style has been added. For this release, the 'default' and 'classic' styles are identical. By using them now in your scripts, you can help ensure a smooth transition during future upgrades of matplotlib, so that you can upgrade to the snazzy new defaults when you are ready!

```
import matplotlib.style
matplotlib.style.use('classic')
```

The 'default' style will give you matplotlib's latest plotting styles:

```
matplotlib.style.use('default')
```

## 7.10.6 Backends

### New backend selection

The environment variable *MPLBACKEND* can now be used to set the matplotlib backend.

### wx backend has been updated

The wx backend can now be used with both wxPython classic and [Phoenix](#).

wxPython classic has to be at least version 2.8.12 and works on Python 2.x. As of May 2015 no official release of wxPython Phoenix is available but a current snapshot will work on Python 2.7+ and 3.4+.

If you have multiple versions of wxPython installed, then the user code is responsible setting the wxPython version. How to do this is explained in the comment at the beginning of the example `examplesuser_interfacesembedding_in_wx2.py`.

## 7.10.7 Configuration (rcParams)

Some parameters have been added, others have been improved.

Parameter	Description
{x, y}axis. labelpad	mplot3d now respects these parameters
axes. labelpad	Default space between the axis and the label
errorbar. capsize	Default length of end caps on error bars
{x, y}tick. minor. visible	Default visibility of minor x/y ticks
legend. framealpha	Default transparency of the legend frame box
legend. facecolor	Default facecolor of legend frame box (or 'inherit' from axes.facecolor)
legend. edgecolor	Default edgecolor of legend frame box (or 'inherit' from axes.edgecolor)
figure. titlesize	Default font size for figure subtitles
figure. titleweight	Default font weight for figure subtitles
image. composite_image	Whether a vector graphics backend should composite several images into a single image or not when saving. Useful when needing to edit the files further in Inkscape or other programs.
markers. fillstyle	Default fillstyle of markers. Possible values are 'full' (the default), 'left', 'right', 'bottom', 'top' and 'none'
toolbar	Added 'toolmanager' as a valid value, enabling the experimental ToolManager feature.

## 7.10.8 Widgets

### Active state of Selectors

All selectors now implement `set_active` and `get_active` methods (also called when accessing the active property) to properly update and query whether they are active.

### Moved `ignore`, `set_active`, and `get_active` methods to base class `Widget`

Pushes up duplicate methods in child class to parent class to avoid duplication of code.

### Adds `enable/disable` feature to `MultiCursor`

A `MultiCursor` object can be disabled (and enabled) after it has been created without destroying the object. Example:

```
multi_cursor.active = False
```

### Improved RectangleSelector and new EllipseSelector Widget

Adds an interactive keyword which enables visible handles for manipulating the shape after it has been drawn.

Adds keyboard modifiers for:

- Moving the existing shape (default key = 'space')
- Making the shape square (default 'shift')
- Make the initial point the center of the shape (default 'control')
- Square and center can be combined

### Allow Artists to Display Pixel Data in Cursor

Adds `get_pixel_data` and `format_pixel_data` methods to artists which can be used to add zdata to the cursor display in the status bar. Also adds an implementation for Images.

## 7.10.9 New plotting features

### Auto-wrapping Text

Added the keyword argument "wrap" to Text, which automatically breaks long lines of text when being drawn. Works for any rotated text, different modes of alignment, and for text that are either labels or titles. This breaks at the Figure, not Axes edge.

### Contour plot corner masking

Ian Thomas rewrote the C++ code that calculates contours to add support for corner masking. This is controlled by a new keyword argument `corner_mask` in the functions `contour()` and `contourf()`. The previous behaviour, which is now obtained using `corner_mask=False`, was for a single masked point to completely mask out all four quads touching that point. The new behaviour, obtained using `corner_mask=True`, only masks the corners of those quads touching the point; any triangular corners comprising three unmasked points are contoured as usual. If the `corner_mask` keyword argument is not specified, the default value is taken from `rcParams`.

### Mostly unified linestyles for Line2D, Patch and Collection

The handling of linestyles for Lines, Patches and Collections has been unified. Now they all support defining linestyles with short symbols, like "--", as well as with full names, like "dashed". Also the definition using a dash pattern ((0., [3., 3.])) is supported for all methods using Line2D, Patch or Collection.

### Legend marker order

Added ability to place the label before the marker in a legend box with `markerfirst` keyword

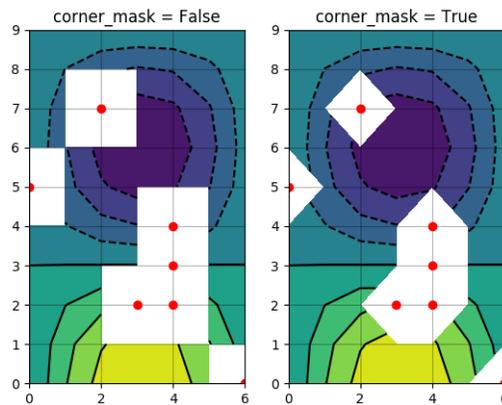
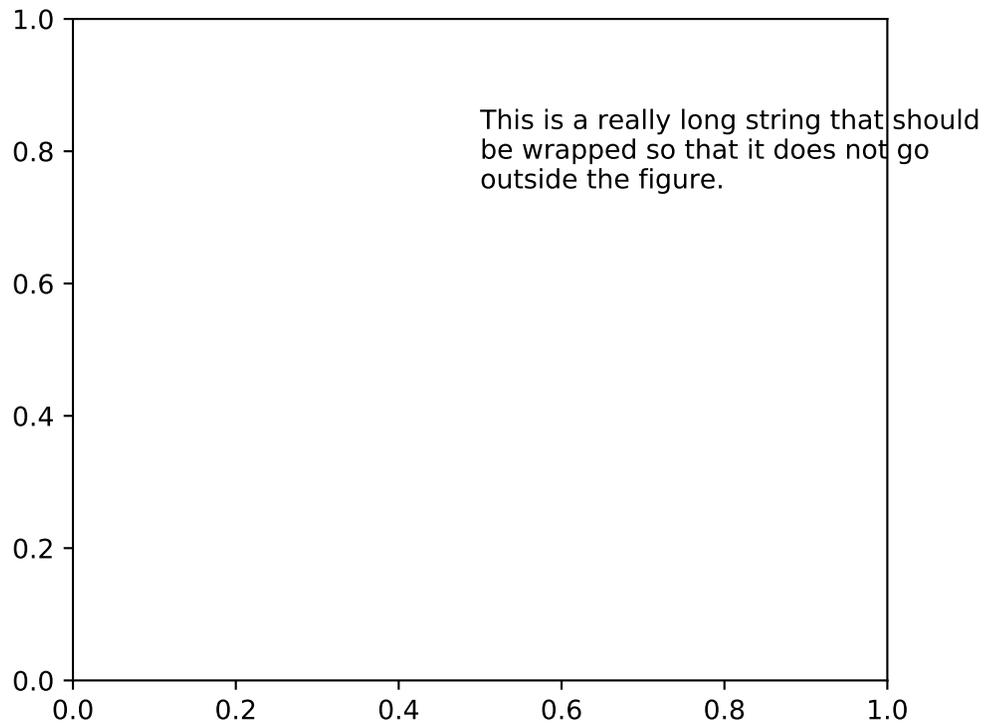


Fig. 28: Contour Corner Mask

### Support for legend for PolyCollection and stackplot

Added a `legend_handler` for `PolyCollection` as well as a `labels` argument to `stackplot()`.

### Support for alternate pivots in mplot3d quiver plot

Added a `pivot` kwarg to `quiver()` that controls the pivot point around which the quiver line rotates. This also determines the placement of the arrow head along the quiver line.

### Logit Scale

Added support for the 'logit' axis scale, a nonlinear transformation

$$x \rightarrow \log_{10}(x/(1-x))$$

for data between 0 and 1 excluded.

### Add step kwargs to fill\_between

Added `step` kwarg to `Axes.fill_between` to allow to fill between lines drawn using the 'step' draw style. The values of `step` match those of the `where` kwarg of `Axes.step`. The asymmetry of the kwargs names is not ideal, but `Axes.fill_between` already has a `where` kwarg.

This is particularly useful for plotting pre-binned histograms.

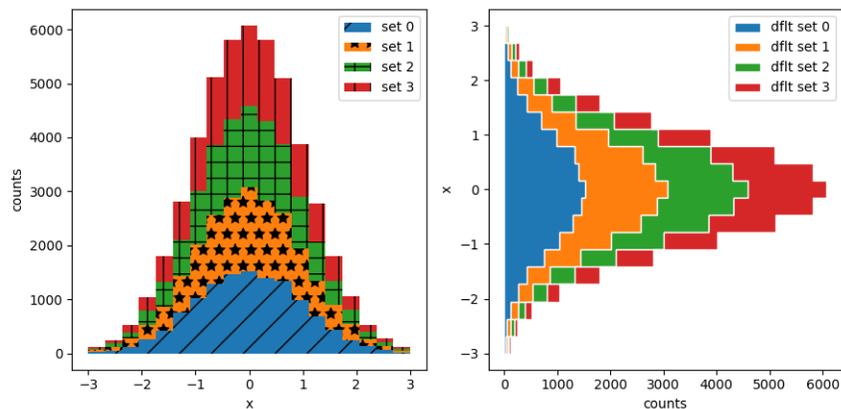
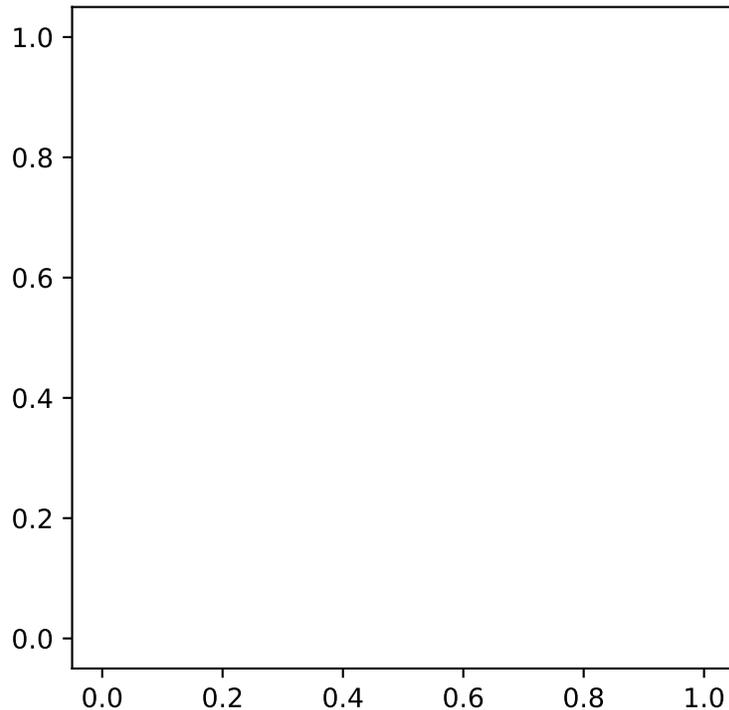


Fig. 29: Filled Step

### Square Plot

Implemented square plots feature as a new parameter in the axis function. When argument 'square' is specified, equal scaling is set, and the limits are set such that `xmax-xmin == ymax-ymin`.



#### Updated `figimage` to take optional `resize` parameter

Added the ability to plot simple 2D-Array using `plt.figimage(X, resize=True)`. This is useful for plotting simple 2D-Array without the Axes or whitespacing around the image.

#### Updated `Figure.savefig()` can now use figure's `dpi`

Added support to save the figure with the same `dpi` as the figure on the screen using `dpi='figure'`.

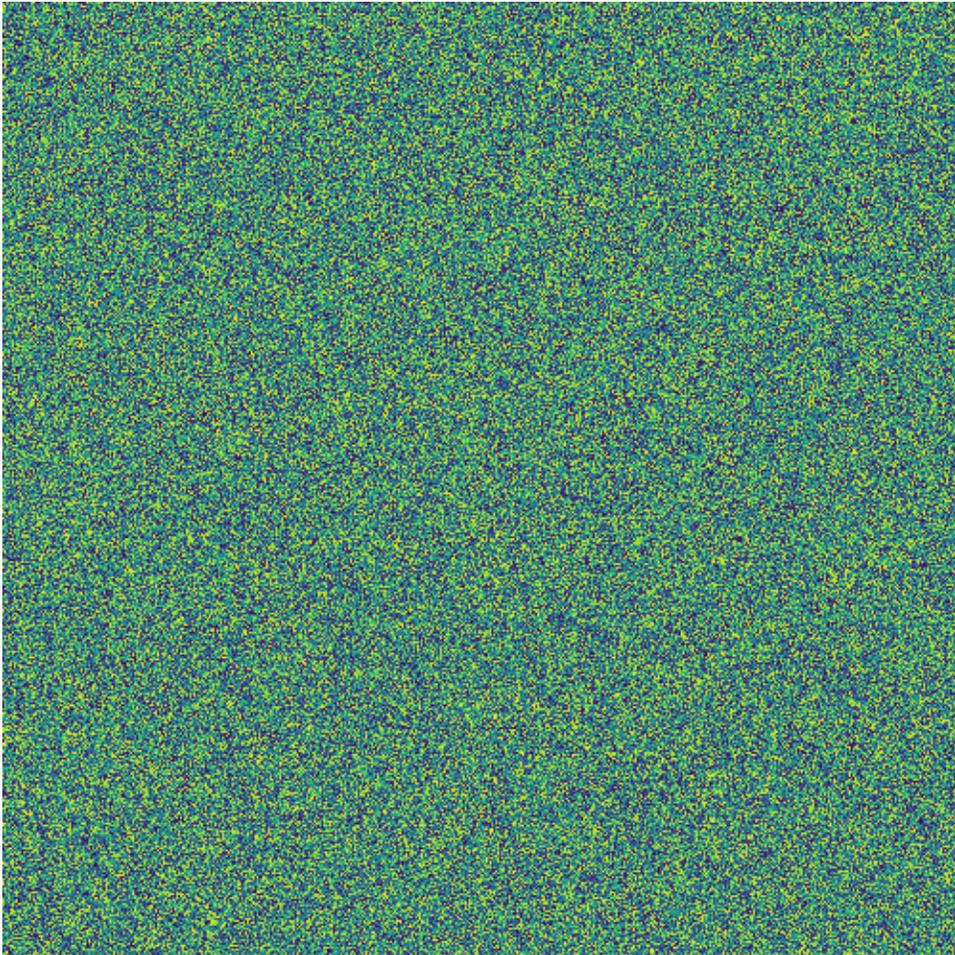
Example:

```
f = plt.figure(dpi=25)                # dpi set to 25
S = plt.scatter([1,2,3],[4,5,6])
f.savefig('output.png', dpi='figure') # output savefig dpi set to 25 (same as figure)
```

#### Updated `Table` to control edge visibility

Added the ability to toggle the visibility of lines in `Tables`. Functionality added to the `pyplot.table()` factory function under the keyword argument `"edges"`. Values can be the strings `"open"`, `"closed"`, `"horizontal"`, `"vertical"` or combinations of the letters `"L"`, `"R"`, `"T"`, `"B"` which represent left, right, top, and bottom respectively.

Example:



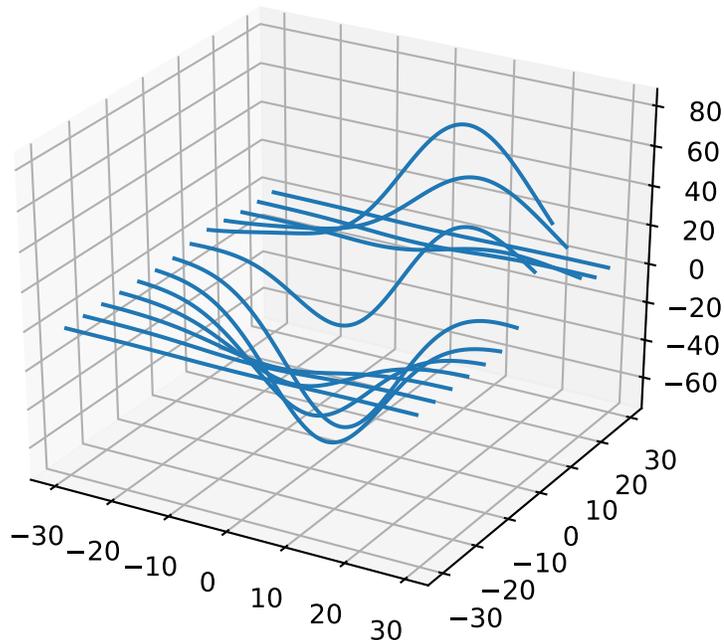
```

table(..., edges="open") # No line visible
table(..., edges="closed") # All lines visible
table(..., edges="horizontal") # Only top and bottom lines visible
table(..., edges="LT") # Only left and top lines visible.

```

### Zero *r*/cstride support in `plot_wireframe`

Adam Hughes added support to `mplot3d`'s `plot_wireframe` to draw only row or column line plots.

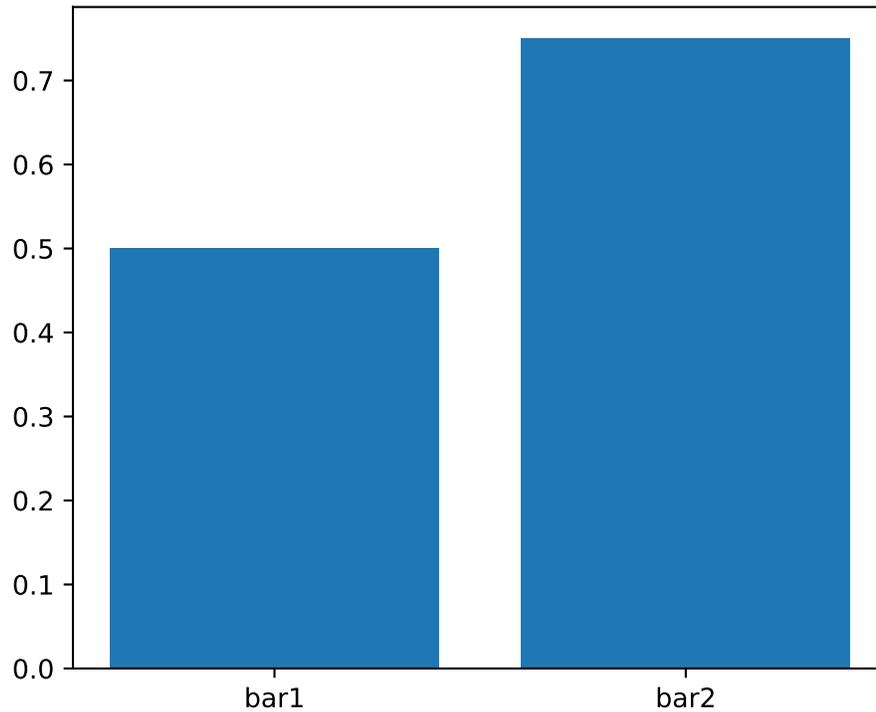


### Plot bar and barh with labels

Added kwarg `"tick_label"` to `bar` and `barh` to support plotting bar graphs with a text label for each bar.

### Added `center` and `frame` kwargs to `pie`

These control where the center of the pie graph are and if the Axes frame is shown.



### Fixed 3D filled contour plot polygon rendering

Certain cases of 3D filled contour plots that produce polygons with multiple holes produced improper rendering due to a loss of path information between *PolyCollection* and *Poly3DCollection*. A function `set_verts_and_codes()` was added to allow path information to be retained for proper rendering.

### Dense colorbars are rasterized

Vector file formats (pdf, ps, svg) are efficient for many types of plot element, but for some they can yield excessive file size and even rendering artifacts, depending on the renderer used for screen display. This is a problem for colorbars that show a large number of shades, as is most commonly the case. Now, if a colorbar is showing 50 or more colors, it will be rasterized in vector backends.

### DateFormatter strftime

`strftime` method will format a `datetime.datetime` object with the format string passed to the formatter's constructor. This method accepts datetimes with years before 1900, unlike `datetime.datetime.strftime()`.

### Artist-level `{get,set}_usetex` for text

Add `{get,set}_usetex` methods to `Text` objects which allow artist-level control of LaTeX rendering vs the internal `mathtext` rendering.

`ax.remove()` works as expected

As with artists added to an `Axes`, `Axes` objects can be removed from their figure via `remove()`.

### API Consistency fix within Locators `set_params()` function

`set_params()` function, which sets parameters within a `Locator` type instance, is now available to all `Locator` types. The implementation also prevents unsafe usage by strictly defining the parameters that a user can set.

To use, call `set_params()` on a `Locator` instance with desired arguments:

```
loc = matplotlib.ticker.LogLocator()
# Set given attributes for loc.
loc.set_params(numticks=8, numdecs=8, subs=[2.0], base=8)
# The below will error, as there is no such parameter for LogLocator
# named foo
# loc.set_params(foo='bar')
```

### Date Locators

Date Locators (derived from `DateLocator`) now implement the `tick_values()` method. This is expected of all Locators derived from `Locator`.

The Date Locators can now be used easily without creating axes

```
from datetime import datetime
from matplotlib.dates import YearLocator
t0 = datetime(2002, 10, 9, 12, 10)
tf = datetime(2005, 10, 9, 12, 15)
loc = YearLocator()
values = loc.tick_values(t0, tf)
```

### OffsetBoxes now support clipping

Artists draw onto objects of type `OffsetBox` through `DrawingArea` and `TextArea`. The `TextArea` calculates the required space for the text and so the text is always within the bounds, for this nothing has changed.

However, `DrawingArea` acts as a parent for zero or more Artists that draw on it and may do so beyond the bounds. Now child Artists can be clipped to the bounds of the `DrawingArea`.

### OffsetBoxes now considered by `tight_layout`

When `tight_layout()` or `Figure.tight_layout()` or `GridSpec.tight_layout()` is called, `OffsetBoxes` that are anchored outside the axes will not get chopped out. The `OffsetBoxes` will also not get overlapped by other axes in case of multiple subplots.

### Per-page pdf notes in multi-page pdfs (`PdfPages`)

Add a new method `attach_note()` to the `PdfPages` class, allowing the attachment of simple text notes to pages in a multi-page pdf of figures. The new note is visible in the list of pdf annotations in a viewer that has this facility (Adobe Reader, OSX Preview, Skim, etc.). Per default the note itself is kept off-page to prevent it to appear in print-outs.

`PdfPages.attach_note` needs to be called before `savefig()` in order to be added to the correct figure.

### Updated `fignum_exists` to take figure name

Added the ability to check the existence of a figure using its name instead of just the figure number. Example:

```
figure('figure')
fignum_exists('figure') #true
```

## 7.10.10 ToolManager

Federico Ariza wrote the new *ToolManager* that comes as replacement for `NavigationToolbar2`. `ToolManager` offers a new way of looking at the user interactions with the figures. Before we had the `NavigationToolbar2` with its own tools like `zoom/pan/home/save/...` and also we had the shortcuts like `yscale/grid/quit/...`. `Toolmanager` relocate all those actions as `Tools` (located in `backend_tools`), and defines a way to access/trigger/reconfigure them.

The `Toolbars` are replaced for `ToolContainers` that are just GUI interfaces to trigger the tools. But don't worry the default backends include a `ToolContainer` called `toolbar`.

---

**Note:** At the moment, we release this primarily for feedback purposes and should be treated as experimental until further notice as API changes will occur. For the moment the `ToolManager` works only with the `GTK3` and `Tk` backends. Make sure you use one of those. Port for the rest of the backends is coming soon.

To activate the `ToolManager` include the following at the top of your file

```
>>> matplotlib.rcParams['toolbar'] = 'toolmanager'
```

### Interact with the `ToolContainer`

The most important feature is the ability to easily reconfigure the `ToolContainer` (aka `toolbar`). For example, if we want to remove the "forward" button we would just do.

```
>>> fig.canvas.manager.toolmanager.remove_tool('forward')
```

Now if you want to programmatically trigger the “home” button

```
>>> fig.canvas.manager.toolmanager.trigger_tool('home')
```

### New Tools for ToolManager

It is possible to add new tools to the ToolManager

A very simple tool that prints “You’re awesome” would be:

```
from matplotlib.backend_tools import ToolBase
class AwesomeTool(ToolBase):
    def trigger(self, *args, **kwargs):
        print("You're awesome")
```

To add this tool to ToolManager

```
>>> fig.canvas.manager.toolmanager.add_tool('Awesome', AwesomeTool)
```

If we want to add a shortcut (“d”) for the tool

```
>>> fig.canvas.manager.toolmanager.update_keymap('Awesome', 'd')
```

To add it to the toolbar inside the group ‘foo’

```
>>> fig.canvas.manager.toolbar.add_tool('Awesome', 'foo')
```

There is a second class of tools, “Toggleable Tools”, this are almost the same as our basic tools, just that belong to a group, and are mutually exclusive inside that group. For tools derived from `ToolToggleBase` there are two basic methods `enable` and `disable` that are called automatically whenever it is toggled.

A full example is located in `/gallery/user_interfaces/toolmanager_sgskip`

#### 7.10.11 `cbook.is_sequence_of_strings` recognizes string objects

This is primarily how pandas stores a sequence of strings

```
import pandas as pd
import matplotlib.cbook as cbook

a = np.array(['a', 'b', 'c'])
print(cbook.is_sequence_of_strings(a)) # True

a = np.array(['a', 'b', 'c'], dtype=object)
print(cbook.is_sequence_of_strings(a)) # True

s = pd.Series(['a', 'b', 'c'])
print(cbook.is_sequence_of_strings(s)) # True
```

Previously, the last two prints returned false.

### 7.10.12 New `close-figs` argument for `plot` directive

Matplotlib has a sphinx extension `plot_directive` that creates plots for inclusion in sphinx documents. Matplotlib 1.5 adds a new option to the `plot` directive - `close-figs` - that closes any previous figure windows before creating the plots. This can help avoid some surprising duplicates of plots when using `plot_directive`.

### 7.10.13 Support for URL string arguments to `imread`

The `imread()` function now accepts URL strings that point to remote PNG files. This circumvents the generation of a `HTTPResponse` object directly.

### 7.10.14 Display hook for animations in the IPython notebook

`Animation` instances gained a `_repr_html_` method to support inline display of animations in the notebook. The method used to display is controlled by the `animation.html` rc parameter, which currently supports values of `none` and `html5`. `none` is the default, performing no display. `html5` converts the animation to an h264 encoded video, which is embedded directly in the notebook.

Users not wishing to use the `_repr_html_` display hook can also manually call the `to_html5_video` method to get the HTML and display using IPython's HTML display class:

```
from IPython.display import HTML
HTML(anim.to_html5_video())
```

### 7.10.15 Prefixed `pkg-config` for building

Handling of `pkg-config` has been fixed in so far as it is now possible to set it using the environment variable `PKG_CONFIG`. This is important if your toolchain is prefixed. This is done in a similar way as setting `CC` or `CXX` before building. An example follows.

```
export PKG_CONFIG=x86_64-pc-linux-gnu-pkg-config
```

## 7.11 New in matplotlib 2.0

---

**Note:** matplotlib 2.0 supports Python 2.7, and 3.4+

---

### 7.11.1 Default style changes

The major changes in v2.0 are related to overhauling the default styles.

## Changes to the default style

The most important changes in matplotlib 2.0 are the changes to the default style.

While it is impossible to select the best default for all cases, these are designed to work well in the most common cases.

A 'classic' style sheet is provided so reverting to the 1.x default values is a single line of python

```
import matplotlib.style
import matplotlib as mpl
mpl.style.use('classic')
```

See *The matplotlibrc file* for details about how to persistently and selectively revert many of these changes.

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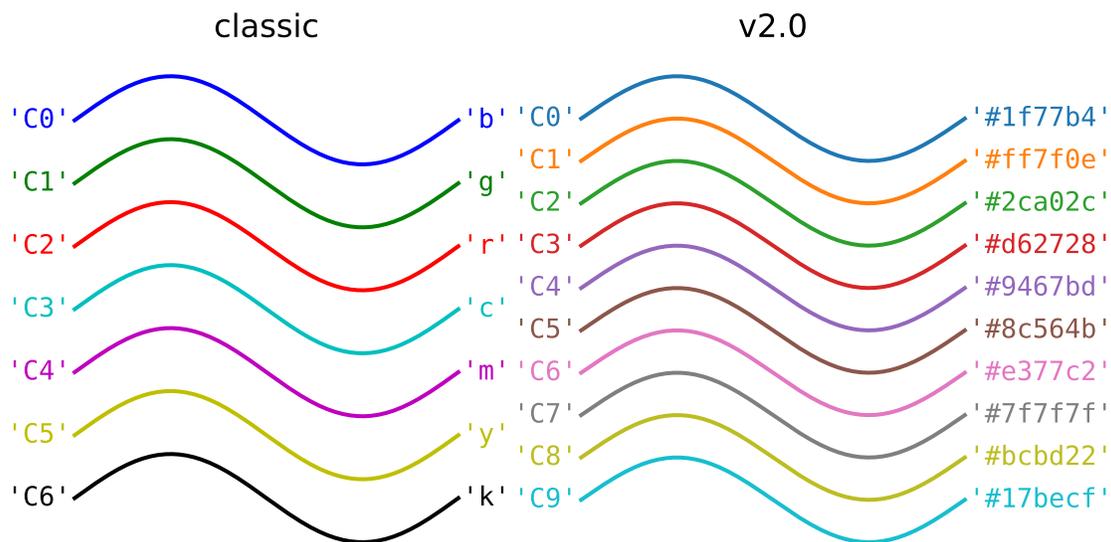
- *Colors, color cycles, and color maps*
  - *Colors in default property cycle*
  - *Colormap*
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  - *Tick label formatting*
- *mplot3d*

## Colors, color cycles, and color maps

### Colors in default property cycle

The colors in the default property cycle have been changed from ['b', 'g', 'r', 'c', 'm', 'y', 'k'] to the category10 color palette used by Vega and d3 originally developed at Tableau.



In addition to changing the colors, an additional method to specify colors was added. Previously, the default colors were the single character short-hand notations for red, green, blue, cyan, magenta, yellow, and black. This made them easy to type and usable in the abbreviated style string in `plot`, however the new default colors are only specified via hex values. To access these colors outside of the property cycling the notation for colors 'CN', where N takes values 0-9, was added to denote the first 10 colors in `mpl.rcParams['axes.prop_cycle']`. See *Specifying Colors* for more details.

To restore the old color cycle use

```
from cycler import cycler
mpl.rcParams['axes.prop_cycle'] = cycler(color='bgrcmk')
```

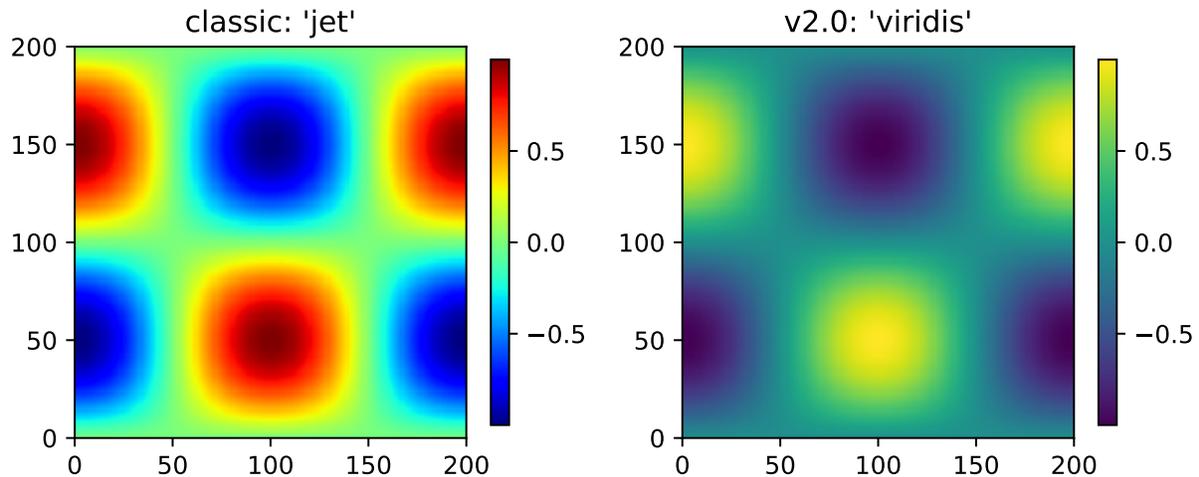
or set

```
axes.prop_cycle : cycler('color', 'bgrcmyk')
```

in your `matplotlibrc` file.

## Colormap

**The new default color map used by `matplotlib.cm.ScalarMappable` instances is 'viridis' (aka option D).**



For an introduction to color theory and how 'viridis' was generated watch Nathaniel Smith and Stéfan van der Walt's talk from SciPy2015. See [here for many more details](#) about the other alternatives and the tools used to create the color map. For details on all of the color maps available in matplotlib see *Choosing Colormaps in Matplotlib*.

The previous default can be restored using

```
mpl.rcParams['image.cmap'] = 'jet'
```

or setting

```
image.cmap : 'jet'
```

in your `matplotlibrc` file; however this is strongly discouraged.

## Interactive figures

The default interactive figure background color has changed from grey to white, which matches the default background color used when saving.

The previous defaults can be restored by

```
mpl.rcParams['figure.facecolor'] = '0.75'
```

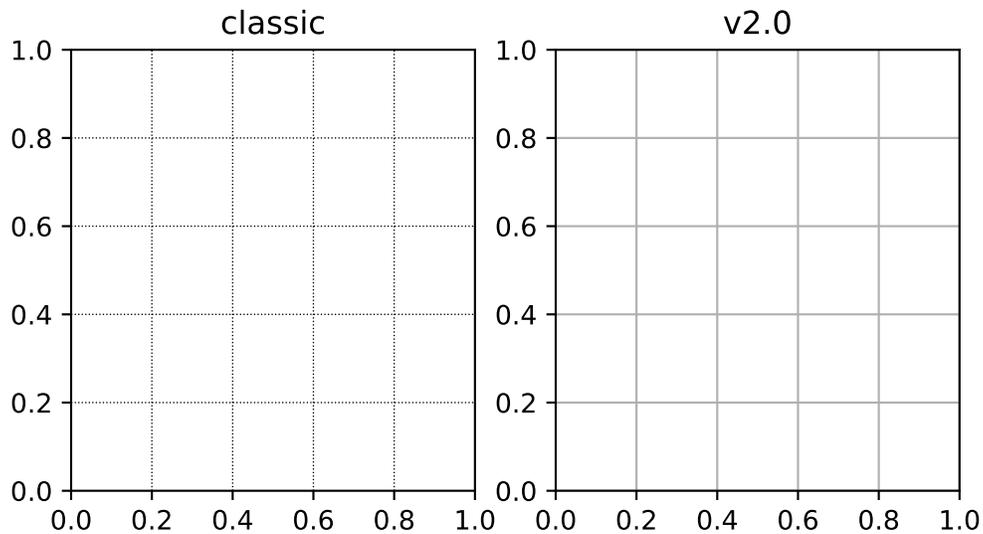
or by setting

```
figure.facecolor : '0.75'
```

in your `matplotlibrc` file.

### Grid lines

The default style of grid lines was changed from black dashed lines to thicker solid light grey lines.



The previous default can be restored by using:

```
mpl.rcParams['grid.color'] = 'k'
mpl.rcParams['grid.linestyle'] = ':'
mpl.rcParams['grid.linewidth'] = 0.5
```

or by setting:

```
grid.color      : k      # grid color
grid.linestyle  : :      # dotted
grid.linewidth  : 0.5    # in points
```

in your `matplotlibrc` file.

### Figure size, font size, and screen dpi

The default dpi used for on-screen display was changed from 80 dpi to 100 dpi, the same as the default dpi for saving files. Due to this change, the on-screen display is now more what-you-see-is-what-you-get for saved files. To keep the figure the same size in terms of pixels, in order to maintain approximately the same size on the screen, the default figure size was reduced from 8x6 inches to 6.4x4.8 inches. As a consequence of this the default font sizes used for the title, tick labels, and axes labels were reduced to maintain their size relative to the overall size of the figure. By default the dpi of the saved image is now the dpi of the *Figure* instance being saved.

This will have consequences if you are trying to match text in a figure directly with external text.

The previous defaults can be restored by

```
mpl.rcParams['figure.figsize'] = [8.0, 6.0]
mpl.rcParams['figure.dpi'] = 80
mpl.rcParams['savefig.dpi'] = 100

mpl.rcParams['font.size'] = 12
mpl.rcParams['legend.fontsize'] = 'large'
mpl.rcParams['figure.titlesize'] = 'medium'
```

or by setting:

```
figure.figsize : [8.0, 6.0]
figure.dpi     : 80
savefig.dpi   : 100

font.size     : 12.0
legend.fontsize : 'large'
figure.titlesize : 'medium'
```

In your `matplotlibrc` file.

In addition, the forward kwarg to `set_size_inches` now defaults to `True` to improve the interactive experience. Backend canvases that adjust the size of their bound `matplotlib.figure.Figure` must pass `forward=False` to avoid circular behavior. This default is not configurable.

## Plotting functions

### `scatter`

The following changes were made to the default behavior of `scatter`

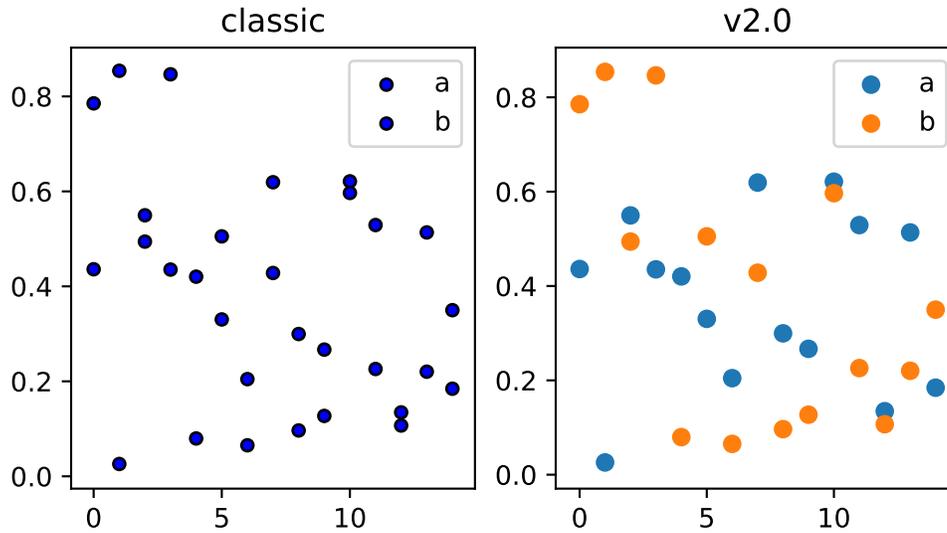
- The default size of the elements in a scatter plot is now based on the rcParam `lines.markersize` so it is consistent with `plot(X, Y, 'o')`. The old value was 20, and the new value is 36 ( $6^2$ ).
- Scatter markers no longer have a black edge.
- If the color of the markers is not specified it will follow the property cycle, pulling from the 'patches' cycle on the Axes.

The classic default behavior of `scatter` can only be recovered through `mpl.style.use('classic')`. The marker size can be recovered via

```
mpl.rcParams['lines.markersize'] = np.sqrt(20)
```

however, this will also affect the default marker size of `plot`. To recover the classic behavior on a per-call basis pass the following kwargs:

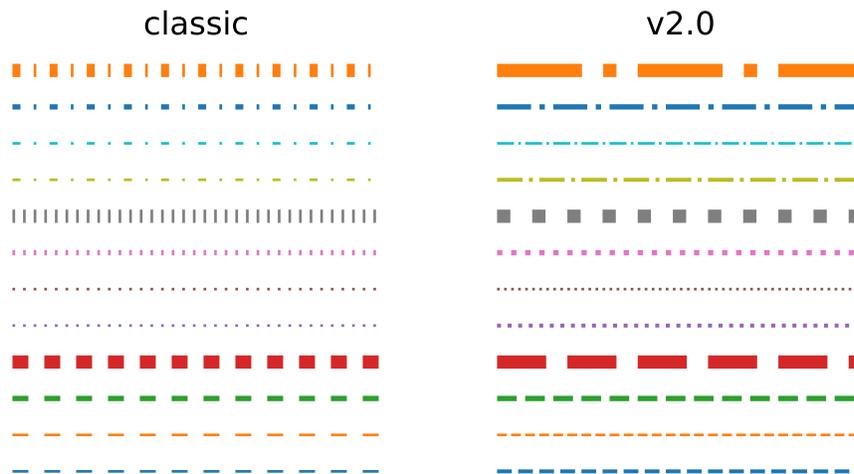
```
classic_kwargs = {'s': 20, 'edgecolors': 'k', 'c': 'b'}
```



`plot`

The following changes were made to the default behavior of `plot`

- the default linewidth increased from 1 to 1.5
- the dash patterns associated with `--`, `:`, and `-.` have changed
- the dash patterns now scale with line width



The previous defaults can be restored by setting:

```
mpl.rcParams['lines.linewidth'] = 1.0
mpl.rcParams['lines.dashed_pattern'] = [6, 6]
mpl.rcParams['lines.dashdot_pattern'] = [3, 5, 1, 5]
```

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```
mpl.rcParams['lines.dotted_pattern'] = [1, 3]
mpl.rcParams['lines.scale_dashes'] = False
```

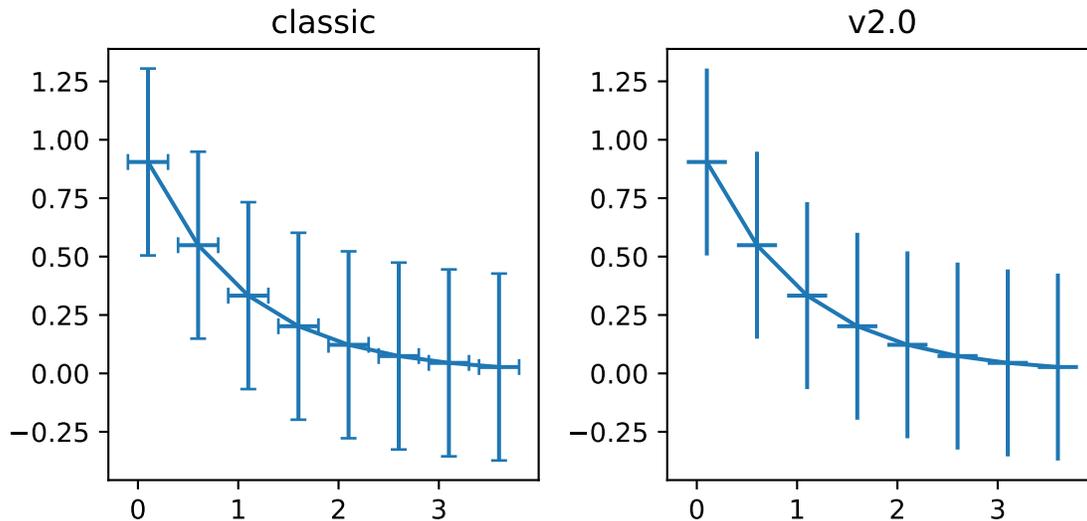
or by setting:

```
lines.linewidth : 1.0
lines.dashed_pattern : 6, 6
lines.dashdot_pattern : 3, 5, 1, 5
lines.dotted_pattern : 1, 3
lines.scale_dashes: False
```

in your `matplotlibrc` file.

### errorbar

By default, caps on the ends of errorbars are not present.



This also changes the return value of `errorbar()` as the list of 'caplines' will be empty by default.

The previous defaults can be restored by setting:

```
mpl.rcParams['errorbar.capsize'] = 3
```

or by setting

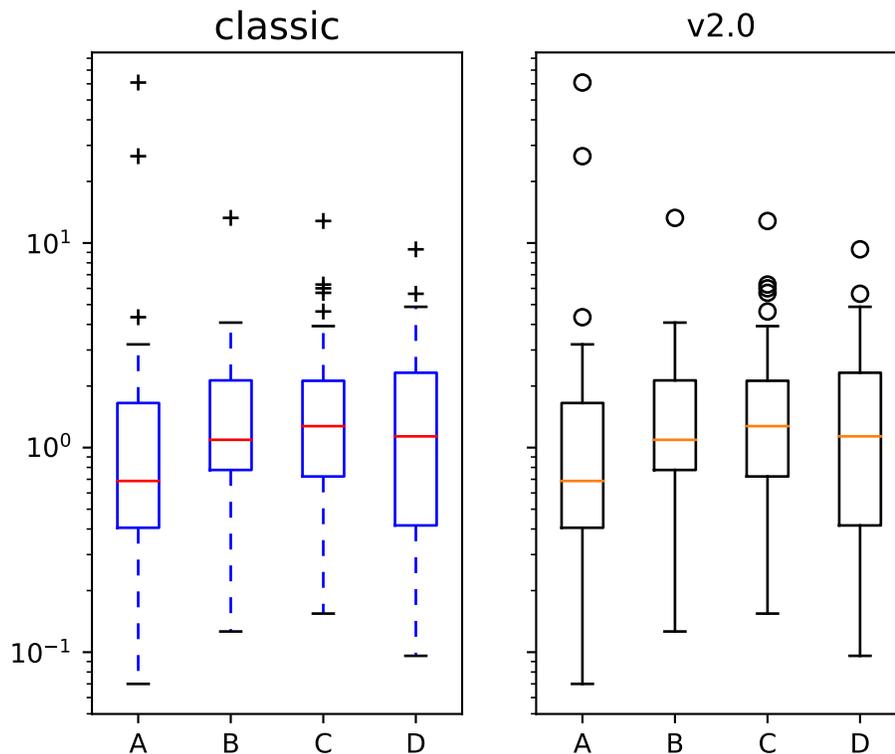
```
errorbar.capsize : 3
```

in your `matplotlibrc` file.

boxplot

Previously, boxplots were composed of a mish-mash of styles that were, for better for worse, inherited from Matlab. Most of the elements were blue, but the medians were red. The fliers (outliers) were black plus-symbols (+) and the whiskers were dashed lines, which created ambiguity if the (solid and black) caps were not drawn.

For the new defaults, everything is black except for the median and mean lines (if drawn), which are set to the first two elements of the current color cycle. Also, the default flier markers are now hollow circles, which maintain the ability of the plus-symbols to overlap without obscuring data too much.



The previous defaults can be restored by setting:

```
mpl.rcParams['boxplot.flierprops.color'] = 'k'
mpl.rcParams['boxplot.flierprops.marker'] = '+'
mpl.rcParams['boxplot.flierprops.markerfacecolor'] = 'none'
mpl.rcParams['boxplot.flierprops.markeredgecolor'] = 'k'
mpl.rcParams['boxplot.boxprops.color'] = 'b'
mpl.rcParams['boxplot.whiskerprops.color'] = 'b'
mpl.rcParams['boxplot.whiskerprops.linestyle'] = '--'
mpl.rcParams['boxplot.medianprops.color'] = 'r'
mpl.rcParams['boxplot.meanprops.color'] = 'r'
mpl.rcParams['boxplot.meanprops.marker'] = '^'
mpl.rcParams['boxplot.meanprops.markerfacecolor'] = 'r'
mpl.rcParams['boxplot.meanprops.markeredgecolor'] = 'k'
```

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```
mpl.rcParams['boxplot.meanprops.markersize'] = 6
mpl.rcParams['boxplot.meanprops.linestyle'] = '--'
mpl.rcParams['boxplot.meanprops.linewidth'] = 1.0
```

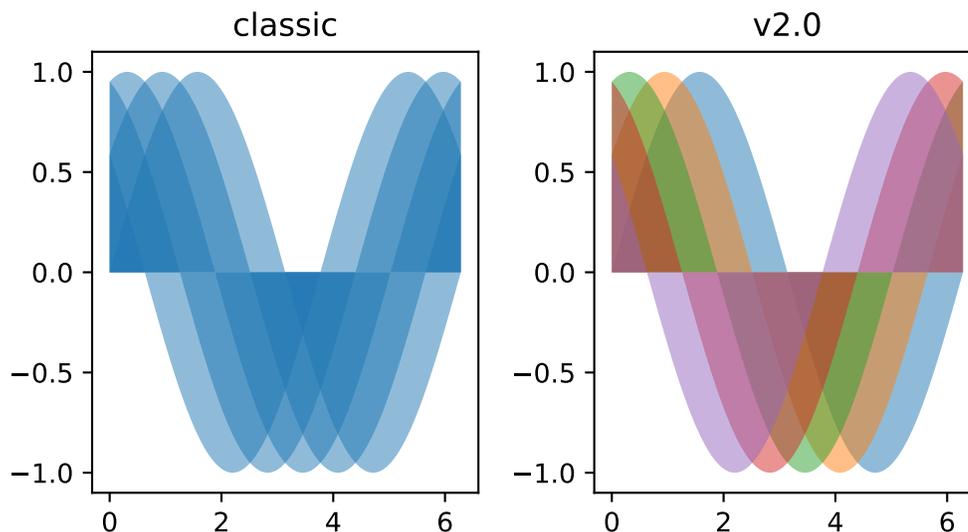
or by setting:

```
boxplot.flierprops.color:          'k'
boxplot.flierprops.marker:         '+'
boxplot.flierprops.markerfacecolor: 'none'
boxplot.flierprops.markeredgecolor: 'k'
boxplot.boxprops.color:           'b'
boxplot.whiskerprops.color:        'b'
boxplot.whiskerprops.linestyle:    '--'
boxplot.medianprops.color:         'r'
boxplot.meanprops.color:           'r'
boxplot.meanprops.marker:          '^'
boxplot.meanprops.markerfacecolor: 'r'
boxplot.meanprops.markeredgecolor: 'k'
boxplot.meanprops.markersize:      6
boxplot.meanprops.linestyle:       '--'
boxplot.meanprops.linewidth:       1.0
```

in your `matplotlibrc` file.

`fill_between` and `fill_betweenx`

`fill_between` and `fill_betweenx` both follow the patch color cycle.

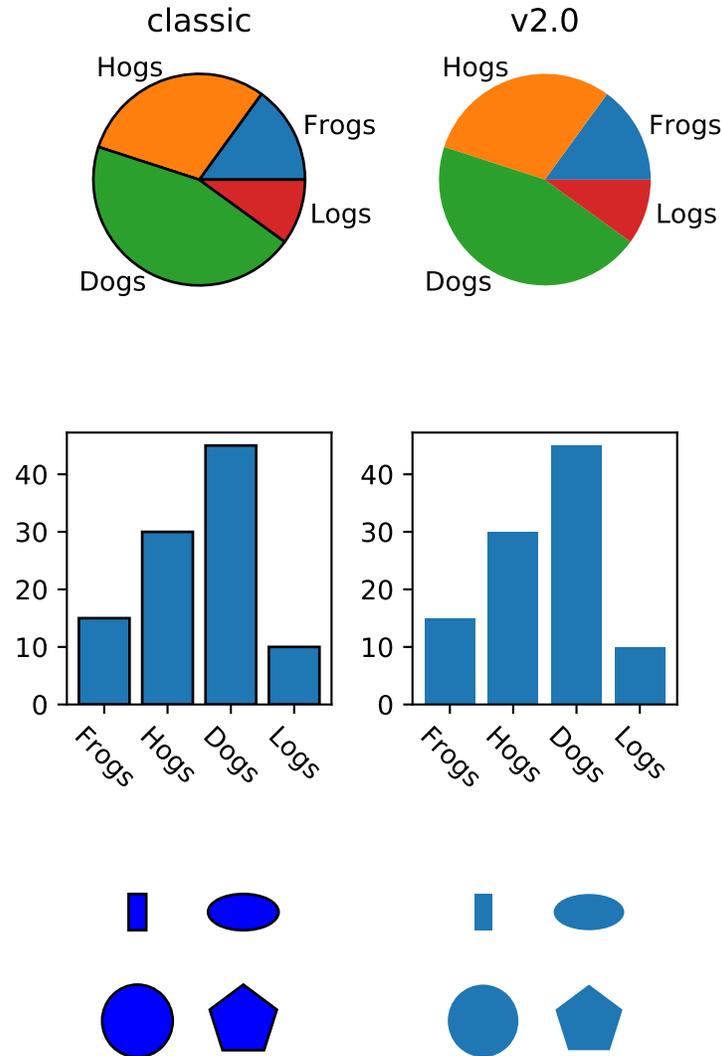


If the facecolor is set via the `facecolors` or `color` keyword argument, then the color is not cycled.

To restore the previous behavior, explicitly pass the keyword argument `facecolors='C0'` to the method call.

### Patch edges and color

Most artists drawn with a patch (`~matplotlib.axes.Axes.bar`, `~matplotlib.axes.Axes.pie`, etc) no longer have a black edge by default. The default face color is now 'C0' instead of 'b'.



The previous defaults can be restored by setting:

```
mpl.rcParams['patch.force_edgecolor'] = True
mpl.rcParams['patch.facecolor'] = 'b'
```

or by setting:

```
patch.facecolor      : b
patch.force_edgecolor : True
```

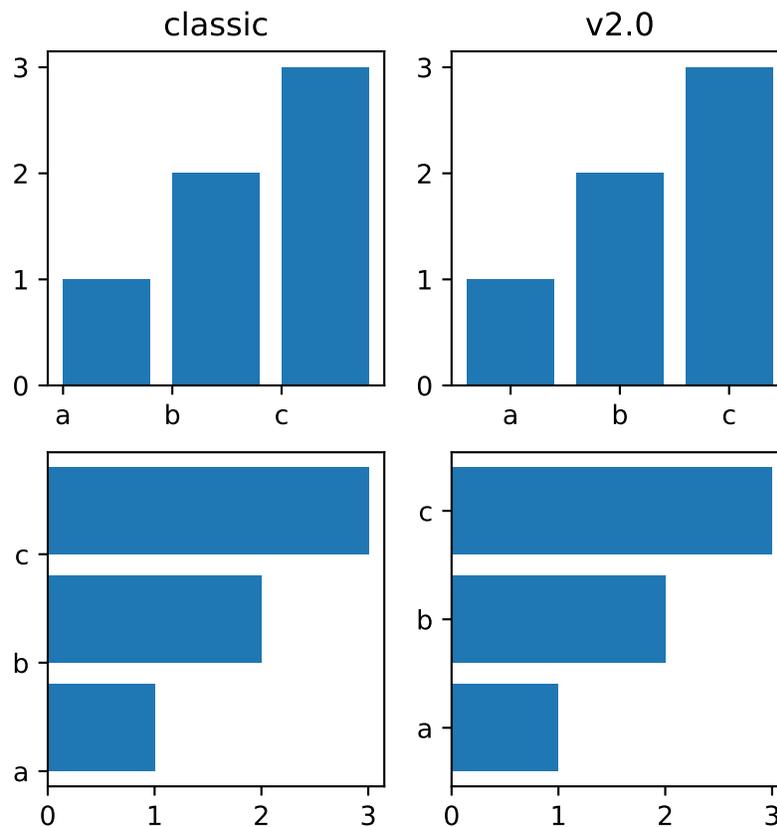
in your `matplotlibrc` file.

**hexbin**

The default value of the `linecolor` kwarg for `hexbin` has changed from `'none'` to `'face'`. If `'none'` is now supplied, no line edges are drawn around the hexagons.

**bar and barh**

The default value of the `align` kwarg for both `bar` and `barh` is changed from `'edge'` to `'center'`.



To restore the previous behavior explicitly pass the keyword argument `align='edge'` to the method call.

**Hatching**

The color of the lines in the hatch is now determined by

- If an edge color is explicitly set, use that for the hatch color
- If the edge color is not explicitly set, use `rcParam['hatch.color']` which is looked up at artist creation time.

The width of the lines in a hatch pattern is now configurable by the rcParams `hatch.linewidth`, which defaults to 1 point. The old behavior for the line width was different depending on backend:

- PDF: 0.1 pt
- SVG: 1.0 pt
- PS: 1 px
- Agg: 1 px

The old line width behavior can not be restored across all backends simultaneously, but can be restored for a single backend by setting:

```
mpl.rcParams['hatch.linewidth'] = 0.1 # previous pdf hatch linewidth
mpl.rcParams['hatch.linewidth'] = 1.0 # previous svg hatch linewidth
```

The behavior of the PS and Agg backends was DPI dependent, thus:

```
mpl.rcParams['figure.dpi'] = dpi
mpl.rcParams['savefig.dpi'] = dpi # or leave as default 'figure'
mpl.rcParams['hatch.linewidth'] = 1.0 / dpi # previous ps and Agg hatch linewidth
```

There is no direct API level control of the hatch color or linewidth.

Hatching patterns are now rendered at a consistent density, regardless of DPI. Formerly, high DPI figures would be more dense than the default, and low DPI figures would be less dense. This old behavior cannot be directly restored, but the density may be increased by repeating the hatch specifier.

## Fonts

### Normal text

The default font has changed from “Bitstream Vera Sans” to “DejaVu Sans”. DejaVu Sans has additional international and math characters, but otherwise has the same appearance as Bitstream Vera Sans. Latin, Greek, Cyrillic, Armenian, Georgian, Hebrew, and Arabic are **all supported** (but right-to-left rendering is still not handled by matplotlib). In addition, DejaVu contains a sub-set of emoji symbols.

See the [DejaVu Sans PDF sample](#) for full coverage.

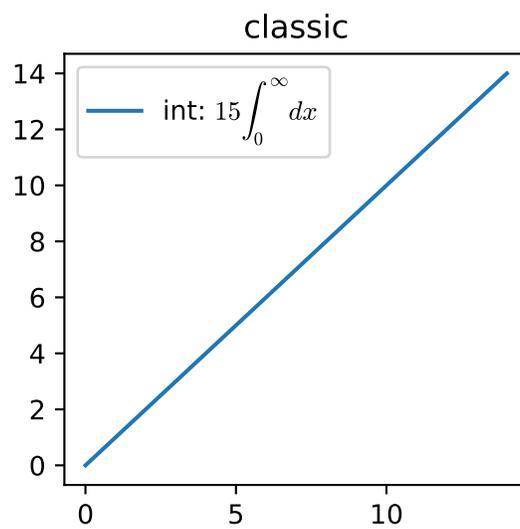
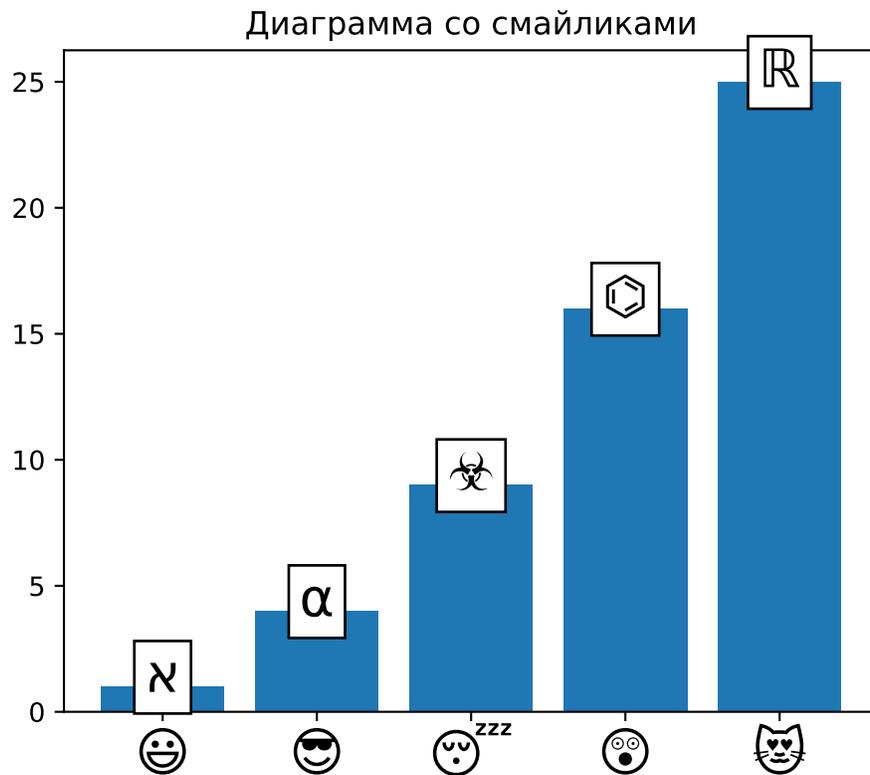
### Math text

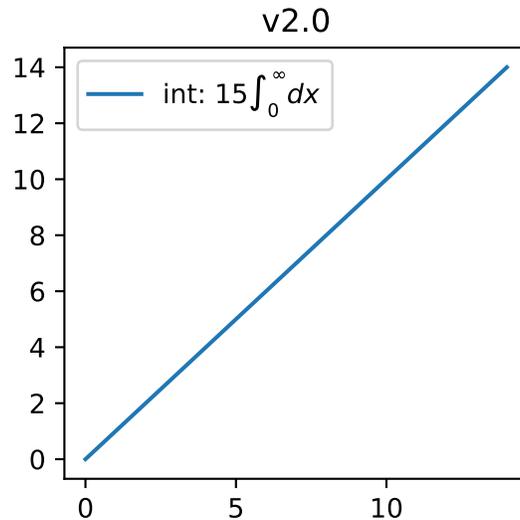
The default math font when using the built-in math rendering engine (`mathtext`) has changed from “Computer Modern” (i.e. LaTeX-like) to “DejaVu Sans”. This change has no effect if the TeX backend is used (i.e. `text.usetex` is True).

To revert to the old behavior set the:

```
mpl.rcParams['mathtext.fontset'] = 'cm'
mpl.rcParams['mathtext.rm'] = 'serif'
```

or set:





```

matplotlib.rcParams['mathtext.fontset'] = 'cm'
matplotlib.rcParams['mathtext.rm'] = 'serif'

```

in your `matplotlibrc` file.

This `rcParam` is consulted when the text is drawn, not when the artist is created. Thus all `mathtext` on a given canvas will use the same fontset.

## Legends

- By default, the number of points displayed in a legend is now 1.
- The default legend location is 'best', so the legend will be automatically placed in a location to minimize overlap with data.
- The legend defaults now include rounded corners, a lighter boundary, and partially transparent boundary and background.

The previous defaults can be restored by setting:

```

matplotlib.rcParams['legend.fancybox'] = False
matplotlib.rcParams['legend.loc'] = 'upper right'
matplotlib.rcParams['legend.numpoints'] = 2
matplotlib.rcParams['legend.fontsize'] = 'large'
matplotlib.rcParams['legend.framealpha'] = None
matplotlib.rcParams['legend.scatterpoints'] = 3
matplotlib.rcParams['legend.edgecolor'] = 'inherit'

```

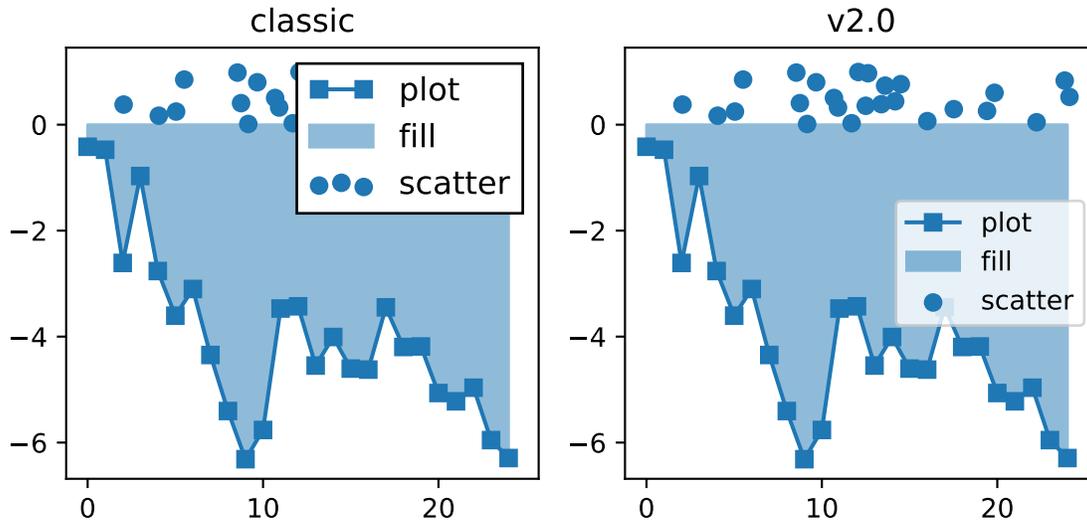
or by setting:

```

legend.fancybox      : False
legend.loc           : upper right
legend.numpoints     : 2      # the number of points in the legend line
legend.fontsize      : large

```

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```

legend.framealpha : None # opacity of legend frame
legend.scatterpoints : 3 # number of scatter points
legend.edgecolor : inherit # legend edge color ('inherit'
                           # means it uses axes.edgecolor)

```

in your matplotlibrc file.

## Image

### Interpolation

The default interpolation method for `imshow` is now 'nearest' and by default it resamples the data (both up and down sampling) before color mapping.

To restore the previous behavior set:

```

mpl.rcParams['image.interpolation'] = 'bilinear'
mpl.rcParams['image.resample'] = False

```

or set:

```

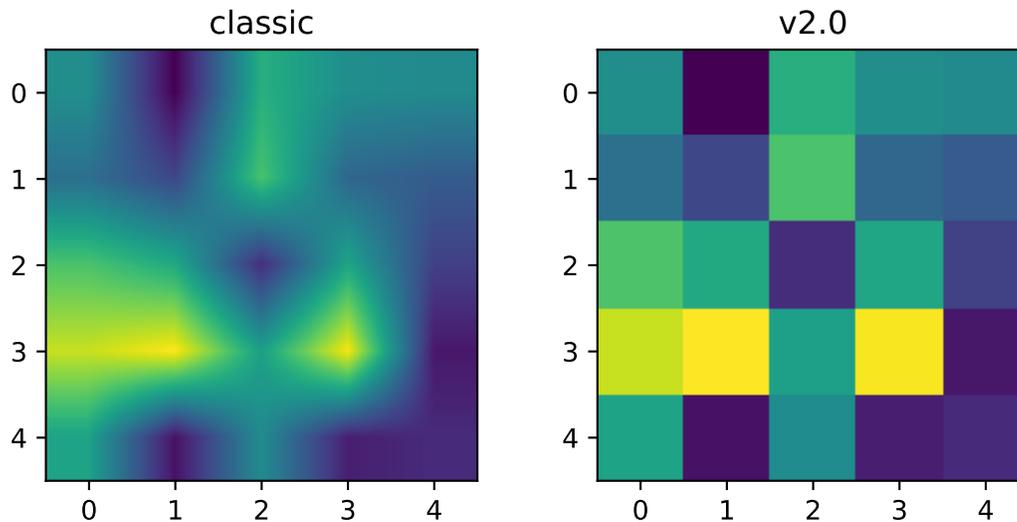
image.interpolation : bilinear # see help(imshow) for options
image.resample : False

```

in your matplotlibrc file.

### Colormapping pipeline

Previously, the input data was normalized, then color mapped, and then resampled to the resolution required for the screen. This meant that the final resampling was being done in color space. Because the color maps are not generally linear in RGB space, colors not in the



color map may appear in the final image. This bug was addressed by an almost complete overhaul of the image handling code.

The input data is now normalized, then resampled to the correct resolution (in normalized dataspace), and then color mapped to RGB space. This ensures that only colors from the color map appear in the final image. (If your viewer subsequently resamples the image, the artifact may reappear.)

The previous behavior cannot be restored.

### Shading

- The default shading mode for light source shading, in `matplotlib.colors.LightSource.shade`, is now `overlay`. Formerly, it was `hsv`.

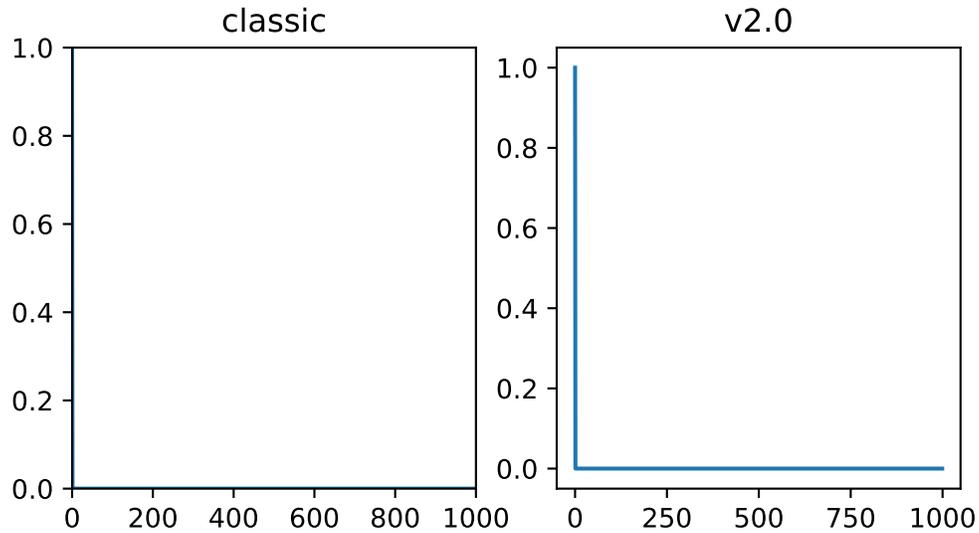
### Plot layout

#### Auto limits

The previous auto-scaling behavior was to find 'nice' round numbers as view limits that enclosed the data limits, but this could produce bad plots if the data happened to fall on a vertical or horizontal line near the chosen 'round number' limit. The new default sets the view limits to 5% wider than the data range.

The size of the padding in the x and y directions is controlled by the `'axes.xmargin'` and `'axes.ymargin'` rcParams respectively. Whether the view limits should be 'round numbers' is controlled by the `'axes.autolimit_mode'` rcParam. In the original `'round_number'` mode, the view limits coincide with ticks.

The previous default can be restored by using:



```
mpl.rcParams['axes.autolimit_mode'] = 'round_numbers'
mpl.rcParams['axes.xmargin'] = 0
mpl.rcParams['axes.ymargin'] = 0
```

or setting:

```
axes.autolimit_mode: round_numbers
axes.xmargin: 0
axes.ymargin: 0
```

in your matplotlibrc file.

### Z-order

- Ticks and grids are now plotted above solid elements such as filled contours, but below lines. To return to the previous behavior of plotting ticks and grids above lines, set `rcParams['axes.axisbelow'] = False`.

### Ticks

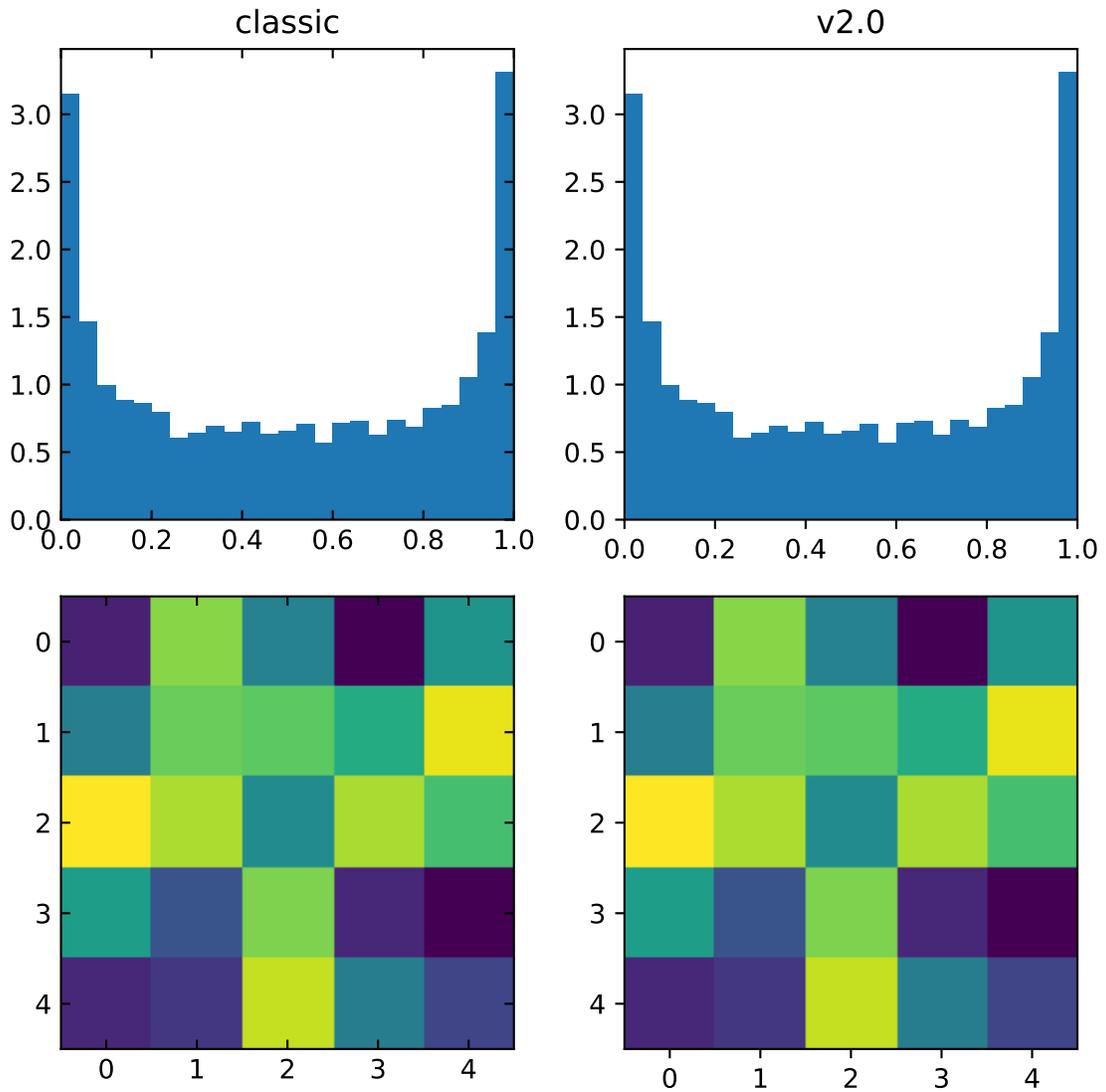
#### Direction

To reduce the collision of tick marks with data, the default ticks now point outward by default. In addition, ticks are now drawn only on the bottom and left spines to prevent a porcupine appearance, and for a cleaner separation between subplots.

To restore the previous behavior set:

```
mpl.rcParams['xtick.direction'] = 'in'
mpl.rcParams['ytick.direction'] = 'in'
```

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```
mpl.rcParams['xtick.top'] = True
mpl.rcParams['ytick.right'] = True
```

or set:

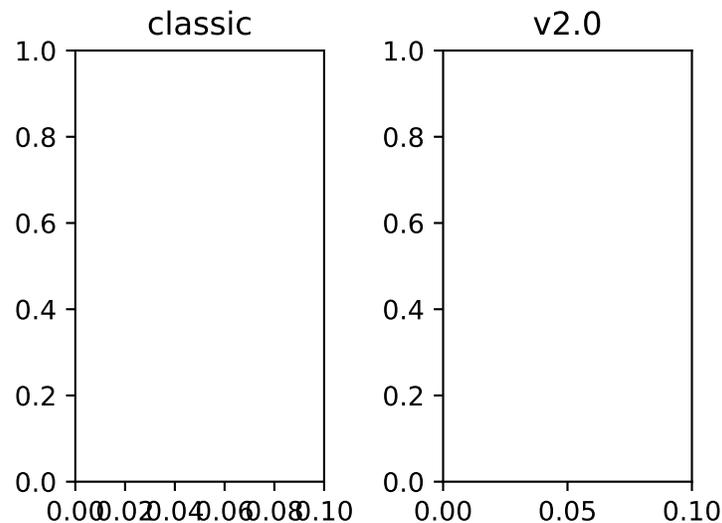
```
xtick.top: True
xtick.direction: in

ytick.right: True
ytick.direction: in
```

in your `matplotlibrc` file.

### Number of ticks

The default *Locator* used for the x and y axis is *AutoLocator* which tries to find, up to some maximum number, 'nicely' spaced ticks. The locator now includes an algorithm to estimate the maximum number of ticks that will leave room for the tick labels. By default it also ensures that there are at least two ticks visible.



There is no way, other than using `mpl.style.use('classic')`, to restore the previous behavior as the default. On an axis-by-axis basis you may either control the existing locator via:

```
ax.xaxis.get_major_locator().set_params(nbins=9, steps=[1, 2, 5, 10])
```

or create a new *MaxNLocator*:

```
import matplotlib.ticker as mticker
ax.set_major_locator(mticker.MaxNLocator(nbins=9, steps=[1, 2, 5, 10]))
```

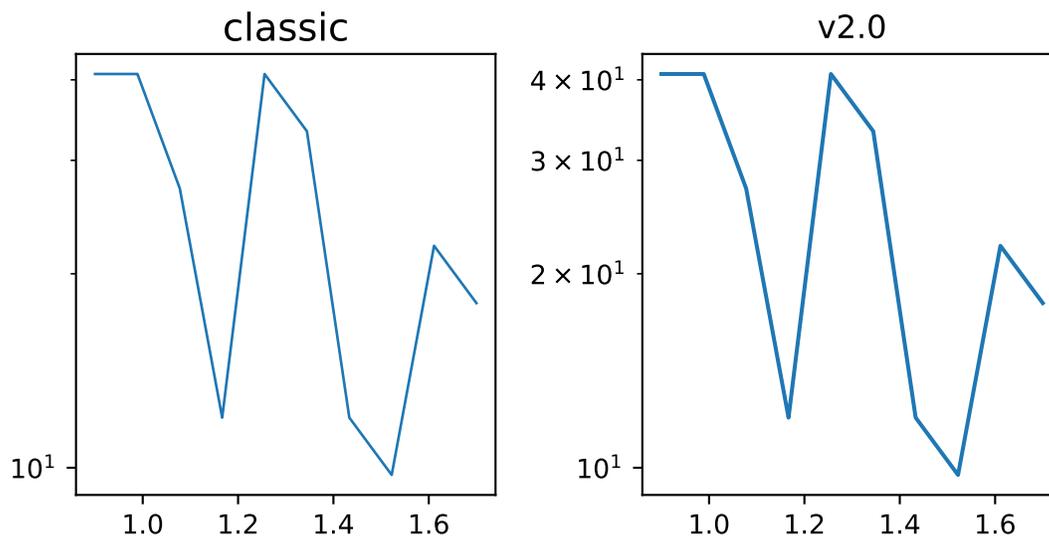
The algorithm used by *MaxNLocator* has been improved, and this may change the choice of tick locations in some cases. This also affects *AutoLocator*, which uses *MaxNLocator* internally.

For a log-scaled axis the default locator is the *LogLocator*. Previously the maximum number of ticks was set to 15, and could not be changed. Now there is a `numticks` kwarg for setting the maximum to any integer value, to the string 'auto', or to its default value of `None` which is equivalent to 'auto'. With the 'auto' setting the maximum number will be no larger than 9, and will be reduced depending on the length of the axis in units of the tick font size. As in the case of the *AutoLocator*, the heuristic algorithm reduces the incidence of overlapping tick labels but does not prevent it.

## Tick label formatting

### LogFormatter labeling of minor ticks

Minor ticks on a log axis are now labeled when the axis view limits span a range less than or equal to the interval between two major ticks. See *LogFormatter* for details. The minor tick labeling is turned off when using `mpl.style.use('classic')`, but cannot be controlled independently via `rcParams`.

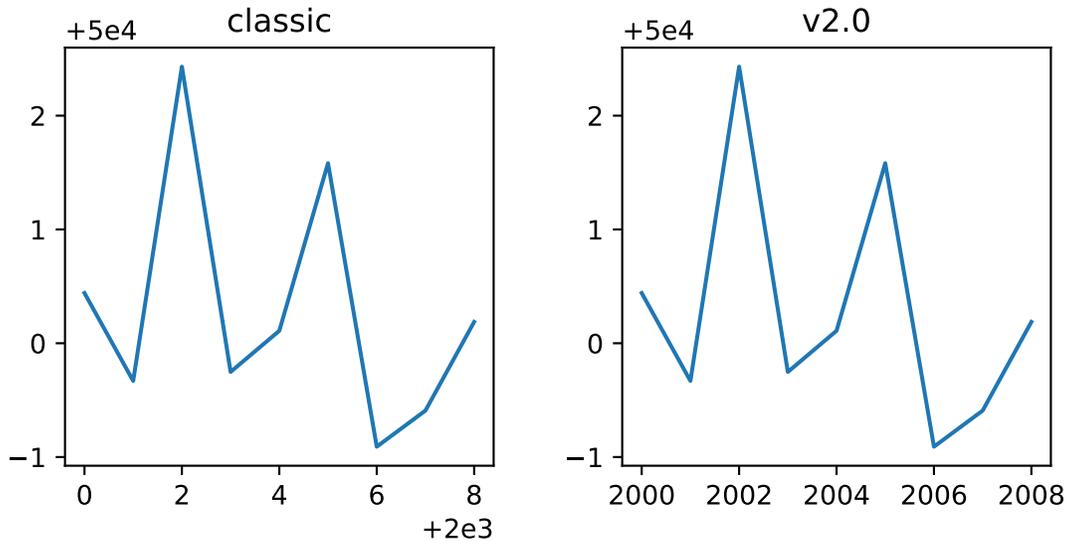


### ScalarFormatter tick label formatting with offsets

With the default of `rcParams['axes.formatter.useoffset'] = True`, an offset will be used when it will save 4 or more digits. This can be controlled with the new `rcParam`, `axes.formatter.offset_threshold`. To restore the previous behavior of using an offset to save 2 or more digits, use `rcParams['axes.formatter.offset_threshold'] = 2`.

### AutoDateFormatter format strings

The default date formats are now all based on ISO format, i.e., with the slowest-moving value first. The date formatters are configurable through the `date.autoformatter.*rcParams`.



Threshold (tick interval $\geq$ than)	rcParam	classic	v2.0
365 days	'date.autoformatter.year'	'%Y'	'%Y'
30 days	'date.autoformatter.month'	'%b %Y'	'%Y-%m'
1 day	'date.autoformatter.day'	'%b %d %Y'	'%Y-%m-%d'
1 hour	'date.autoformatter.hour'	'%H:%M:%S'	'%H:%M'
1 minute	'date.autoformatter.minute'	'%H:%M:%S. %f'	'%H:%M:%S'
1 second	'date.autoformatter.second'	'%H:%M:%S. %f'	'%H:%M:%S'
1 microsecond	'date.autoformatter. microsecond'	'%H:%M:%S. %f'	'%H:%M:%S. %f'

Python's `%x` and `%X` date formats may be of particular interest to format dates based on the current locale.

The previous default can be restored by:

```
mpl.rcParams['date.autoformatter.year'] = '%Y'
mpl.rcParams['date.autoformatter.month'] = '%b %Y'
mpl.rcParams['date.autoformatter.day'] = '%b %d %Y'
mpl.rcParams['date.autoformatter.hour'] = '%H:%M:%S'
mpl.rcParams['date.autoformatter.minute'] = '%H:%M:%S.%f'
mpl.rcParams['date.autoformatter.second'] = '%H:%M:%S.%f'
mpl.rcParams['date.autoformatter.microsecond'] = '%H:%M:%S.%f'
```

or setting

```
date.autoformatter.year : %Y
date.autoformatter.month : %b %Y
date.autoformatter.day : %b %d %Y
date.autoformatter.hour : %H:%M:%S
date.autoformatter.minute : %H:%M:%S.%f
```

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```
date.autoformatter.second : %H:%M:%S.%f
date.autoformatter.microsecond : %H:%M:%S.%f
```

in your `matplotlibrc` file.

### **mplot3d**

- `mplot3d` now obeys some style-related `rcParams`, rather than using hard-coded defaults. These include:
  - `xtick.major.width`
  - `ytick.major.width`
  - `xtick.color`
  - `ytick.color`
  - `axes.linewidth`
  - `axes.edgecolor`
  - `grid.color`
  - `grid.linewidth`
  - `grid.linestyle`

### **7.11.2 Improved color conversion API and RGBA support**

The `colors` gained a new color conversion API with full support for the alpha channel. The main public functions are `is_color_like()`, `matplotlib.colors.to_rgba()`, `matplotlib.colors.to_rgba_array()` and `to_hex()`. RGBA quadruplets are encoded in hex format as `#rrggbbaa`.

A side benefit is that the Qt options editor now allows setting the alpha channel of the artists as well.

### **7.11.3 New Configuration (rcParams)**

New `rcparams` added

Parameter	Description
<code>date.autoformatter.year</code>	format string for 'year' scale dates
<code>date.autoformatter.month</code>	format string for 'month' scale dates
<code>date.autoformatter.day</code>	format string for 'day' scale dates
<code>date.autoformatter.hour</code>	format string for 'hour' scale times
<code>date.autoformatter.minute</code>	format string for 'minute' scale times
<code>date.autoformatter.second</code>	format string for 'second' scale times
<code>date.autoformatter.microsecond</code>	format string for 'microsecond' scale times
<code>scatter.marker</code>	default marker for scatter plot
<code>svg.hashsalt</code>	see note
<code>xtick.top</code> , <code>xtick.minor.top</code> , <code>xtick.major.top</code> , <code>xtick.bottom</code> , <code>xtick.minor.bottom</code> , <code>xtick.major.bottom</code> , <code>ytick.left</code> , <code>ytick.minor.left</code> , <code>ytick.major.left</code> , <code>ytick.right</code> , <code>ytick.minor.right</code> , <code>ytick.major.right</code>	Control where major and minor ticks are drawn. The global values are and ed with the corresponding major/minor values.
<code>hist.bins</code>	The default number of bins to use in <code>hist</code> . This can be an <code>int</code> , a list of floats, or 'auto' if numpy $\geq$ 1.11 is installed.
<code>lines.scale_dashes</code>	Whether the line dash patterns should scale with linewidth.
<code>axes.formatter.offset_threshold</code>	Minimum number of digits saved in tick labels that triggers using an offset.

#### Added `svg.hashsalt` key to `rcParams`

If `svg.hashsalt` is `None` (which it is by default), the `svg` backend uses `uuid4` to generate the hash salt. If it is not `None`, it must be a string that is used as the hash salt instead of `uuid4`. This allows for deterministic SVG output.

#### Removed the `svg.image_noscale` `rcParam`

As a result of the extensive changes to image handling, the `svg.image_noscale` `rcParam` has been removed. The same functionality may be achieved by setting `interpolation='none'` on individual images or globally using the `image.interpolation` `rcParam`.

### 7.11.4 Qualitative colormaps

ColorBrewer's "qualitative" colormaps ("Accent", "Dark2", "Paired", "Pastel1", "Pastel2", "Set1", "Set2", "Set3") were intended for discrete categorical data, with no implication of value, and therefore have been converted to `ListedColormap` instead of `LinearSegmentedColormap`, so the colors will no longer be interpolated and they can be used for choropleths, labeled image features, etc.

### 7.11.5 Axis offset label now responds to `labelcolor`

Axis offset labels are now colored the same as axis tick markers when `labelcolor` is altered.

### 7.11.6 Improved offset text choice

The default offset-text choice was changed to only use significant digits that are common to all ticks (e.g. 1231..1239 -> 1230, instead of 1231), except when they straddle a relatively large multiple of a power of ten, in which case that multiple is chosen (e.g. 1999..2001->2000).

### 7.11.7 Style parameter blacklist

In order to prevent unexpected consequences from using a style, style files are no longer able to set parameters that affect things unrelated to style. These parameters include:

```
'interactive', 'backend', 'backend.qt4', 'webagg.port',  
'webagg.port_retries', 'webagg.open_in_browser', 'backend_fallback',  
'toolbar', 'timezone', 'datapath', 'figure.max_open_warning',  
'savefig.directory', 'tk.window_focus', 'docstring.hardcopy'
```

### 7.11.8 Change in default font

The default font used by matplotlib in text has been changed to DejaVu Sans and DejaVu Serif for the sans-serif and serif families, respectively. The DejaVu font family is based on the previous matplotlib default -Bitstream Vera- but includes a much wider range of characters.

The default mathtext font has been changed from Computer Modern to the DejaVu family to maintain consistency with regular text. Two new options for the `mathtext.fontset` configuration parameter have been added: `dejavusans` (default) and `dejavuserif`. Both of these options use DejaVu glyphs whenever possible and fall back to STIX symbols when a glyph is not found in DejaVu. To return to the previous behavior, set the rcParam `mathtext.fontset` to `cm`.

### 7.11.9 Faster text rendering

Rendering text in the Agg backend is now less fuzzy and about 20% faster to draw.

### 7.11.10 Improvements for the Qt figure options editor

Various usability improvements were implemented for the Qt figure options editor, among which:

- Line style entries are now sorted without duplicates.
- The colormap and normalization limits can now be set for images.
- Line edits for floating values now display only as many digits as necessary to avoid precision loss. An important bug was also fixed regarding input validation using Qt5 and a locale where the decimal separator is `","`.

- The axes selector now uses shorter, more user-friendly names for axes, and does not crash if there are no axes.
- Line and image entries using the default labels ("`_lineX`", "`_imageX`") are now sorted numerically even when there are more than 10 entries.

### 7.11.11 Improved image support

Prior to version 2.0, matplotlib resampled images by first applying the color map and then resizing the result. Since the resampling was performed on the colored image, this introduced colors in the output image that didn't actually exist in the color map. Now, images are resampled first (and entirely in floating-point, if the input image is floating-point), and then the color map is applied.

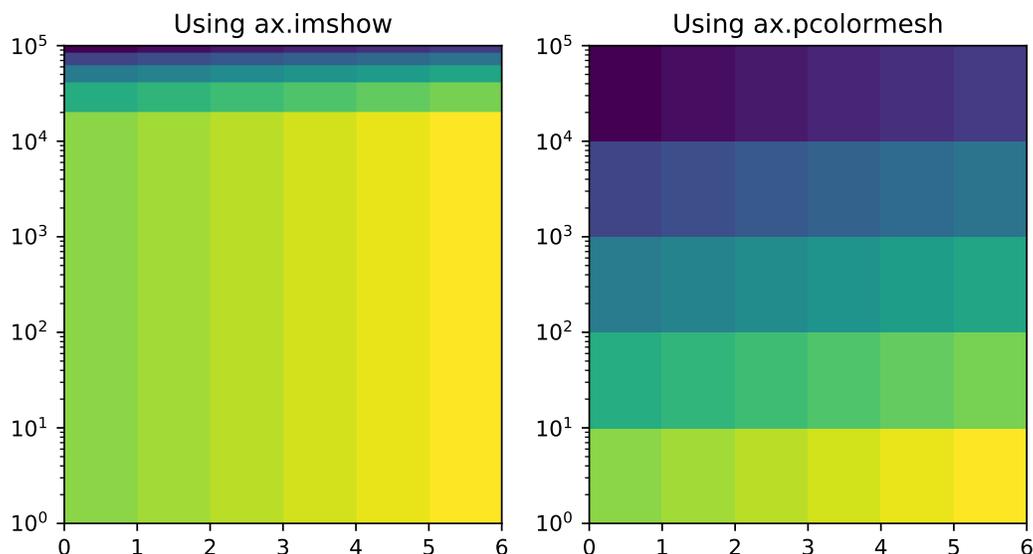
In order to make this important change, the image handling code was almost entirely rewritten. As a side effect, image resampling uses less memory and fewer datatype conversions than before.

The experimental private feature where one could "skew" an image by setting the private member `_image_skew_coordinate` has been removed. Instead, images will obey the transform of the axes on which they are drawn.

#### Non-linear scales on image plots

`imshow()` now draws data at the requested points in data space after the application of non-linear scales.

The image on the left demonstrates the new, correct behavior. The old behavior can be recreated using `pcolormesh()` as demonstrated on the right.



This can be understood by analogy to plotting a histogram with linearly spaced bins with a logarithmic x-axis. Equal sized bins will be displayed as wider for small  $x$  and narrower for large  $x$ .

### 7.11.12 Support for HiDPI (Retina) displays in the NbAgg and WebAgg backends

The NbAgg and WebAgg backends will now use the full resolution of your high-pixel-density display.

### 7.11.13 Change in the default animation codec

The default animation codec has been changed from mpeg4 to h264, which is more efficient. It can be set via the `animation.codec` rcParam.

### 7.11.14 Deprecated support for mencoder in animation

The use of mencoder for writing video files with mpl is problematic; switching to ffmpeg is strongly advised. All support for mencoder will be removed in version 2.2.

### 7.11.15 Boxplot Zorder Keyword Argument

The `zorder` parameter now exists for `boxplot()`. This allows the zorder of a boxplot to be set in the plotting function call.

```
boxplot(np.arange(10), zorder=10)
```

### 7.11.16 Filled + and x markers

New fillable *plus* and *x* markers have been added. See the *markers* module and marker reference examples.

### 7.11.17 rcount and ccount for plot\_surface()

As of v2.0, `mplot3d`'s `plot_surface()` now accepts `rcount` and `ccount` arguments for controlling the sampling of the input data for plotting. These arguments specify the maximum number of evenly spaced samples to take from the input data. These arguments are also the new default sampling method for the function, and is considered a style change.

The old `rstride` and `cstride` arguments, which specified the size of the evenly spaced samples, become the default when 'classic' mode is invoked, and are still available for use. There are no plans for deprecating these arguments.

### 7.11.18 Streamplot Zorder Keyword Argument Changes

The `zorder` parameter for `streamplot()` now has default value of `None` instead of `2`. If `None` is given as `zorder`, `streamplot()` has a default `zorder` of `matplotlib.lines.Line2D.zorder`.

### 7.11.19 Extension to `matplotlib.backend_bases.GraphicsContextBase`

To support standardizing hatch behavior across the backends we ship the `matplotlib.backend_bases.GraphicsContextBase.get_hatch_color` method as added to `matplotlib.backend_bases.GraphicsContextBase`. This is only used during the render process in the backends we ship so will not break any third-party backends.

If you maintain a third-party backend which extends `GraphicsContextBase` this method is now available to you and should be used to color hatch patterns.

## 7.12 New in Matplotlib 2.1.0

### 7.12.1 Documentation

The examples have been migrated to use [sphinx gallery](#). This allows better mixing of prose and code in the examples, provides links to download the examples as both a Python script and a Jupyter notebook, and improves the thumbnail galleries. The examples have been re-organized into *Tutorials* and a gallery.

Many docstrings and examples have been clarified and improved.

### 7.12.2 New features

#### String categorical values

All plotting functions now support string categorical values as input. For example:

```
data = {'apples': 10, 'oranges': 15, 'lemons': 5, 'limes': 20}
fig, ax = plt.subplots()
ax.bar(data.keys(), data.values(), color='lightgray')
```

#### Interactive JS widgets for animation

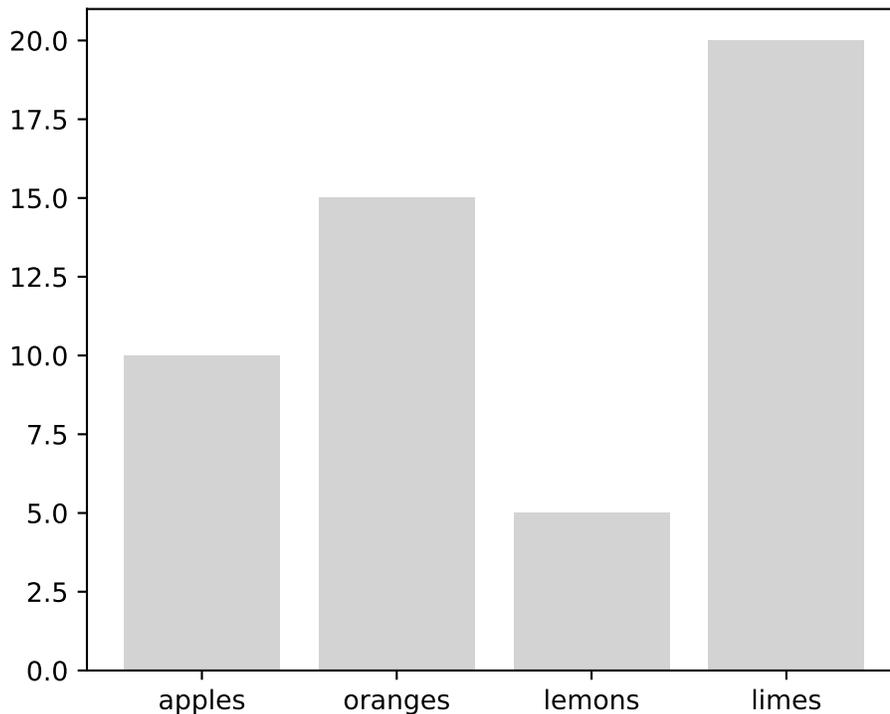
Jake Vanderplas' `JSAAnimation` package has been merged into Matplotlib. This adds to Matplotlib the `HTMLWriter` class for generating a JavaScript HTML animation, suitable for the IPython notebook. This can be activated by default by setting the `animation.html` rc parameter to `jshtml`. One can also call the `to_jshtml` method to manually convert an animation. This can be displayed using IPython's HTML display class:

```
from IPython.display import HTML
HTML(animation.to_jshtml())
```

The `HTMLWriter` class can also be used to generate an HTML file by asking for the `html` writer.

#### Enhancements to polar plot

The polar axes transforms have been greatly re-factored to allow for more customization of view limits and tick labelling. Additional options for view limits allow for creating an annulus, a sector, or some combination of the two.



The `set_rorigin()` method may be used to provide an offset to the minimum plotting radius, producing an annulus.

The `set_theta_zero_location()` method now has an optional `offset` argument. This argument may be used to further specify the zero location based on the given anchor point.

The `set_thetamin()` and `set_thetamax()` methods may be used to limit the range of angles plotted, producing sectors of a circle.

Previous releases allowed plots containing negative radii for which the negative values are simply used as labels, and the real radius is shifted by the configured minimum. This release also allows negative radii to be used for grids and ticks, which were previously silently ignored.

Radial ticks have been modified to be parallel to the circular grid line, and angular ticks have been modified to be parallel to the grid line. It may also be useful to rotate tick *labels* to match the boundary. Calling `ax.tick_params(rotation='auto')` will enable the new behavior: radial tick labels will be parallel to the circular grid line, and angular tick labels will be perpendicular to the grid line (i.e., parallel to the outer boundary). Additionally, tick labels now obey the padding settings that previously only worked on Cartesian plots. Consequently, the `frac` argument to `PolarAxes.set_theta grids` is no longer applied. Tick padding can be modified with the `pad` argument to `Axes.tick_params` or `Axis.set_tick_params`.

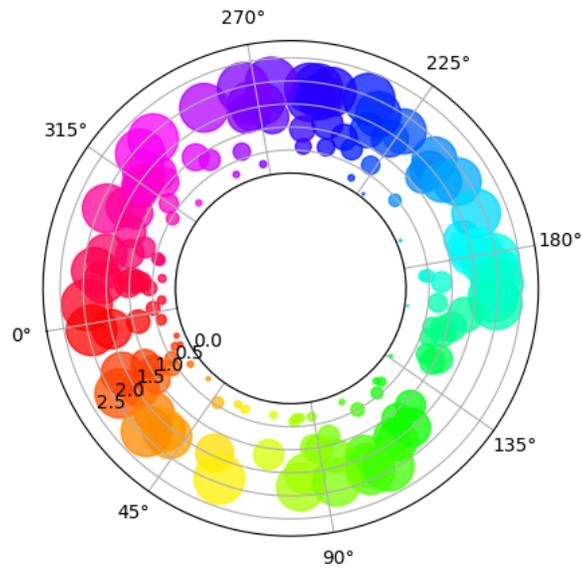


Fig. 30: Polar Offset Demo

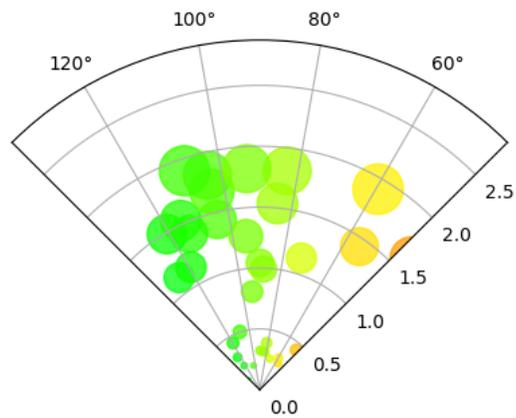


Fig. 31: Polar Sector Demo

### Figure class now has subplots method

The *Figure* class now has a *subplots()* method which behaves the same as *pyplot.subplots()* but on an existing figure.

### Metadata savefig keyword argument

*savefig()* now accepts metadata as a keyword argument. It can be used to store key/value pairs in the image metadata.

- 'png' with Agg backend
- 'pdf' with PDF backend (see *writeInfoDict()* for a list of supported keywords)
- 'eps' and 'ps' with PS backend (only 'Creator' key is accepted)

```
plt.savefig('test.png', metadata={'Software': 'My awesome software'})
```

### Busy Cursor

The interactive GUI backends will now change the cursor to busy when Matplotlib is rendering the canvas.

### PolygonSelector

A *PolygonSelector* class has been added to *matplotlib.widgets*. See [/gallery/widgets/polygon\\_selector\\_demo](/gallery/widgets/polygon_selector_demo) for details.

### Added matplotlib.ticker.PercentFormatter

The new *PercentFormatter* formatter has some nice features like being able to convert from arbitrary data scales to percents, a customizable percent symbol and either automatic or manual control over the decimal points.

### Reproducible PS, PDF and SVG output

The `SOURCE_DATE_EPOCH` environment variable can now be used to set the timestamp value in the PS and PDF outputs. See [source date epoch](#).

Alternatively, calling *savefig* with `metadata={'CreationDate': None}` will omit the timestamp altogether for the PDF backend.

The reproducibility of the output from the PS and PDF backends has so far been tested using various plot elements but only default values of options such as `{ps,pdf}.fonttype` that can affect the output at a low level, and not with the `mathtext` or `usetex` features. When Matplotlib calls external tools (such as PS distillers or LaTeX) their versions need to be kept constant for reproducibility, and they may add sources of nondeterminism outside the control of Matplotlib.

For SVG output, the `svg.hashsalt` rc parameter has been added in an earlier release. This parameter changes some random identifiers in the SVG file to be deterministic. The downside

of this setting is that if more than one file is generated using deterministic identifiers and they end up as parts of one larger document, the identifiers can collide and cause the different parts to affect each other.

These features are now enabled in the tests for the PDF and SVG backends, so most test output files (but not all of them) are now deterministic.

### Orthographic projection for mplot3d

*Axes3D* now accepts `proj_type` keyword argument and has a method `set_proj_type()`. The default option is 'persp' as before, and supplying 'ortho' enables orthographic view.

Compare the z-axis which is vertical in orthographic view, but slightly skewed in the perspective view.

```
import numpy as np
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D

fig = plt.figure(figsize=(4, 6))
ax1 = fig.add_subplot(2, 1, 1, projection='3d')
ax1.set_proj_type('persp')
ax1.set_title('Perspective (default)')

ax2 = fig.add_subplot(2, 1, 2, projection='3d')
ax2.set_proj_type('ortho')
ax2.set_title('Orthographic')

plt.show()
```

### voxels function for mplot3d

*Axes3D* now has a `voxels` method, for visualizing boolean 3D data. Uses could include plotting a sparse 3D heat map, or visualizing a volumetric model.

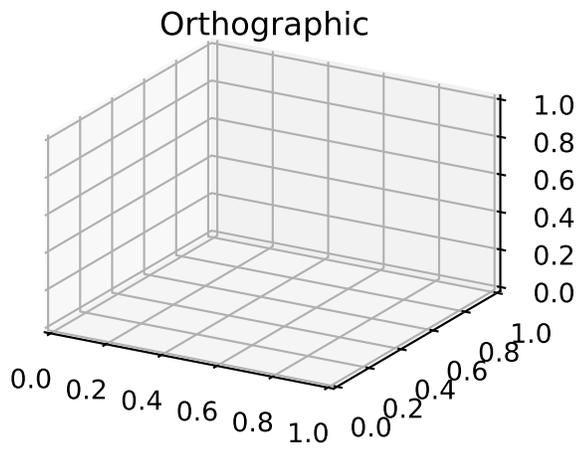
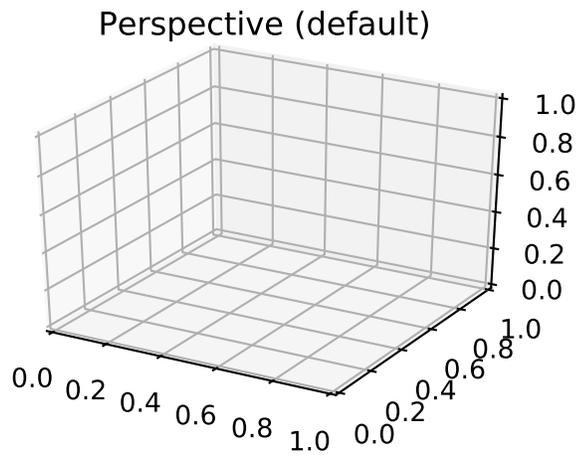
## 7.12.3 Improvements

### CheckButtons widget `get_status` function

A `get_status()` method has been added to the `matplotlib.widgets.CheckButtons` class. This `get_status` method allows user to query the status (True/False) of all of the buttons in the `CheckButtons` object.

### Add `fill_bar` argument to `AnchoredSizeBar`

The `mpl_toolkits` class `AnchoredSizeBar` now has an additional `fill_bar` argument, which makes the size bar a solid rectangle instead of just drawing the border of the rectangle. The default is `None`, and whether or not the bar will be filled by default depends on the value of `size_vertical`. If `size_vertical` is nonzero, `fill_bar` will be set to `True`. If `size_vertical` is zero then `fill_bar`



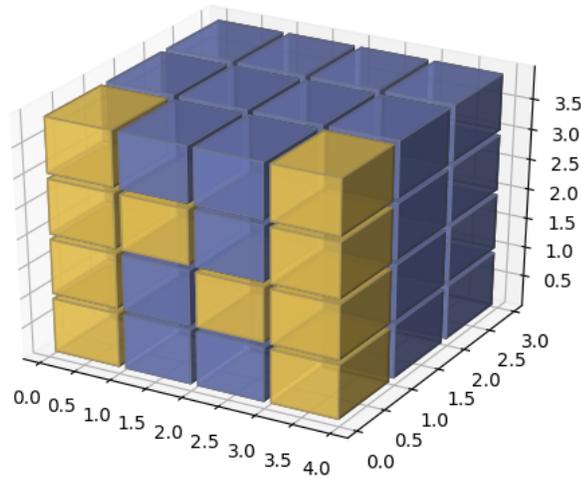


Fig. 32: Voxel Demo

will be set to `False`. If you wish to override this default behavior, set `fill_bar` to `True` or `False` to unconditionally always or never use a filled patch rectangle for the size bar.

```
import matplotlib.pyplot as plt
from mpl_toolkits.axes_grid1.anchored_artists import AnchoredSizeBar

fig, ax = plt.subplots(figsize=(3, 3))

bar0 = AnchoredSizeBar(ax.transData, 0.3, 'unfilled', loc='lower left',
                       frameon=False, size_vertical=0.05, fill_bar=False)
ax.add_artist(bar0)
bar1 = AnchoredSizeBar(ax.transData, 0.3, 'filled', loc='lower right',
                       frameon=False, size_vertical=0.05, fill_bar=True)
ax.add_artist(bar1)

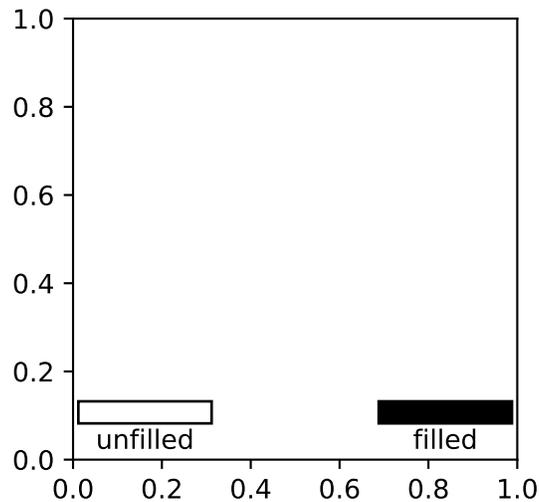
plt.show()
```

### Annotation can use a default arrow style

Annotations now use the default arrow style when setting `arrowprops={}`, rather than no arrow (the new behavior actually matches the documentation).

### Barbs and Quiver Support Dates

When using the `quiver()` and `barbs()` plotting methods, it is now possible to pass dates, just like for other methods like `plot()`. This also allows these functions to handle values that need unit-conversion applied.



### Hexbin default line color

The default `linecolor` keyword argument for `hexbin()` is now `'face'`, and supplying `'none'` now prevents lines from being drawn around the hexagons.

### `Figure.legend()` can be called without arguments

Calling `Figure.legend()` can now be done with no arguments. In this case a legend will be created that contains all the artists on all the axes contained within the figure.

### Multiple legend keys for legend entries

A legend entry can now contain more than one legend key. The extended `HandlerTuple` class now accepts two parameters: `ndivide` divides the legend area in the specified number of sections; `pad` changes the padding between the legend keys.

### New parameter `clear` for `figure()`

When the pyplot's function `figure()` is called with a `num` parameter, a new window is only created if no existing window with the same value exists. A new bool parameter `clear` was added for explicitly clearing its existing contents. This is particularly useful when utilized in interactive sessions. Since `subplots()` also accepts keyword arguments from `figure()`, it can also be used there:

```
import matplotlib.pyplot as plt

fig0 = plt.figure(num=1)
fig0.suptitle("A fancy plot")
print("fig0.texts: ", [t.get_text() for t in fig0.texts])
```

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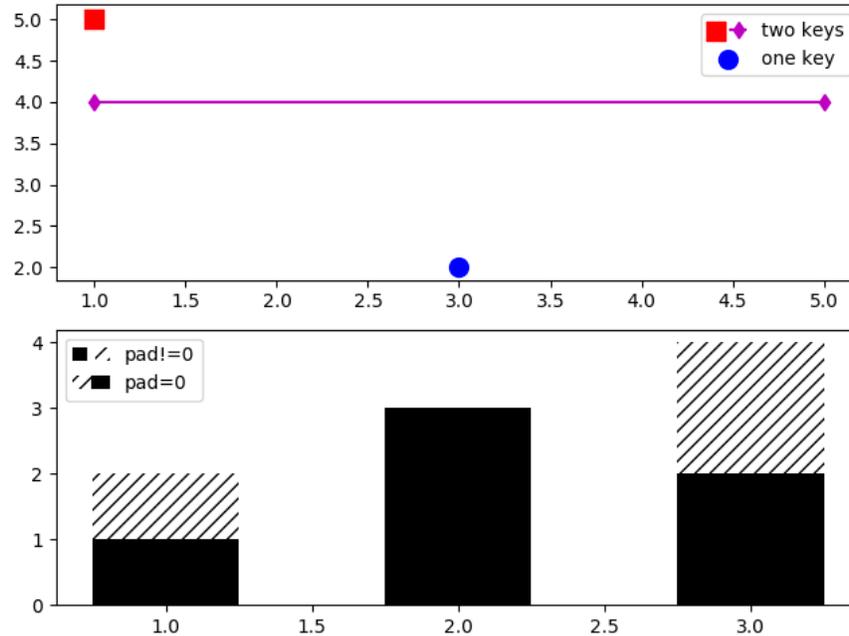


Fig. 33: Multiple Legend Keys

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```

fig1 = plt.figure(num=1, clear=False) # do not clear contents of window
fig1.text(0.5, 0.5, "Really fancy!")
print("fig0 is fig1: ", fig0 is fig1)
print("fig1.texts: ", [t.get_text() for t in fig1.texts])

fig2, ax2 = plt.subplots(2, 1, num=1, clear=True) # clear contents
print("fig0 is fig2: ", fig0 is fig2)
print("fig2.texts: ", [t.get_text() for t in fig2.texts])

# The output:
# fig0.texts: ['A fancy plot']
# fig0 is fig1: True
# fig1.texts: ['A fancy plot', 'Really fancy!']
# fig0 is fig2: True
# fig2.texts: []

```

### Specify minimum value to format as scalar for `LogFormatterMathtext`

`LogFormatterMathtext` now includes the option to specify a minimum value exponent to format as a scalar (i.e., 0.001 instead of  $10^{-3}$ ).

### New `quiverkey` angle keyword argument

Plotting a `quiverkey()` now admits the `angle` keyword argument, which sets the angle at which to draw the key arrow.

### Colormap reversed method

The methods `matplotlib.colors.LinearSegmentedColormap.reversed()` and `matplotlib.colors.ListedColormap.reversed()` return a reversed instance of the Colormap. This implements a way for any Colormap to be reversed.

### Artist.setp (and pyplot.setp) accept a file argument

The argument is keyword-only. It allows an output file other than `sys.stdout` to be specified. It works exactly like the `file` argument to `print`.

### streamplot streamline generation more configurable

The starting point, direction, and length of the stream lines can now be configured. This allows to follow the vector field for a longer time and can enhance the visibility of the flow pattern in some use cases.

### Axis.set\_tick\_params now responds to rotation

Bulk setting of tick label rotation is now possible via `tick_params()` using the `rotation` keyword.

```
ax.tick_params(which='both', rotation=90)
```

### Ticklabels are turned off instead of being invisible

Internally, the Tick's `label10n()` attribute is now used to hide tick labels instead of setting the visibility on the tick label objects. This improves overall performance and fixes some issues. As a consequence, in case those labels ought to be shown, `tick_params()` needs to be used, e.g.

```
ax.tick_params(labelbottom=True)
```

### Shading in 3D bar plots

A new `shade` parameter has been added the 3D `bar` plotting method. The default behavior remains to shade the bars, but now users have the option of setting `shade` to `False`.

```
import numpy as np
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D

x = np.arange(2)
y = np.arange(3)
x2d, y2d = np.meshgrid(x, y)
x, y = x2d.ravel(), y2d.ravel()
z = np.zeros_like(x)
dz = x + y
```

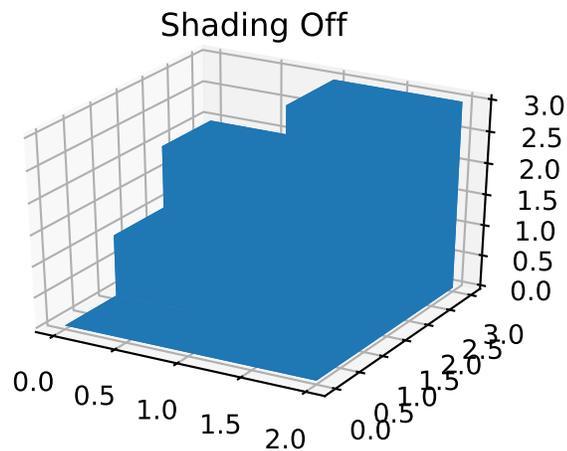
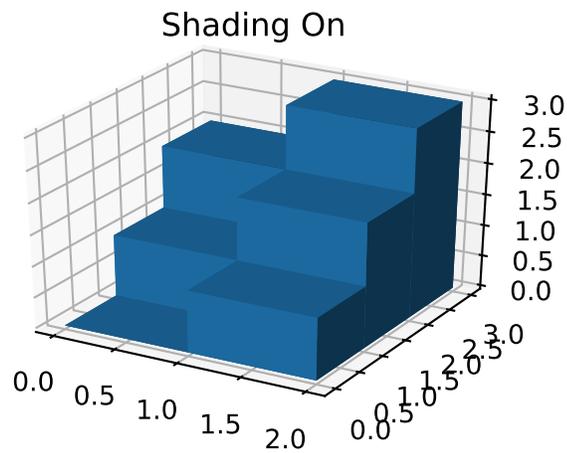
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```
fig = plt.figure(figsize=(4, 6))
ax1 = fig.add_subplot(2, 1, 1, projection='3d')
ax1.bar3d(x, y, z, 1, 1, dz, shade=True)
ax1.set_title('Shading On')

ax2 = fig.add_subplot(2, 1, 2, projection='3d')
ax2.bar3d(x, y, z, 1, 1, dz, shade=False)
ax2.set_title('Shading Off')

plt.show()
```



#### New which Parameter for `autofmt_xdate`

A `which` parameter now exists for the method `autofmt_xdate()`. This allows a user to format major, minor or both tick labels selectively. The default behavior will rotate and align the major tick labels.

```
fig.autofmt_xdate(bottom=0.2, rotation=30, ha='right', which='minor')
```

#### New Figure Parameter for `subplot2grid`

A `fig` parameter now exists for the function `subplot2grid()`. This allows a user to specify the figure where the subplots will be created. If `fig` is `None` (default) then the method will use the current figure retrieved by `gcf()`.

```
subplot2grid(shape, loc, rowspan=1, colspan=1, fig=myfig)
```

#### Interpolation in `fill_betweenx`

The `interpolate` parameter now exists for the method `fill_betweenx()`. This allows a user to interpolate the data and fill the areas in the crossover points, similarly to `fill_between()`.

#### New keyword argument `sep` for `EngFormatter`

A new `sep` keyword argument has been added to `EngFormatter` and provides a means to define the string that will be used between the value and its unit. The default string is " ", which preserves the former behavior. Additionally, the separator is now present between the value and its unit even in the absence of SI prefix. There was formerly a bug that was causing strings like "3.14V" to be returned instead of the expected "3.14 V" (with the default behavior).

#### Extend MATPLOTLIBRC behavior

The environmental variable can now specify the full file path or the path to a directory containing a `matplotlibrc` file.

#### `density` kwarg to `hist`

The `hist()` method now prefers `density` to `normed` to control if the histogram should be normalized, following a change upstream to NumPy. This will reduce confusion as the behavior has always been that the integral of the histogram is 1 (rather than sum or maximum value).

## 7.12.4 Internals

#### New `TransformedPatchPath` caching object

A newly added `TransformedPatchPath` provides a means to transform a `Patch` into a `Path` via a `Transform` while caching the resulting path. If neither the patch nor the transform have changed, a cached copy of the path is returned.

This class differs from the older *TransformedPath* in that it is able to refresh itself based on the underlying patch while the older class uses an immutable path.

### Abstract base class for movie writers

The new *AbstractMovieWriter* class defines the API required by a class that is to be used as the writer in the `matplotlib.animation.Animation.save()` method. The existing *MovieWriter* class now derives from the new abstract base class.

### Stricter validation of line style rcParams

The validation of rcParams that are related to line styles (`lines.linestyle`, `boxplot.*.linestyle`, `grid.linestyle` and `contour.negative_linestyle`) now effectively checks that the values are valid line styles. Strings like 'dashed' or '--' are accepted, as well as even-length sequences of on-off ink like [1, 1.65]. In this latter case, the offset value is handled internally and should *not* be provided by the user.

The new validation scheme replaces the former one used for the `contour.negative_linestyle` rcParams, that was limited to 'solid' and 'dashed' line styles.

The validation is case-insensitive. The following are now valid:

```
grid.linestyle          : (1, 3)  # loosely dotted grid lines
contour.negative_linestyle : dashdot # previously only solid or dashed
```

### pytest

The automated tests have been switched from nose to pytest.

## 7.12.5 Performance

### Path simplification updates

Line simplification controlled by the `path.simplify` and `path.simplify_threshold` parameters has been improved. You should notice better rendering performance when plotting large amounts of data (as long as the above parameters are set accordingly). Only the line segment portion of paths will be simplified - if you are also drawing markers and experiencing problems with rendering speed, you should consider using the `markevery` option to `plot`. See the *Performance* section in the usage tutorial for more information.

The simplification works by iteratively merging line segments into a single vector until the next line segment's perpendicular distance to the vector (measured in display-coordinate space) is greater than the `path.simplify_threshold` parameter. Thus, higher values of `path.simplify_threshold` result in quicker rendering times. If you are plotting just to explore data and not for publication quality, pixel perfect plots, then a value of 1.0 can be safely used. If you want to make sure your plot reflects your data *exactly*, then you should set `path.simplify` to false and/or `path.simplify_threshold` to 0. Matplotlib currently defaults to a conservative value of 1/9, smaller values are unlikely to cause any visible differences in your plots.

### Implement `intersects_bbox` in c++

`intersects_bbox()` has been implemented in c++ which improves the performance of automatically placing the legend.

## 7.13 New in Matplotlib 2.2

### 7.13.1 Constrained Layout Manager

**Warning:** Constrained Layout is **experimental**. The behaviour and API are subject to change, or the whole functionality may be removed without a deprecation period.

A new method to automatically decide spacing between subplots and their organizing `GridSpec` instances has been added. It is meant to replace the venerable `tight_layout` method. It is invoked via a new `constrained_layout=True` kwarg to `Figure` or subplots.

There are new `rcParams` for this package, and spacing can be more finely tuned with the new `set_constrained_layout_pads`.

Features include:

- Automatic spacing for subplots with a fixed-size padding in inches around subplots and all their decorators, and space between as a fraction of subplot size between subplots.
- Spacing for `suptitle`, and colorbars that are attached to more than one axes.
- Nested `GridSpec` layouts using `GridSpecFromSubplotSpec`.

For more details and capabilities please see the new tutorial: *Constrained Layout Guide*

Note the new API to access this:

#### New `plt.figure` and `plt.subplots` kwarg: `constrained_layout`

`figure()` and `subplots()` can now be called with `constrained_layout=True` kwarg to enable `constrained_layout`.

#### New `ax.set_position` behaviour

`set_position()` now makes the specified axis no longer responsive to `constrained_layout`, consistent with the idea that the user wants to place an axis manually.

Internally, this means that old `ax.set_position` calls *inside* the library are changed to private `ax._set_position` calls so that `constrained_layout` will still work with these axes.

### New figure kwarg for GridSpec

In order to facilitate `constrained_layout`, `GridSpec` now accepts a `figure` keyword. This is backwards compatible, in that not supplying this will simply cause `constrained_layout` to not operate on the subplots organized by this `GridSpec` instance. Routines that use `GridSpec` (e.g. `fig.subplots`) have been modified to pass the figure to `GridSpec`.

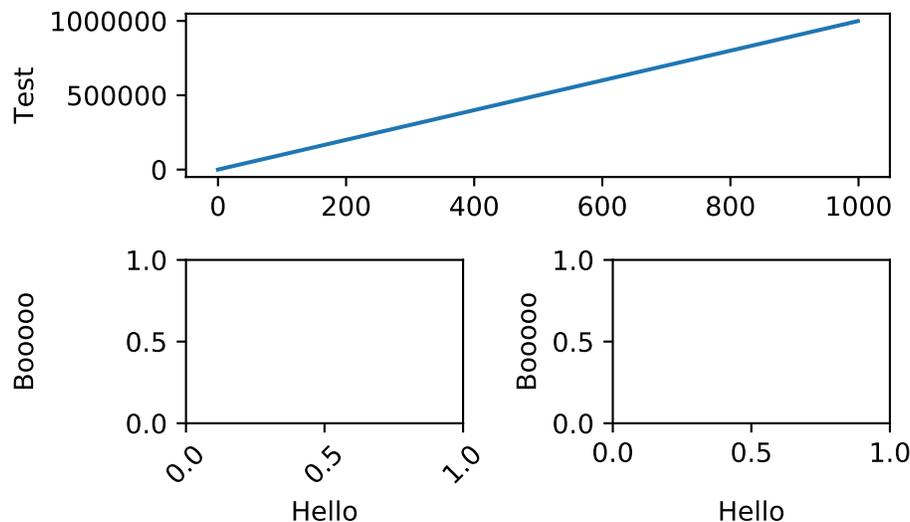
### 7.13.2 xlabels and ylabels can now be automatically aligned

Subplot axes ylabels can be misaligned horizontally if the tick labels are very different widths. The same can happen to xlabels if the ticklabels are rotated on one subplot (for instance). The new methods on the `Figure` class: `Figure.align_xlabels` and `Figure.align_ylabels` will now align these labels horizontally or vertically. If the user only wants to align some axes, a list of axes can be passed. If no list is passed, the algorithm looks at all the labels on the figure.

Only labels that have the same subplot locations are aligned. i.e. the ylabels are aligned only if the subplots are in the same column of the subplot layout.

Alignment is persistent and automatic after these are called.

A convenience wrapper `Figure.align_labels` calls both functions at once.



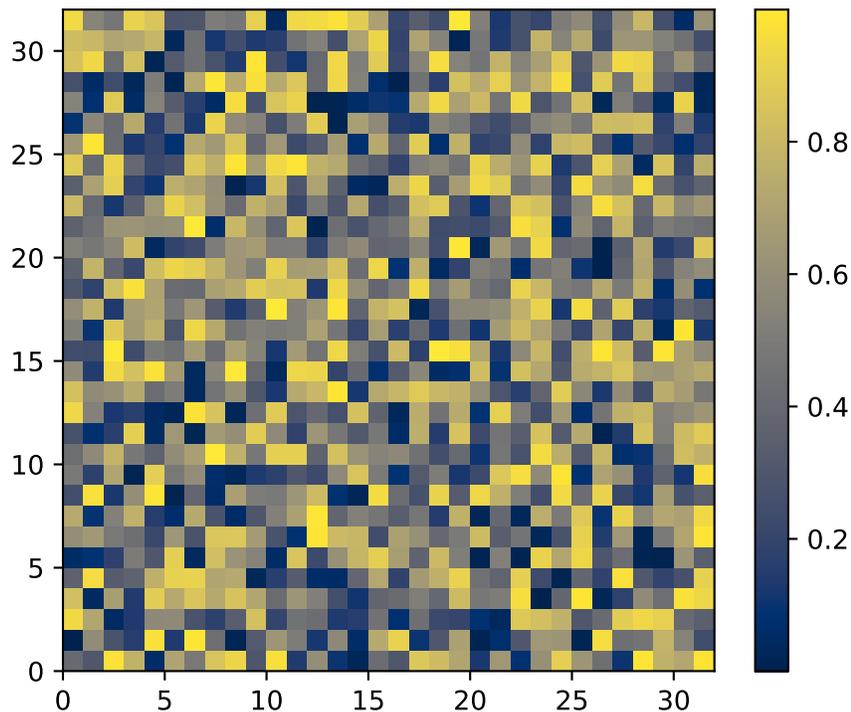
### 7.13.3 Axes legends now included in `tight_bbox`

Legends created via `ax.legend` can sometimes overspill the limits of the axis. Tools like `fig.tight_layout()` and `fig.savefig(bbox_inches='tight')` would clip these legends. A change was made to include them in the `tight` calculations.

### 7.13.4 Cividis colormap

A new dark blue/yellow colormap named 'cividis' was added. Like `viridis`, `cividis` is perceptually uniform and colorblind friendly. However, `cividis` also goes a step further: not only

is it usable by colorblind users, it should actually look effectively identical to colorblind and non-colorblind users. For more details see Nuñez J, Anderton C, and Renslow R: "Optimizing colormaps with consideration for color vision deficiency to enable accurate interpretation of scientific data".



### 7.13.5 New style colorblind-friendly color cycle

A new style defining a color cycle has been added, `tableau-colorblind10`, to provide another option for colorblind-friendly plots. A demonstration of this new style can be found in the [reference](#) of style sheets. To load this color cycle in place of the default one:

```
import matplotlib.pyplot as plt
plt.style.use('tableau-colorblind10')
```

### 7.13.6 Support for `numpy.datetime64`

Matplotlib has supported `datetime.datetime` dates for a long time in `matplotlib.dates`. We now support `numpy.datetime64` dates as well. Anywhere that `datetime.datetime` could be used, `numpy.datetime64` can be used. eg:

```
time = np.arange('2005-02-01', '2005-02-02', dtype='datetime64[h]')
plt.plot(time)
```

### 7.13.7 Writing animations with Pillow

It is now possible to use Pillow as an animation writer. Supported output formats are currently gif (Pillow>=3.4) and webp (Pillow>=5.0). Use e.g. as

```
from __future__ import division

from matplotlib import pyplot as plt
from matplotlib.animation import FuncAnimation, PillowWriter

fig, ax = plt.subplots()
line, = plt.plot([0, 1])

def animate(i):
    line.set_ydata([0, i / 20])
    return [line]

anim = FuncAnimation(fig, animate, 20, blit=True)
anim.save("movie.gif", writer=PillowWriter(fps=24))
plt.show()
```

### 7.13.8 Slider UI widget can snap to discrete values

The slider UI widget can take the optional argument *valstep*. Doing so forces the slider to take on only discrete values, starting from *valmin* and counting up to *valmax* with steps of size *valstep*.

If *closedmax==True*, then the slider will snap to *valmax* as well.

### 7.13.9 capstyle and joinstyle attributes added to Collection

The Collection class now has customizable *capstyle* and *joinstyle* attributes. This allows the user for example to set the *capstyle* of errorbars.

### 7.13.10 pad kwarg added to ax.set\_title

The method `axes.set_title` now has a *pad* kwarg, that specifies the distance from the top of an axes to where the title is drawn. The units of *pad* is points, and the default is the value of the (already-existing) `rcParams['axes.titlepad']`.

### 7.13.11 Comparison of 2 colors in Matplotlib

As the colors in Matplotlib can be specified with a wide variety of ways, the `matplotlib.colors.same_color` method has been added which checks if two *colors* are the same.

### 7.13.12 Autoscaling a polar plot snaps to the origin

Setting the limits automatically in a polar plot now snaps the radial limit to zero if the automatic limit is nearby. This means plotting from zero doesn't automatically scale to include small negative values on the radial axis.

The limits can still be set manually in the usual way using `set_ylim`.

### 7.13.13 PathLike support

On Python 3.6+, `savefig`, `imsave`, `imread`, and animation writers now accept `os.PathLikes` as input.

### 7.13.14 Axes.tick\_params can set gridline properties

Tick objects hold gridlines as well as the tick mark and its label. `Axis.set_tick_params`, `Axes.tick_params` and `pyplot.tick_params` now have keyword arguments `'grid_color'`, `'grid_alpha'`, `'grid_linewidth'`, and `'grid_linestyle'` for overriding the defaults in `rcParams`: `'grid.color'`, etc.

### 7.13.15 Axes.imshow clips RGB values to the valid range

When `Axes.imshow` is passed an RGB or RGBA value with out-of-range values, it now logs a warning and clips them to the valid range. The old behaviour, wrapping back in to the range, often hid outliers and made interpreting RGB images unreliable.

### 7.13.16 Properties in matplotlibrc to place xaxis and yaxis tick labels

Introducing four new boolean properties in `matplotlibrc` for default positions of xaxis and yaxis tick labels, namely, `xtick.labeltop`, `xtick.labelbottom`, `ytick.labelright` and `ytick.labelleft`. These can also be changed in `rcParams`.

### 7.13.17 PGI bindings for gtk3

The GTK3 backends can now use `PGI` instead of `PyGObject`. `PGI` is a fairly incomplete binding for `GObject`, thus its use is not recommended; its main benefit is its availability on Travis (thus allowing CI testing for the `gtk3agg` and `gtk3cairo` backends).

The binding selection rules are as follows: - if `gi` has already been imported, use it; else - if `pgi` has already been imported, use it; else - if `gi` can be imported, use it; else - if `pgi` can be imported, use it; else - error out.

Thus, to force usage of `PGI` when both bindings are installed, import it first.

### 7.13.18 Cairo rendering for Qt, WX, and Tk canvases

The new `Qt4Cairo`, `Qt5Cairo`, `WXCairo`, and `TkCairo` backends allow Qt, Wx, and Tk canvases to use Cairo rendering instead of Agg.

### 7.13.19 Added support for QT in new ToolManager

Now it is possible to use the ToolManager with Qt5 For example

```
import matplotlib
matplotlib.use('QT5AGG') matplotlib.rcParams['toolbar'] = 'toolmanager' import
matplotlib.pyplot as plt
plt.plot([1,2,3]) plt.show()
```

Treat the new Tool classes experimental for now, the API will likely change and perhaps the rcParam as well

The main example `examples/user_interfaces/toolmanager_sgskip.py` shows more details, just adjust the header to use QT instead of GTK3

### 7.13.20 TkAgg backend reworked to support PyPy

PyPy can now plot using the TkAgg backend, supported on PyPy 5.9 and greater (both PyPy for python 2.7 and PyPy for python 3.5).

### 7.13.21 Python logging library used for debug output

Matplotlib has in the past (sporadically) used an internal verbose-output reporter. This version converts those calls to using the standard python `logging` library.

Support for the old `rcParams.verbose.level` and `verbose.fileo` is dropped.

The command-line options `--verbose-helpful` and `--verbose-debug` are still accepted, but deprecated. They are now equivalent to setting `logging.INFO` and `logging.DEBUG`.

The logger's root name is `matplotlib` and can be accessed from programs as:

```
import logging
mlog = logging.getLogger('matplotlib')
```

Instructions for basic usage are in *Troubleshooting* and for developers in *Contributing*.

### 7.13.22 Improved repr for Transforms

Transforms now indent their `reprs` in a more legible manner:

```
In [1]: l, = plt.plot([]); l.get_transform()
Out[1]:
CompositeGenericTransform(
  TransformWrapper(
    BlendedAffine2D(
      IdentityTransform(),
      IdentityTransform()),
  CompositeGenericTransform(
    BboxTransformFrom(
      TransformedBbox(
        Bbox(x0=-0.05500000000000001, y0=-0.05500000000000001, x1=0.
↳ 05500000000000001, y1=0.05500000000000001), (continues on next page)
```

(continued from previous page)

```

        TransformWrapper(
            BlendedAffine2D(
                IdentityTransform(),
                IdentityTransform()))),
    BboxTransformTo(
        TransformedBbox(
            Bbox(x0=0.125, y0=0.10999999999999999, x1=0.9, y1=0.88),
            BboxTransformTo(
                TransformedBbox(
                    Bbox(x0=0.0, y0=0.0, x1=6.4, y1=4.8),
                    Affine2D(
                        [[ 100.    0.    0.]
                         [  0.  100.    0.]
                         [  0.    0.    1.]])]]))))))

```

## 7.14 New in Matplotlib 3.0

### 7.14.1 Improved default backend selection

The default backend no longer must be set as part of the build process. Instead, at run time, the builtin backends are tried in sequence until one of them imports.

Headless linux servers (identified by the `DISPLAY` env not being defined) will not select a GUI backend.

### 7.14.2 Cyclic colormaps

Two new colormaps named `'twilight'` and `'twilight_shifted'` have been added. These colormaps start and end on the same color, and have two symmetric halves with equal lightness, but diverging color. Since they wrap around, they are a good choice for cyclic data such as phase angles, compass directions, or time of day. Like *viridis* and *cividis*, *twilight* is perceptually uniform and colorblind friendly.

### 7.14.3 Ability to scale axis by a fixed order of magnitude

To scale an axis by a fixed order of magnitude, set the `scilimits` argument of `Axes.ticklabel_format` to the same (non-zero) lower and upper limits. Say to scale the y axis by a million (1e6), use

```
ax.ticklabel_format(style='sci', scilimits=(6, 6), axis='y')
```

The behavior of `scilimits=(0, 0)` is unchanged. With this setting, Matplotlib will adjust the order of magnitude depending on the axis values, rather than keeping it fixed. Previously, setting `scilimits=(m, m)` was equivalent to setting `scilimits=(0, 0)`.

### 7.14.4 Add `AnchoredDirectionArrows` feature to `mpl_toolkits`

A new `mpl_toolkits` class `AnchoredDirectionArrows` draws a pair of orthogonal arrows to indicate directions on a 2D plot. A minimal working example takes in the transformation object for the coordinate system (typically `ax.transAxes`), and arrow labels. There are several optional parameters that can be used to alter layout. For example, the arrow pairs can be rotated and the color can be changed. By default the labels and arrows have the same color, but the class may also pass arguments for customizing arrow and text layout, these are passed to `matplotlib.text.TextPath` and `matplotlib.patches.FancyArrowPatch`. Location, length and width for both arrow tail and head can be adjusted, the the direction arrows and labels can have a frame. Padding and separation parameters can be adjusted.

### 7.14.5 Add `minorticks_on()/off()` methods for colorbar

A new method `colorbar.Colorbar.minorticks_on()` has been added to correctly display minor ticks on a colorbar. This method doesn't allow the minor ticks to extend into the regions beyond `vmin` and `vmax` when the `extend` kwarg (used while creating the colorbar) is set to 'both', 'max' or 'min'. A complementary method `colorbar.Colorbar.minorticks_off()` has also been added to remove the minor ticks on the colorbar.

### 7.14.6 Colorbar ticks can now be automatic

The number of ticks placed on colorbars was previously appropriate for a large colorbar, but looked bad if the colorbar was made smaller (i.e. via the `shrink` kwarg). This has been changed so that the number of ticks is now responsive to how large the colorbar is.

### 7.14.7 Don't automatically rename duplicate file names

Previously, when saving a figure to a file using the GUI's save dialog box, if the default filename (based on the figure window title) already existed on disk, Matplotlib would append a suffix (e.g. `Figure_1-1.png`), preventing the dialog from prompting to overwrite the file. This behaviour has been removed. Now if the file name exists on disk, the user is prompted whether or not to overwrite it. This eliminates guesswork, and allows intentional overwriting, especially when the figure name has been manually set using `figure.Figure.canvas.set_window_title()`.

### 7.14.8 Legend now has a `title_fontsize` kwarg (and `rcParam`)

The title for a `Figure.legend` and `Axes.legend` can now have its fontsize set via the `title_fontsize` kwarg. There is also a new `rcParams["legend.title_fontsize"]`. Both default to `None`, which means the legend title will have the same fontsize as the axes default fontsize (not the legend fontsize, set by the `fontsize` kwarg or `rcParams["legend.fontsize"]`).

### 7.14.9 Support for `axes.prop_cycle` property `markevery` in `rcParams`

The Matplotlib `rcParams` settings object now supports configuration of the attribute `axes.prop_cycle` with cyclers using the `markevery` `Line2D` object property. An example of this feature is provided at `/gallery/lines_bars_and_markers/markevery_prop_cycle`.

### 7.14.10 Multipage PDF support for pgf backend

The pgf backend now also supports multipage PDF files.

```
from matplotlib.backends.backend_pgf import PdfPages
import matplotlib.pyplot as plt

with PdfPages('multipage.pdf') as pdf:
    # page 1
    plt.plot([2, 1, 3])
    pdf.savefig()

    # page 2
    plt.cla()
    plt.plot([3, 1, 2])
    pdf.savefig()
```

### 7.14.11 Pie charts are now circular by default

We acknowledge that the majority of people do not like egg-shaped pies. Therefore, an axes to which a pie chart is plotted will be set to have equal aspect ratio by default. This ensures that the pie appears circular independent on the axes size or units. To revert to the previous behaviour set the axes' aspect ratio to automatic by using `ax.set_aspect("auto")` or `plt.axis("auto")`.

### 7.14.12 Add `ax.get_gridspec` to `SubplotBase`

New method `SubplotBase.get_gridspec` is added so that users can easily get the gridspec that went into making an axes:

```
import matplotlib.pyplot as plt

fig, axs = plt.subplots(3, 2)
gs = axs[0, -1].get_gridspec()

# remove the last column
for ax in axs[:, -1].flatten():
    ax.remove()

# make a subplot in last column that spans rows.
ax = fig.add_subplot(gs[:, -1])
plt.show()
```

### 7.14.13 Axes titles will no longer overlap xaxis

Previously an axes title had to be moved manually if an axis overlapped (usually when the axis was put on the top of the axes). Now, the title will be automatically moved above the axis and its decorators (including the xlabel) if they are at the top.

If desired, the title can still be placed manually. There is a slight kludge; the algorithm checks if the y-position of the title is 1.0 (the default), and moves it if it is. If the user places the title in the default location (i.e. `ax.title.set_position(0.5, 1.0)`), the title will still be moved above the xaxis. If the user wants to avoid this, they can specify a number that is close (i.e. `ax.title.set_position(0.5, 1.01)`) and the title will not be moved via this algorithm.

#### 7.14.14 New convenience methods for GridSpec

There are new convenience methods for `gridspec.GridSpec` and `gridspec.GridSpecFromSubplotSpec`. Instead of the former we can now call `Figure.add_gridspec` and for the latter `SubplotSpec.subgridspec`.

```
import matplotlib.pyplot as plt

fig = plt.figure()
gs0 = fig.add_gridspec(3, 1)
ax1 = fig.add_subplot(gs0[0])
ax2 = fig.add_subplot(gs0[1])
gssub = gs0[2].subgridspec(1, 3)
for i in range(3):
    fig.add_subplot(gssub[0, i])
```

#### 7.14.15 Figure has an add\_artist method

A method `add_artist` has been added to the `Figure` class, which allows artists to be added directly to a figure. E.g.

```
circ = plt.Circle((.7, .5), .05)
fig.add_artist(circ)
```

In case the added artist has no transform set previously, it will be set to the figure transform (`fig.transFigure`). This new method may be useful for adding artists to figures without axes or to easily position static elements in figure coordinates.

#### 7.14.16 `:math:` directive renamed to `:mathmpl:`

The `:math:` rst role provided by `matplotlib.sphinxext.mathmpl` has been renamed to `:mathmpl:` to avoid conflicting with the `:math:` role that Sphinx 1.8 provides by default. (`:mathmpl:` uses Matplotlib to render math expressions to images embedded in html, whereas Sphinx uses MathJax.)

When using Sphinx<1.8, both names (`:math:` and `:mathmpl:`) remain available for backcompatibility.

## 7.15 What's new in Matplotlib 3.1

For a list of all of the issues and pull requests since the last revision, see the *GitHub Stats*.

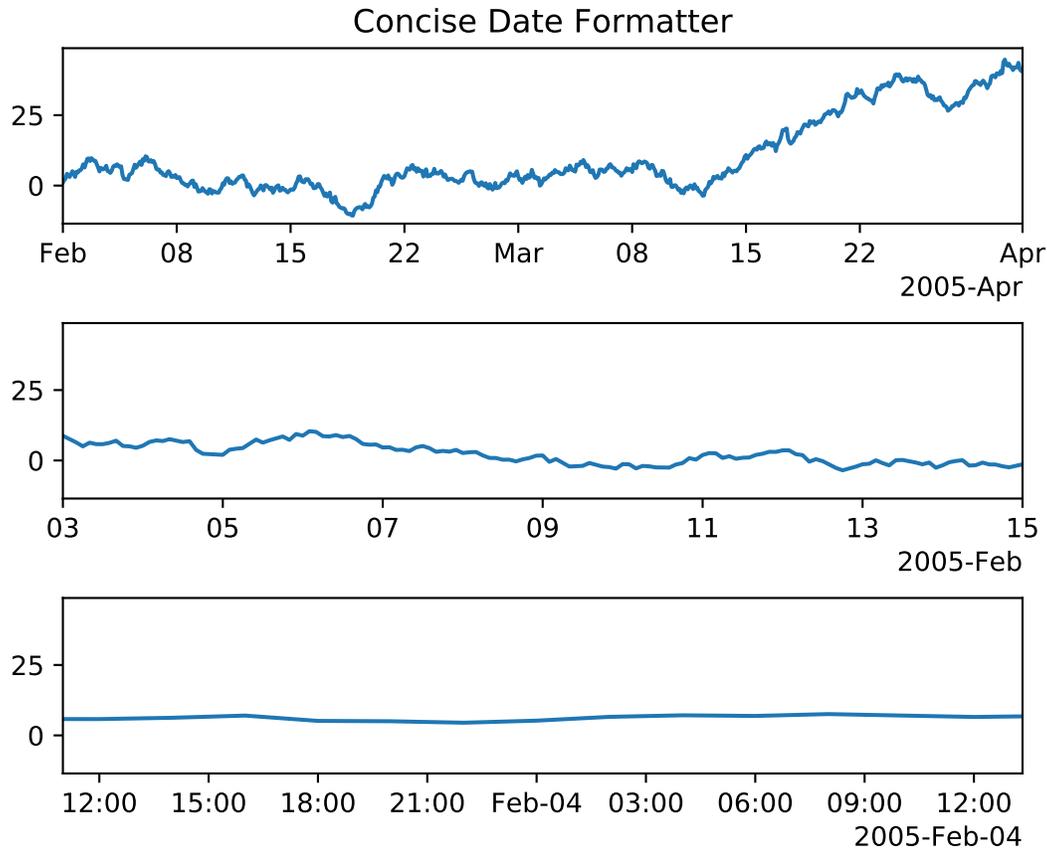
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## 7.15.1 New Features

### ConciseDateFormatter

The automatic date formatter used by default can be quite verbose. A new formatter can be accessed that tries to make the tick labels appropriately concise.

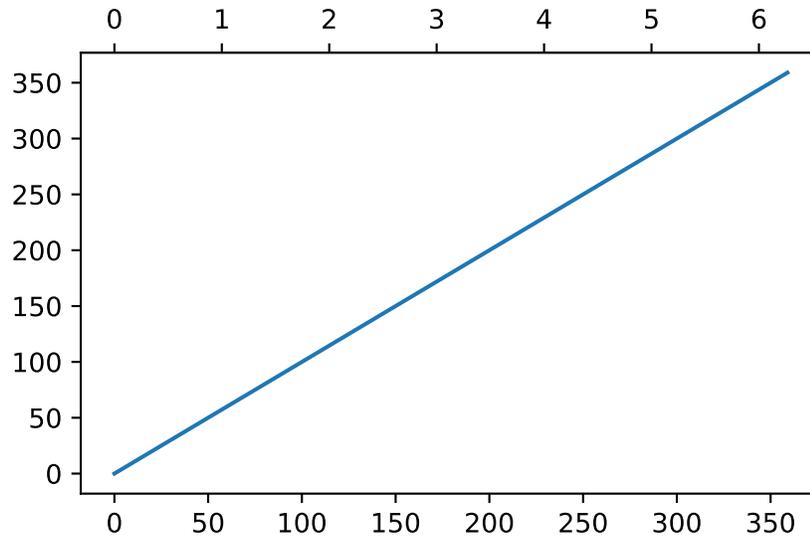


### Secondary x/y Axis support

A new method provides the ability to add a second axis to an existing axes via `Axes.secondary_xaxis` and `Axes.secondary_yaxis`. See [/gallery/subplots\\_axes\\_and\\_figures/secondary\\_axis](#) for examples.

### FuncScale for arbitrary axes scales

A new `FuncScale` class was added (and `FuncTransform`) to allow the user to have arbitrary scale transformations without having to write a new subclass of `ScaleBase`. This can be accessed by:



```
ax.set_yscale('function', functions=(forward, inverse))
```

where *forward* and *inverse* are callables that return the scale transform and its inverse. See the last example in `/gallery/scales/scales`.

### Legend for scatter

A new method for creating legends for scatter plots has been introduced. Previously, in order to obtain a legend for a `scatter()` plot, one could either plot several scatters, each with an individual label, or create proxy artists to show in the legend manually. Now, `PathCollection` provides a method `legend_elements()` to obtain the handles and labels for a scatter plot in an automated way. This makes creating a legend for a scatter plot as easy as

An example can be found in `automatedlegendcreation`.

### Matplotlib no longer requires framework app build on MacOSX backend

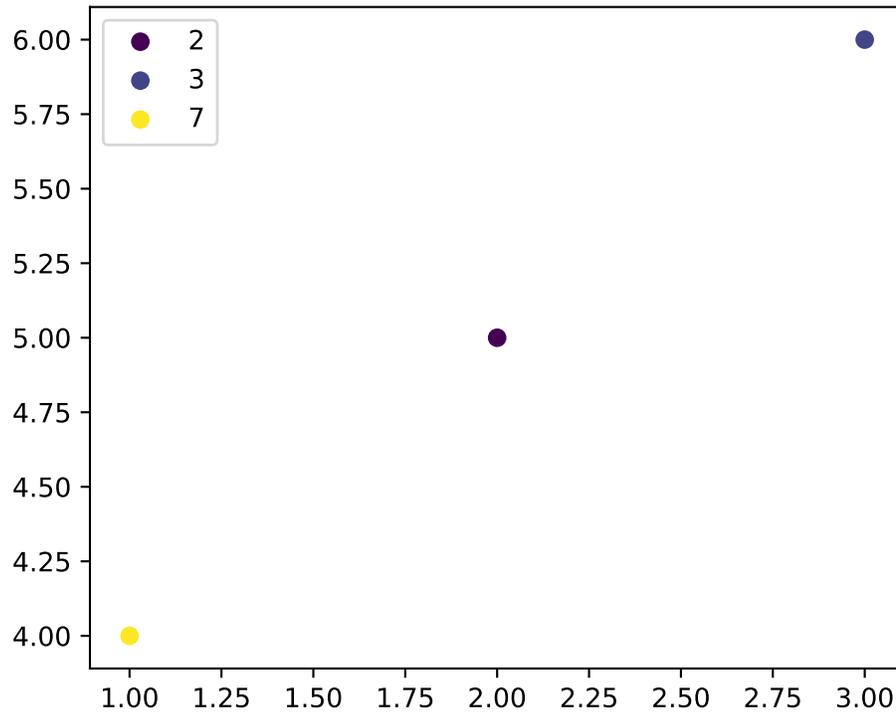
Previous versions of matplotlib required a Framework build of python to work. The app type was updated to no longer require this, so the MacOSX backend should work with non-framework python.

This also adds support for the MacOSX backend for PyPy3.

## 7.15.2 Figure, FigureCanvas, and Backends

### Figure.frameon is now a direct proxy for the Figure patch visibility state

Accessing `Figure.frameon` (including via `get_frameon` and `set_frameon` now directly forwards to the visibility of the underlying Rectangle artist (`Figure.patch.get_frameon`, `Figure.patch.set_frameon`).



### *pil\_kwargs* argument added to `savefig`

Matplotlib uses Pillow to handle saving to the JPEG and TIFF formats. The `savefig()` function gained a `pil_kwargs` keyword argument, which can be used to forward arguments to Pillow's `pillow.Image.save()`.

The `pil_kwargs` argument can also be used when saving to PNG. In that case, Matplotlib also uses Pillow's `pillow.Image.save()` instead of going through its own builtin PNG support.

### Add `inaxes` method to `FigureCanvasBase`

The `FigureCanvasBase` class has now an `inaxes` method to check whether a point is in an axes and returns the topmost axes, else `None`.

### cairo backend defaults to `pycairo` instead of `cairocffi`

This leads to faster import/runtime performance in some cases. The backend will fall back to `cairocffi` in case `pycairo` isn't available.

## 7.15.3 Axes and Artists

### axes\_grid1 and axisartist Axes no longer draw spines twice

Previously, spines of `axes_grid1` and `axisartist` Axes would be drawn twice, leading to a “bold” appearance. This is no longer the case.

### Return type of `ArtistInspector.get_aliases` changed

`ArtistInspector.get_aliases` previously returned the set of aliases as `{fullname: {alias1: None, alias2: None, ...}}`. The dict-to-None mapping was used to simulate a set in earlier versions of Python. It has now been replaced by a set, i.e. `{fullname: {alias1, alias2, ...}}`.

This value is also stored in `ArtistInspector.aliasd`, which has likewise changed.

### `ConnectionPatch` accepts arbitrary transforms

Alternatively to strings like “data” or “axes fraction” `ConnectionPatch` now accepts any *Transform* as input for the `coordsA` and `coordsB` argument. This allows to draw lines between points defined in different user defined coordinate systems. Also see the `Connect Simple01` example.

### `mplot3d` `Line3D` now allows `{set,get}_data_3d`

Lines created with the 3d projection in `mplot3d` can now access the data using `get_data_3d()` which returns a tuple of array\_likes containing the (x, y, z) data. The equivalent `set_data_3d` can be used to modify the data of an existing `Line3D`.

### `Axes3D.voxels` now shades the resulting voxels

The `voxels()` method now takes a *shade* parameter that defaults to `True`. This shades faces based on their orientation, behaving just like the matching parameters to `trisurf()` and `bar3d()`. The plot below shows how this affects the output.

## 7.15.4 Axis and Ticks

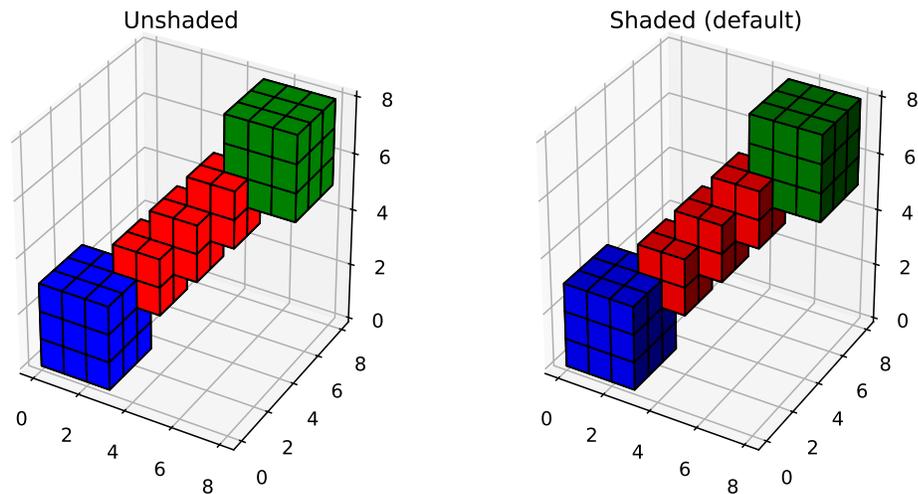
### Added `Axis.get_inverted` and `Axis.set_inverted`

The `Axis.get_inverted` and `Axis.set_inverted` methods query and set whether the axis uses “inverted” orientation (i.e. increasing to the left for the x-axis and to the bottom for the y-axis).

They perform tasks similar to `Axes.xaxis_inverted`, `Axes.yaxis_inverted`, `Axes.invert_xaxis`, and `Axes.invert_yaxis`, with the specific difference that `Axes.set_inverted` makes it easier to set the invertedness of an axis regardless of whether it had previously been inverted before.

### Adjust default minor tick spacing

Default minor tick spacing was changed from 0.625 to 0.5 for major ticks spaced 2.5 units apart.



`EngFormatter` now accepts `usetex`, `useMathText` as keyword only arguments

A public API has been added to `EngFormatter` to control how the numbers in the ticklabels will be rendered. By default, `useMathText` evaluates to `rcParams["axes.formatter.use_mathtext"]` and `usetex` evaluates to `rcParams["text.usetex"]`.

If either is `True` then the numbers will be encapsulated by `$` signs. When using `TeX` this implies that the numbers will be shown in `TeX`'s math font. When using `mathtext`, the `$` signs around numbers will ensure unicode rendering (as implied by `mathtext`). This will make sure that the minus signs in the ticks are rendered as the unicode=minus (U+2212) when using `mathtext` (without relying on the `fix_minus` method).

## 7.15.5 Animation and Interactivity

### Support for forward/backward mouse buttons

Figure managers now support a `button_press` event for mouse buttons, similar to the `key_press` events. This allows binding actions to mouse buttons (see `MouseButton`) The first application of this mechanism is support of forward/backward mouse buttons in figures created with the Qt5 backend.

*progress\_callback* argument to `save()`

The method `Animation.save` gained an optional *progress\_callback* argument to notify the saving progress.

Add `cache_frame_data` keyword-only argument into `animation.FuncAnimation`

`matplotlib.animation.FuncAnimation` has been caching frame data by default; however, this caching is not ideal in certain cases e.g. When `FuncAnimation` needs to be only drawn(not

saved) interactively and memory required by frame data is quite large. By adding `cache_frame_data` keyword-only argument, users can now disable this caching; thereby, this new argument provides a fix for issue [#8528](#).

### Endless Looping GIFs with PillowWriter

We acknowledge that most people want to watch a gif more than once. Saving an animation as a gif with PillowWriter now produces an endless looping gif.

### Adjusted `matplotlib.widgets.Slider` to have vertical orientation

The `matplotlib.widgets.Slider` widget now takes an optional argument `orientation` which indicates the direction ('horizontal' or 'vertical') that the slider should take.

### Improved formatting of image values under cursor when a colorbar is present

When a colorbar is present, its formatter is now used to format the image values under the mouse cursor in the status bar. For example, for an image displaying the values 10,000 and 10,001, the statusbar will now (using default settings) display the values as 10000 and 10001), whereas both values were previously displayed as `1e+04`.

### MouseEvent button attribute is now an IntEnum

The `button` attribute of `MouseEvent` instances can take the values None, 1 (left button), 2 (middle button), 3 (right button), "up" (scroll), and "down" (scroll). For better legibility, the 1, 2, and 3 values are now represented using the `IntEnum` class `matplotlib.backend_bases.MouseButton`, with the values `MouseButton.LEFT` (`== 1`), `MouseButton.MIDDLE` (`== 2`), and `MouseButton.RIGHT` (`== 3`).

## 7.15.6 Configuration, Install, and Development

### The `MATPLOTLIBRC` environment variable can now point to any "file" path

This includes device files; in particular, on Unix systems, one can set `MATPLOTLIBRC` to `/dev/null` to ignore the user's `matplotlibrc` file and fall back to Matplotlib's defaults.

As a reminder, if `MATPLOTLIBRC` points to a directory, Matplotlib will try to load the `matplotlibrc` file from `$MATPLOTLIBRC/matplotlibrc`.

### Allow LaTeX code `pgf.preamble` and `text.latex.preamble` in `MATPLOTLIBRC` file

Previously, the rc file keys `rcParams["pgf.preamble"]` and `rcParams["text.latex.preamble"]` were parsed using commas as separators. This would break valid LaTeX code, such as:

```
\usepackage[protrusion=true, expansion=false]{microtype}
```

The parsing has been modified to pass the complete line to the LaTeX system, keeping all commas. Passing a list of strings from within a Python script still works as it used to.

### New logging API

`matplotlib.set_loglevel` / `pyplot.set_loglevel` can be called to display more (or less) detailed logging output.



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## **Part II**

# **The Matplotlib FAQ**



## INSTALLATION

### Contents

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  - *Report a compilation problem*
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    - \* *Checking your installation*
  - *Install from source*

### 10.1 Report a compilation problem

See *Getting help*.

### 10.2 Matplotlib compiled fine, but nothing shows up when I use it

The first thing to try is a *clean install* and see if that helps. If not, the best way to test your install is by running a script, rather than working interactively from a python shell or an integrated development environment such as IDLE which add additional complexities. Open up a UNIX shell or a DOS command prompt and run, for example:

```
python -c "from pylab import *; plot(); show()" --verbose-helpful
```

This will give you additional information about which backends Matplotlib is loading, version information, and more. At this point you might want to make sure you understand Matplotlib's

*configuration* process, governed by the `matplotlibrc` configuration file which contains instructions within and the concept of the Matplotlib backend.

If you are still having trouble, see *Getting help*.

## 10.3 How to completely remove Matplotlib

Occasionally, problems with Matplotlib can be solved with a clean installation of the package. In order to fully remove an installed Matplotlib:

1. Delete the caches from your *Matplotlib configuration directory*.
2. Delete any Matplotlib directories or eggs from your *installation directory*.

## 10.4 Linux Notes

To install Matplotlib at the system-level, we recommend that you use your distribution's package manager. This will guarantee that Matplotlib's dependencies will be installed as well.

If, for some reason, you cannot use the package manager, you may use the wheels available on PyPI:

```
python -mpip install matplotlib
```

or *build Matplotlib from source*.

## 10.5 OSX Notes

### 10.5.1 Which python for OSX?

Apple ships OSX with its own Python, in `/usr/bin/python`, and its own copy of Matplotlib. Unfortunately, the way Apple currently installs its own copies of NumPy, Scipy and Matplotlib means that these packages are difficult to upgrade (see [system python packages](#)). For that reason we strongly suggest that you install a fresh version of Python and use that as the basis for installing libraries such as NumPy and Matplotlib. One convenient way to install Matplotlib with other useful Python software is to use one of the excellent Python scientific software collections that are now available:

- [Anaconda from Continuum Analytics](#)
- [Canopy from Enthought](#)

These collections include Python itself and a wide range of libraries; if you need a library that is not available from the collection, you can install it yourself using standard methods such as *pip*. Continuum and Enthought offer their own installation support for these collections; see the Anaconda and Canopy web pages for more information.

Other options for a fresh Python install are the standard installer from [python.org](#), or installing Python using a general OSX package management system such as [homebrew](#) or [macports](#). Power users on OSX will likely want one of homebrew or macports on their system to install open source software packages, but it is perfectly possible to use these systems with another source for your Python binary, such as Anaconda, Canopy or Python.org Python.

## 10.5.2 Installing OSX binary wheels

If you are using Python from <https://www.python.org>, Homebrew, or Macports, then you can use the standard pip installer to install Matplotlib binaries in the form of wheels.

pip is installed by default with python.org and Homebrew Python, but needs to be manually installed on Macports with

```
sudo port install py36-pip
```

Once pip is installed, you can install Matplotlib and all its dependencies with from the Terminal.app command line:

```
python3 -mpip install matplotlib
```

(sudo python3.6 ... on Macports).

You might also want to install IPython or the Jupyter notebook (python3 -mpip install ipython notebook).

### pip problems

If you get errors with pip trying to run a compiler like gcc or clang, then the first thing to try is to [install xcode](#) and retry the install. If that does not work, then check *Getting help*.

## 10.5.3 Checking your installation

The new version of Matplotlib should now be on your Python "path". Check this at the Terminal.app command line:

```
python3 -c 'import matplotlib; print(matplotlib.__version__, matplotlib.__file__)'
```

You should see something like

```
3.0.0 /Library/Frameworks/Python.framework/Versions/3.6/lib/python3.6/site-packages/  
↳matplotlib/__init__.py
```

where 3.0.0 is the Matplotlib version you just installed, and the path following depends on whether you are using Python.org Python, Homebrew or Macports. If you see another version, or you get an error like

```
Traceback (most recent call last):  
  File "<string>", line 1, in <module>  
ImportError: No module named matplotlib
```

then check that the Python binary is the one you expected by running

```
which python3
```

If you get a result like /usr/bin/python..., then you are getting the Python installed with OSX, which is probably not what you want. Try closing and restarting Terminal.app before running the check again. If that doesn't fix the problem, depending on which Python you wanted to use, consider reinstalling Python.org Python, or check your homebrew or macports setup.

Remember that the disk image installer only works for Python.org Python, and will not get picked up by other Pythons. If all these fail, please *let us know*.

## 10.6 Install from source

Clone the main source using one of:

```
git clone git@github.com:matplotlib/matplotlib.git
```

or:

```
git clone git://github.com/matplotlib/matplotlib.git
```

and build and install as usual with:

```
cd matplotlib
python -mpip install .
```

---

**Note:** If you are on Debian/Ubuntu, you can get all the dependencies required to build Matplotlib with:

```
sudo apt-get build-dep python-matplotlib
```

If you are on Fedora/RedHat, you can get all the dependencies required to build Matplotlib by first installing yum-builddep and then running:

```
su -c 'yum-builddep python-matplotlib'
```

This does not build Matplotlib, but it does get all of the build dependencies, which will make building from source easier.

---

If you want to be able to follow the development branch as it changes just replace the last step with:

```
python -mpip install -e .
```

This creates links and installs the command line script in the appropriate places.

---

**Note:** OSX users please see the *Building on macOS* guide.

Windows users please see the *Building on Windows* guide.

---

Then, if you want to update your Matplotlib at any time, just do:

```
git pull
```

When you run `git pull`, if the output shows that only Python files have been updated, you are all set. If C files have changed, you need to run `pip install -e .` again to compile them.

There is more information on *using git* in the developer docs.

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## 11.1 Plotting: howto

### 11.1.1 Plot `numpy.datetime64` values

As of Matplotlib 2.2, `numpy.datetime64` objects are handled the same way as `datetime.datetime` objects.

If you prefer the pandas converters and locators, you can register their converter with the `matplotlib.units` module:

```
from pandas.tseries import converter as pdtc
pdtc.register()
```

If you only want to use the `pandas` converter for `datetime64` values

```
from pandas.tseries import converter as pdtc
import matplotlib.units as munits
import numpy as np

munits.registry[np.datetime64] = pdtc.DatetimeConverter()
```

### 11.1.2 Find all objects in a figure of a certain type

Every Matplotlib artist (see *Artist tutorial*) has a method called `findobj()` that can be used to recursively search the artist for any artists it may contain that meet some criteria (e.g., match all `Line2D` instances or match some arbitrary filter function). For example, the following snippet finds every object in the figure which has a `set_color` property and makes the object blue:

```
def myfunc(x):
    return hasattr(x, 'set_color')

for o in fig.findobj(myfunc):
    o.set_color('blue')
```

You can also filter on class instances:

```
import matplotlib.text as text
for o in fig.findobj(text.Text):
    o.set_fontstyle('italic')
```

### 11.1.3 How to prevent ticklabels from having an offset

The default formatter will use an offset to reduce the length of the ticklabels. To turn this feature off on a per-axis basis:

```
ax.get_xaxis().get_major_formatter().set_useOffset(False)
```

set the rcParam `axes.formatter.useoffset`, or use a different formatter. See *ticker* for details.

### 11.1.4 Save transparent figures

The `savefig()` command has a keyword argument `transparent` which, if 'True', will make the figure and axes backgrounds transparent when saving, but will not affect the displayed image on the screen.

If you need finer grained control, e.g., you do not want full transparency or you want to affect the screen displayed version as well, you can set the alpha properties directly. The figure has a `Rectangle` instance called `patch` and the axes has a `Rectangle` instance called `patch`. You can set any property on them directly (`facecolor`, `edgecolor`, `linewidth`, `linestyle`, `alpha`). e.g.:

```
fig = plt.figure()
fig.patch.set_alpha(0.5)
ax = fig.add_subplot(111)
ax.patch.set_alpha(0.5)
```

If you need *all* the figure elements to be transparent, there is currently no global alpha setting, but you can set the alpha channel on individual elements, e.g.:

```
ax.plot(x, y, alpha=0.5)
ax.set_xlabel('volts', alpha=0.5)
```

### 11.1.5 Save multiple plots to one pdf file

Many image file formats can only have one image per file, but some formats support multi-page files. Currently only the pdf backend has support for this. To make a multi-page pdf file, first initialize the file:

```
from matplotlib.backends.backend_pdf import PdfPages
pp = PdfPages('multipage.pdf')
```

You can give the `PdfPages` object to `savefig()`, but you have to specify the format:

```
plt.savefig(pp, format='pdf')
```

An easier way is to call `PdfPages.savefig()`:

```
pp.savefig()
```

Finally, the multipage pdf object has to be closed:

```
pp.close()
```

The same can be done using the pgf backend:

```
from matplotlib.backends.backend_pgf import PdfPages
```

### 11.1.6 Move the edge of an axes to make room for tick labels

For subplots, you can control the default spacing on the left, right, bottom, and top as well as the horizontal and vertical spacing between multiple rows and columns using the `matplotlib.figure.Figure.subplots_adjust()` method (in pyplot it is `subplots_adjust()`). For example, to move the bottom of the subplots up to make room for some rotated x tick labels:

```
fig = plt.figure()
fig.subplots_adjust(bottom=0.2)
ax = fig.add_subplot(111)
```

You can control the defaults for these parameters in your `matplotlibrc` file; see *Customizing Matplotlib with style sheets and rcParams*. For example, to make the above setting permanent, you would set:

```
figure.subplot.bottom : 0.2 # the bottom of the subplots of the figure
```

The other parameters you can configure are, with their defaults

**left = 0.125** the left side of the subplots of the figure

**right = 0.9** the right side of the subplots of the figure

**bottom = 0.1** the bottom of the subplots of the figure

**top = 0.9** the top of the subplots of the figure

**wspace = 0.2** the amount of width reserved for space between subplots, expressed as a fraction of the average axis width

**hspace = 0.2** the amount of height reserved for space between subplots, expressed as a fraction of the average axis height

If you want additional control, you can create an *Axes* using the `axes()` command (or equivalently the figure `add_axes()` method), which allows you to specify the location explicitly:

```
ax = fig.add_axes([left, bottom, width, height])
```

where all values are in fractional (0 to 1) coordinates. See [/gallery/subplots\\_axes\\_and\\_figures/axes\\_demo](/gallery/subplots_axes_and_figures/axes_demo) for an example of placing axes manually.

### 11.1.7 Automatically make room for tick labels

---

**Note:** This is now easier to handle than ever before. Calling `tight_layout()` can fix many common layout issues. See the *Tight Layout guide*.

The information below is kept here in case it is useful for other purposes.

---

In most use cases, it is enough to simply change the subplots adjust parameters as described in *Move the edge of an axes to make room for tick labels*. But in some cases, you don't know ahead of time what your tick labels will be, or how large they will be (data and labels outside your control may be being fed into your graphing application), and you may need to automatically adjust your subplot parameters based on the size of the tick labels. Any *Text* instance can report its extent in window coordinates (a negative x coordinate is outside the window), but there is a rub.

The `RendererBase` instance, which is used to calculate the text size, is not known until the figure is drawn (`draw()`). After the window is drawn and the text instance knows its renderer, you can call `get_window_extent()`. One way to solve this chicken and egg problem is to wait until the figure is drawn by connecting (`mpl_connect()`) to the "on\_draw" signal (`DrawEvent`) and get the window extent there, and then do something with it, e.g., move the left of the canvas over; see *Event handling and picking*.

Here is an example that gets a bounding box in relative figure coordinates (0..1) of each of the labels and uses it to move the left of the subplots over so that the tick labels fit in the figure:

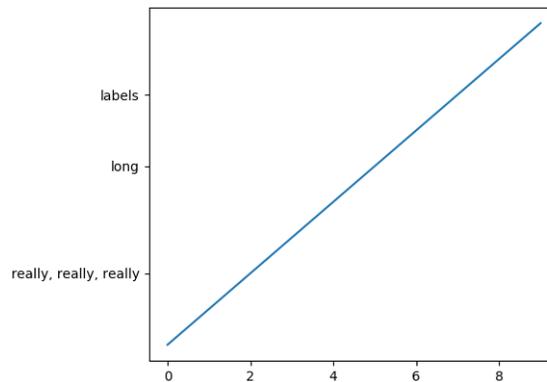


Fig. 1: Auto Subplots Adjust

### 11.1.8 Configure the tick widths

Wherever possible, it is recommended to use the `tick_params()` or `set_tick_params()` methods to modify tick properties:

```
import matplotlib.pyplot as plt

fig, ax = plt.subplots()
ax.plot(range(10))

ax.tick_params(width=10)

plt.show()
```

For more control of tick properties that are not provided by the above methods, it is important to know that in Matplotlib, the ticks are *markers*. All `Line2D` objects support a line (solid, dashed, etc) and a marker (circle, square, tick). The tick width is controlled by the "markeredgewidth" property, so the above effect can also be achieved by:

```
import matplotlib.pyplot as plt

fig, ax = plt.subplots()
ax.plot(range(10))
```

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```

for line in ax.get_xticklines() + ax.get_yticklines():
    line.set_markeredgewidth(10)

plt.show()

```

The other properties that control the tick marker, and all markers, are `markerfacecolor`, `markeredgewidth`, `markeredgewidth`, `markersize`. For more information on configuring ticks, see *Axis containers* and *Tick containers*.

### 11.1.9 Align my ylabels across multiple subplots

If you have multiple subplots over one another, and the y data have different scales, you can often get ylabels that do not align vertically across the multiple subplots, which can be unattractive. By default, Matplotlib positions the x location of the ylabel so that it does not overlap any of the y ticks. You can override this default behavior by specifying the coordinates of the label. The example below shows the default behavior in the left subplots, and the manual setting in the right subplots.

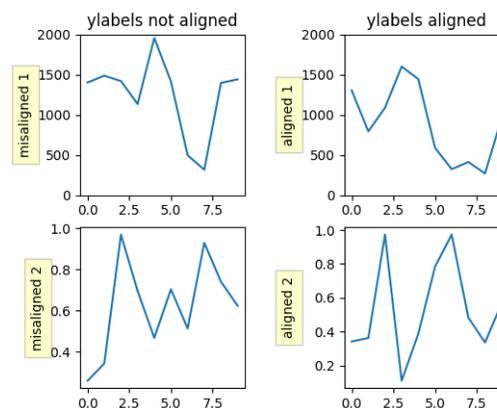


Fig. 2: Align Ylabels

### 11.1.10 Skip dates where there is no data

When plotting time series, e.g., financial time series, one often wants to leave out days on which there is no data, e.g., weekends. By passing in dates on the x-axis, you get large horizontal gaps on periods when there is not data. The solution is to pass in some proxy x-data, e.g., evenly sampled indices, and then use a custom formatter to format these as dates. The example below shows how to use an 'index formatter' to achieve the desired plot:

```

import numpy as np
import matplotlib.pyplot as plt
import matplotlib.mlab as mlab
import matplotlib.ticker as ticker

r = mlab.csv2rec('../data/aapl.csv')

```

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```

r.sort()
r = r[-30:] # get the last 30 days

N = len(r)
ind = np.arange(N) # the evenly spaced plot indices

def format_date(x, pos=None):
    thisind = np.clip(int(x+0.5), 0, N-1)
    return r.date[thisind].strftime('%Y-%m-%d')

fig = plt.figure()
ax = fig.add_subplot(111)
ax.plot(ind, r.adj_close, 'o-')
ax.xaxis.set_major_formatter(ticker.FuncFormatter(format_date))
fig.autofmt_xdate()

plt.show()

```

### 11.1.11 Control the depth of plot elements

Within an axes, the order that the various lines, markers, text, collections, etc appear is determined by the `set_zorder()` property. The default order is patches, lines, text, with collections of lines and collections of patches appearing at the same level as regular lines and patches, respectively:

```
line, = ax.plot(x, y, zorder=10)
```

You can also use the Axes property `set_axisbelow()` to control whether the grid lines are placed above or below your other plot elements.

### 11.1.12 Make the aspect ratio for plots equal

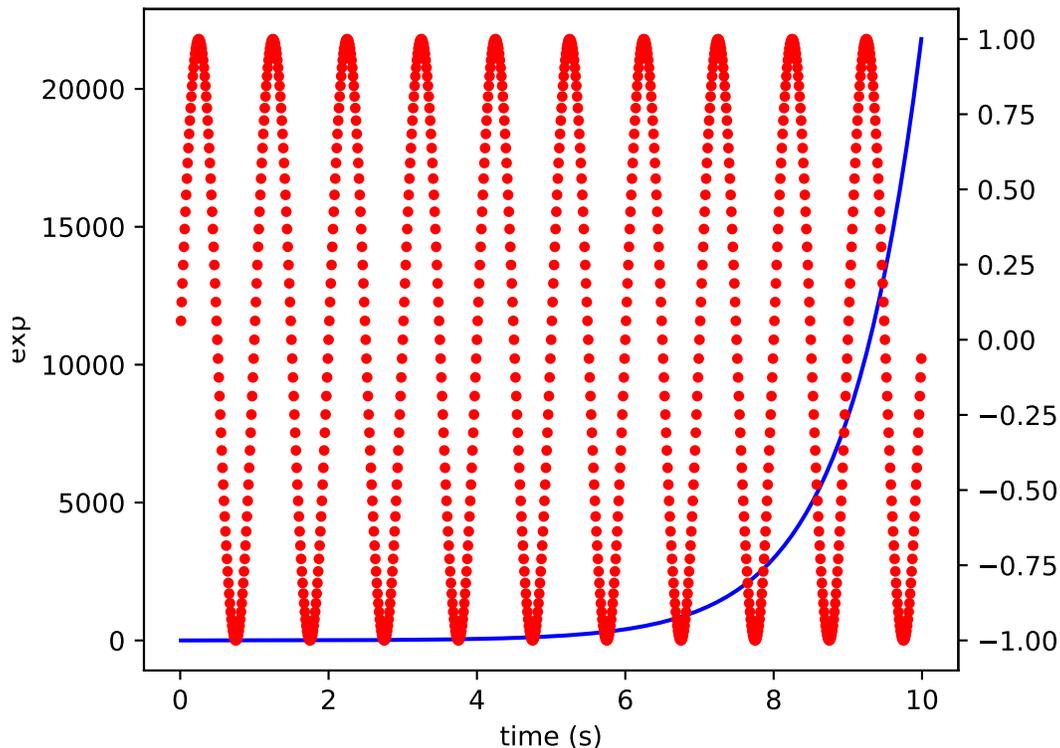
The Axes property `set_aspect()` controls the aspect ratio of the axes. You can set it to be 'auto', 'equal', or some ratio which controls the ratio:

```
ax = fig.add_subplot(111, aspect='equal')
```

### 11.1.13 Multiple y-axis scales

A frequent request is to have two scales for the left and right y-axis, which is possible using `twinx()` (more than two scales are not currently supported, though it is on the wish list). This works pretty well, though there are some quirks when you are trying to interactively pan and zoom, because both scales do not get the signals.

The approach uses `twinx()` (and its sister `twiny()`) to use 2 different axes, turning the axes rectangular frame off on the 2nd axes to keep it from obscuring the first, and manually setting the tick locs and labels as desired. You can use separate `matplotlib.ticker` formatters and locators as desired because the two axes are independent.



### 11.1.14 Generate images without having a window appear

Simply do not call `show`, and directly save the figure to the desired format:

```
import matplotlib.pyplot as plt
plt.plot([1, 2, 3])
plt.savefig('myfig.png')
```

#### See also:

*Matplotlib in a web application server* for information about running matplotlib inside of a web application.

### 11.1.15 Use `show()`

When you want to view your plots on your display, the user interface backend will need to start the GUI mainloop. This is what `show()` does. It tells Matplotlib to raise all of the figure windows created so far and start the mainloop. Because this mainloop is blocking by default (i.e., script execution is paused), you should only call this once per script, at the end. Script execution is resumed after the last window is closed. Therefore, if you are using Matplotlib to generate only images and do not want a user interface window, you do not need to call `show` (see *Generate images without having a window appear* and *What is a backend?*).

**Note:** Because closing a figure window invokes the destruction of its plotting elements, you

should call `savefig()` before calling `show` if you wish to save the figure as well as view it.

New in version v1.0.0: `show` now starts the GUI mainloop only if it isn't already running. Therefore, multiple calls to `show` are now allowed.

Having `show` block further execution of the script or the python interpreter depends on whether Matplotlib is set for interactive mode or not. In non-interactive mode (the default setting), execution is paused until the last figure window is closed. In interactive mode, the execution is not paused, which allows you to create additional figures (but the script won't finish until the last figure window is closed).

**Note:** Support for interactive/non-interactive mode depends upon the backend. Until version 1.0.0 (and subsequent fixes for 1.0.1), the behavior of the interactive mode was not consistent across backends. As of v1.0.1, only the macosx backend differs from other backends because it does not support non-interactive mode.

Because it is expensive to draw, you typically will not want Matplotlib to redraw a figure many times in a script such as the following:

```
plot([1,2,3])           # draw here ?
xlabel('time')         # and here ?
ylabel('volts')        # and here ?
title('a simple plot') # and here ?
show()
```

However, it is *possible* to force Matplotlib to draw after every command, which might be what you want when working interactively at the python console (see *Using matplotlib in a python shell*), but in a script you want to defer all drawing until the call to `show`. This is especially important for complex figures that take some time to draw. `show()` is designed to tell Matplotlib that you're all done issuing commands and you want to draw the figure now.

**Note:** `show()` should typically only be called at most once per script and it should be the last line of your script. At that point, the GUI takes control of the interpreter. If you want to force a figure draw, use `draw()` instead.

Many users are frustrated by `show` because they want it to be a blocking call that raises the figure, pauses the script until they close the figure, and then allow the script to continue running until the next figure is created and the next `show` is made. Something like this:

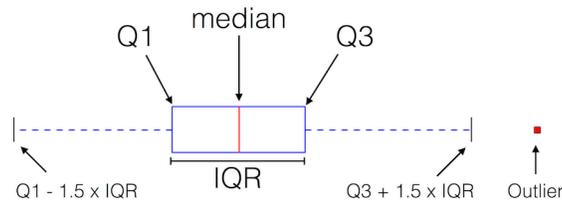
```
# WARNING : illustrating how NOT to use show
for i in range(10):
    # make figure i
    show()
```

This is not what `show` does and unfortunately, because doing blocking calls across user interfaces can be tricky, is currently unsupported, though we have made significant progress towards supporting blocking events.

New in version v1.0.0: As noted earlier, this restriction has been relaxed to allow multiple calls to `show`. In *most* backends, you can now expect to be able to create new figures and raise them in a subsequent call to `show` after closing the figures from a previous call to `show`.

### 11.1.16 Interpreting box plots and violin plots

Tukey's **box plots** (Robert McGill, John W. Tukey and Wayne A. Larsen: "The American Statistician" Vol. 32, No. 1, Feb., 1978, pp. 12-16) are statistical plots that provide useful information about the data distribution such as skewness. However, bar plots with error bars are still the common standard in most scientific literature, and thus, the interpretation of box plots can be challenging for the unfamiliar reader. The figure below illustrates the different visual features of a box plot.



**Q1:** *Quartile 1*, or median of the *left* data subset after dividing the original data set into 2 subsets via the median (25% of the data points fall below this threshold)

**Q3:** *Quartile 3*, median of the *right* data subset (75% of the data points fall below this threshold)

**IQR:** *Interquartile-range*,  $Q3 - Q1$

**Outliers:** Data points are considered to be outliers if  
 value  $< Q1 - 1.5 \times IQR$  or  
 value  $> Q3 + 1.5 \times IQR$



Sebastian Raschka, 2016  
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**Violin plots** are closely related to box plots but add useful information such as the distribution of the sample data (density trace). Violin plots were added in Matplotlib 1.4.

### 11.1.17 Working with threads

Matplotlib is not thread-safe: in fact, there are known race conditions that affect certain artists. Hence, if you work with threads, it is your responsibility to set up the proper locks to serialize access to Matplotlib artists.

Note that (for the case where you are working with an interactive backend) most GUI backends *require* being run from the main thread as well.

## 11.2 Contributing: howto

### 11.2.1 Request a new feature

Is there a feature you wish Matplotlib had? Then ask! The best way to get started is to email the developer [mailing list](#) for discussion. This is an open source project developed primarily in the contributors free time, so there is no guarantee that your feature will be added. The *best* way to get the feature you need added is to contribute it your self.

## 11.2.2 Reporting a bug or submitting a patch

The development of Matplotlib is organized through [github](#). If you would like to report a bug or submit a patch please use that interface.

To report a bug [create an issue](#) on github (this requires having a github account). Please include a [Short, Self Contained, Correct \(Compilable\), Example](#) demonstrating what the bug is. Including a clear, easy to test example makes it easy for the developers to evaluate the bug. Expect that the bug reports will be a conversation. If you do not want to register with github, please email bug reports to the [mailing list](#).

The easiest way to submit patches to Matplotlib is through pull requests on github. Please see the *The Matplotlib Developers' Guide* for the details.

## 11.2.3 Contribute to Matplotlib documentation

Matplotlib is a big library, which is used in many ways, and the documentation has only scratched the surface of everything it can do. So far, the place most people have learned all these features are through studying the examples (*Search examples*), which is a recommended and great way to learn, but it would be nice to have more official narrative documentation guiding people through all the dark corners. This is where you come in.

There is a good chance you know more about Matplotlib usage in some areas, the stuff you do every day, than many of the core developers who wrote most of the documentation. Just pulled your hair out compiling Matplotlib for Windows? Write a FAQ or a section for the *Installation* page. Are you a digital signal processing wizard? Write a tutorial on the signal analysis plotting functions like `xcorr()`, `psd()` and `specgram()`. Do you use Matplotlib with [django](#) or other popular web application servers? Write a FAQ or tutorial and we'll find a place for it in the *User's Guide*. And so on... I think you get the idea.

Matplotlib is documented using the [sphinx](#) extensions to restructured text ([ReST](#)). sphinx is an extensible python framework for documentation projects which generates HTML and PDF, and is pretty easy to write; you can see the source for this document or any page on this site by clicking on the *Show Source* link at the end of the page in the sidebar.

The sphinx website is a good resource for learning sphinx, but we have put together a cheat-sheet at *Writing documentation* which shows you how to get started, and outlines the Matplotlib conventions and extensions, e.g., for including plots directly from external code in your documents.

Once your documentation contributions are working (and hopefully tested by actually *building* the docs) you can submit them as a patch against git. See *Install git* and *Reporting a bug or submitting a patch*. Looking for something to do? Search for [TODO](#) or look at the open issues on github.

## 11.3 Matplotlib in a web application server

In general, the simplest solution when using Matplotlib in a web server is to completely avoid using pyplot (pyplot maintains references to the opened figures to make `show` work, but this will cause memory leaks unless the figures are properly closed). Since Matplotlib 3.1, one can directly create figures using the `Figure` constructor and save them to in-memory buffers. The following example uses [Flask](#), but other frameworks work similarly:

```
import base64
from io import BytesIO

from flask import Flask
from matplotlib.figure import Figure

app = Flask(__name__)

@app.route("/")
def hello():
    # Generate the figure **without using pyplot**.
    fig = Figure()
    ax = fig.subplots()
    ax.plot([1, 2])
    # Save it to a temporary buffer.
    buf = BytesIO()
    fig.savefig(buf, format="png")
    # Embed the result in the html output.
    data = base64.b64encode(buf.getbuffer()).decode("ascii")
    return f"<img src='data:image/png;base64,{data}' />"
```

When using Matplotlib versions older than 3.1, it is necessary to explicitly instantiate an Agg canvas; see e.g. [/gallery/user\\_interfaces/canvasagg](/gallery/user_interfaces/canvasagg).

### 11.3.1 Clickable images for HTML

Andrew Dalke of [Dalke Scientific](#) has written a nice [article](#) on how to make html click maps with Matplotlib agg PNGs. We would also like to add this functionality to SVG. If you are interested in contributing to these efforts that would be great.

## 11.4 Search examples

The nearly 300 code examples-index included with the Matplotlib source distribution are full-text searchable from the search page, but sometimes when you search, you get a lot of results from the *The object-oriented API* or other documentation that you may not be interested in if you just want to find a complete, free-standing, working piece of example code. To facilitate example searches, we have tagged every code example page with the keyword `codex` for *code example* which shouldn't appear anywhere else on this site except in the FAQ. So if you want to search for an example that uses an ellipse, search for `codex ellipse`.

## TROUBLESHOOTING

### Contents

- *Troubleshooting*
  - *Obtaining Matplotlib version*
  - *matplotlib install location*
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### 12.1 Obtaining Matplotlib version

To find out your Matplotlib version number, import it and print the `__version__` attribute:

```
>>> import matplotlib
>>> matplotlib.__version__
'0.98.0'
```

### 12.2 matplotlib install location

You can find what directory Matplotlib is installed in by importing it and printing the `__file__` attribute:

```
>>> import matplotlib
>>> matplotlib.__file__
'/home/jdhunter/dev/lib64/python2.5/site-packages/matplotlib/__init__.pyc'
```

### 12.3 matplotlib configuration and cache directory locations

Each user has a Matplotlib configuration directory which may contain a `matplotlibrc` file. To locate your `matplotlib/` configuration directory, use `matplotlib.get_configdir()`:

```
>>> import matplotlib as mpl
>>> mpl.get_configdir()
'/home/darren/.config/matplotlib'
```

On unix-like systems, this directory is generally located in your *HOME* directory under the `.config/` directory.

In addition, users have a cache directory. On unix-like systems, this is separate from the configuration directory by default. To locate your `.cache/` directory, use `matplotlib.get_cachedir()`:

```
>>> import matplotlib as mpl
>>> mpl.get_cachedir()
'/home/darren/.cache/matplotlib'
```

On windows, both the config directory and the cache directory are the same and are in your Documents and Settings or Users directory by default:

```
>>> import matplotlib as mpl
>>> mpl.get_configdir()
'C:\\Documents and Settings\\jdhunter\\.matplotlib'
>>> mpl.get_cachedir()
'C:\\Documents and Settings\\jdhunter\\.matplotlib'
```

If you would like to use a different configuration directory, you can do so by specifying the location in your `MPLCONFIGDIR` environment variable - see *Setting environment variables in Linux and OS-X*. Note that `MPLCONFIGDIR` sets the location of both the configuration directory and the cache directory.

## 12.4 Getting help

There are a number of good resources for getting help with Matplotlib. There is a good chance your question has already been asked:

- The [mailing list archive](#).
- [Github issues](#).
- Stackoverflow questions tagged [matplotlib](#).

If you are unable to find an answer to your question through search, please provide the following information in your e-mail to the [mailing list](#):

- Your operating system (Linux/UNIX users: post the output of `uname -a`).
- Matplotlib version:

```
python -c "import matplotlib; print matplotlib.__version__"
```

- Where you obtained Matplotlib (e.g., your Linux distribution's packages, Github, PyPi, or [Anaconda](#) or [Enthought Canopy](#)).
- Any customizations to your `matplotlibrc` file (see *Customizing Matplotlib with style sheets and rcParams*).

- If the problem is reproducible, please try to provide a *minimal*, standalone Python script that demonstrates the problem. This is *the* critical step. If you can't post a piece of code that we can run and reproduce your error, the chances of getting help are significantly diminished. Very often, the mere act of trying to minimize your code to the smallest bit that produces the error will help you find a bug in *your* code that is causing the problem.
- Matplotlib provides debugging information through the `logging` library, and a helper function to set the logging level: one can call

```
plt.set_loglevel("info") # or "debug" for more info
```

to obtain this debugging information.

Standard functions from the `logging` module are also applicable; e.g. one could call `logging.basicConfig(level="DEBUG")` even before importing Matplotlib (this is in particular necessary to get the logging info emitted during Matplotlib's import), or attach a custom handler to the "matplotlib" logger. This may be useful if you use a custom logging configuration.

If you compiled Matplotlib yourself, please also provide:

- any changes you have made to `setup.py` or `setupext.py`.
- the output of:

```
rm -rf build
python setup.py build
```

The beginning of the build output contains lots of details about your platform that are useful for the Matplotlib developers to diagnose your problem.

- your compiler version - e.g., `gcc --version`.

Including this information in your first e-mail to the mailing list will save a lot of time.

You will likely get a faster response writing to the mailing list than filing a bug in the bug tracker. Most developers check the bug tracker only periodically. If your problem has been determined to be a bug and can not be quickly solved, you may be asked to file a bug in the tracker so the issue doesn't get lost.

## 12.5 Problems with recent git versions

First make sure you have a clean build and install (see *How to completely remove Matplotlib*), get the latest git update, install it and run a simple test script in debug mode:

```
rm -rf /path/to/site-packages/matplotlib*
git clean -xdf
git pull
python -mpip install -v . > build.out
python examples/pylab_examples/simple_plot.py --verbose-debug > run.out
```

and post `build.out` and `run.out` to the `matplotlib-devel` mailing list (please do not post git problems to the `users` list).

Of course, you will want to clearly describe your problem, what you are expecting and what you are getting, but often a clean build and install will help. See also *Getting help*.



## ENVIRONMENT VARIABLES

### Contents

- *Environment Variables*
  - *Setting environment variables in Linux and OS-X*
    - \* *BASH/KSH*
    - \* *CSH/TCSH*
  - *Setting environment variables in windows*

#### HOME

The user's home directory. On linux, `~` is shorthand for *HOME*.

#### PATH

The list of directories searched to find executable programs

#### PYTHONPATH

The list of directories that is added to Python's standard search list when importing packages and modules

#### MPLCONFIGDIR

This is the directory used to store user customizations to matplotlib, as well as some caches to improve performance. If *MPLCONFIGDIR* is not defined, *HOME/.config/matplotlib* is generally used on unix-like systems and *HOME/.matplotlib* is used on other platforms, if they are writable. Otherwise, the python standard library `tempfile.gettempdir()` is used to find a base directory in which the matplotlib subdirectory is created.

#### MPLBACKEND

This optional variable can be set to choose the matplotlib backend. See *What is a backend?*.

### 13.1 Setting environment variables in Linux and OS-X

To list the current value of *PYTHONPATH*, which may be empty, try:

```
echo $PYTHONPATH
```

The procedure for setting environment variables in depends on what your default shell is. *BASH* seems to be the most common, but *CSH* is also common. You should be able to determine which by running at the command prompt:

```
echo $SHELL
```

### 13.1.1 BASH/KSH

To create a new environment variable:

```
export PYTHONPATH=~/Python
```

To prepend to an existing environment variable:

```
export PATH=~/bin:${PATH}
```

The search order may be important to you, do you want ~/bin to be searched first or last? To append to an existing environment variable:

```
export PATH=${PATH}:~/bin
```

To make your changes available in the future, add the commands to your ~/.bashrc file.

### 13.1.2 CSH/TCSH

To create a new environment variable:

```
setenv PYTHONPATH ~/Python
```

To prepend to an existing environment variable:

```
setenv PATH ~/bin:${PATH}
```

The search order may be important to you, do you want ~/bin to be searched first or last? To append to an existing environment variable:

```
setenv PATH ${PATH}:~/bin
```

To make your changes available in the future, add the commands to your ~/.cshrc file.

## 13.2 Setting environment variables in windows

Open the **Control Panel** (*Start* → *Control Panel*), start the **System** program. Click the *Advanced* tab and select the *Environment Variables* button. You can edit or add to the *User Variables*.

## WORKING WITH MATPLOTLIB IN VIRTUAL ENVIRONMENTS

While Matplotlib itself runs fine in a [virtual environment](#) (venv), some of the GUI frameworks that Matplotlib uses for interactive figures are tricky to install in a venv. Everything below assumes some familiarity with the Matplotlib backends as found in *What is a backend?*.

If you only use the IPython and Jupyter Notebook's `inline` and `notebook` backends, or non-interactive backends, you should not have any issues and can ignore everything below.

Likewise, the Tk framework (TkAgg backend) does not require any external dependencies and is normally always available. On certain Linux distributions, a package named `python-tk` (or similar) needs to be installed.

Otherwise, the situation (at the time of writing) is as follows:

framework	bindings	pip-installable?	conda or conda-forge-installable?
Qt5	PyQt5	yes	yes
Qt5	PySide2	yes	yes
Qt4	PyQt4	no	yes
Qt4	PySide	OSX and Windows	yes
GTK3	PyGObject	yes <sup>1</sup>	Linux and OSX
wxWidgets	wxPython	yes <sup>2</sup>	yes

For cases where the framework is not installable in a venv, it needs to be installed in the global (system) site-packages, and then made available from within the venv. This can be achieved by either of the following methods (in all cases, the system-wide Python and the venv Python must be of the same version):

- `vext` allows controlled access from within the venv to specific system-wide packages. A specific package needs to be installed for each framework, e.g. `vext.pyqt5`, etc. It is recommended to use `vext>=0.7.0` as earlier versions misconfigure the logging system.
- Using the `--system-site-packages` option when creating an environment adds all system-wide packages to the virtual environment. However, this breaks the isolation between the virtual environment and the system install. Among other issues it results in hard to debug problems with system packages shadowing the environment packages. If you use `virtualenv` (rather than the stdlib's `venv`) together with `virtualenvwrapper`, this can be toggled with the `toggleglobalsitepackages` command.

---

<sup>1</sup> No wheels available, see [https://pygobject.readthedocs.io/en/latest/devguide/dev\\_envirion.html](https://pygobject.readthedocs.io/en/latest/devguide/dev_envirion.html) for build instructions.

<sup>2</sup> OSX and Windows wheels available on PyPI. Linux wheels available but not on PyPI, see <https://wxpython.org/pages/downloads/>.



**Part III**

**API Overview**



## API CHANGES

If updating Matplotlib breaks your scripts, this list may help you figure out what caused the breakage and how to fix it by updating your code.

For API changes in older versions see

### 15.1 Old API Changes

#### 15.1.1 Changes for 0.40

- Artist
  - \* `__init__` takes a DPI instance and a Bound2D instance which is the bounding box of the artist in display coords
  - \* `get_window_extent` returns a Bound2D instance
  - \* `set_size` is removed; replaced by `bbox` and `dpi`
  - \* the `clip_gc` method is removed. Artists now clip themselves with their box
  - \* added `_clipOn` boolean attribute. If True, gc clip to bbox.
- AxisTextBase
  - \* Initialized with a `transx`, `transy` which are Transform instances
  - \* `set_drawing_area` removed
  - \* `get_left_right` and `get_top_bottom` are replaced by `get_window_extent`
- Line2D Patches now take `transx`, `transy`
  - \* Initialized with a `transx`, `transy` which are Transform instances
- Patches
  - \* Initialized with a `transx`, `transy` which are Transform instances
- FigureBase attributes `dpi` is a DPI instance rather than scalar and new attribute `bbox` is a Bound2D in display coords, and I got rid of the `left`, `width`, `height`, etc... attributes. These are now accessible as, for example, `bbox.x.min` is `left`, `bbox.x.interval()` is `width`, `bbox.y.max` is `top`, etc...
- GcfBase attribute `pagesize` renamed to `figsize`
- Axes

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```
* removed figbg attribute
* added fig instance to __init__
* resizing is handled by figure call to resize.

- Subplot
  * added fig instance to __init__

- Renderer methods for patches now take gcEdge and gcFace instances.
  gcFace=None takes the place of filled=False

- True and False symbols provided by cbook in a python2.3 compatible
  way

- new module transforms supplies Bound1D, Bound2D and Transform
  instances and more

- Changes to the MATLAB helpers API

  * _matplotlib_helpers.GcfBase is renamed by Gcf. Backends no longer
    need to derive from this class. Instead, they provide a factory
    function new_figure_manager(num, figsize, dpi). The destroy
    method of the GcfDerived from the backends is moved to the derived
    FigureManager.

  * FigureManagerBase moved to backend_bases

  * Gcf.get_all_figwins renamed to Gcf.get_all_fig_managers

Jeremy:

Make sure to self._reset = False in AxisTextWX._set_font. This was
something missing in my backend code.
```

### 15.1.2 Changes for 0.42

```
* Refactoring AxisText to be backend independent. Text drawing and
  get_window_extent functionality will be moved to the Renderer.

* backend_bases.AxisTextBase is now text.Text module

* All the erase and reset functionality removed from AxisText - not
  needed with double buffered drawing. Ditto with state change.
  Text instances have a get_prop_tup method that returns a hashable
  tuple of text properties which you can use to see if text props
  have changed, e.g., by caching a font or layout instance in a dict
  with the prop tup as a key -- see RendererGTK.get_pango_layout in
  backend_gtk for an example.

* Text._get_xy_display renamed Text.get_xy_display
```

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- \* Artist `set_renderer` and `wash_brushes` methods removed
- \* Moved `Legend` class from `matplotlib.axes` into `matplotlib.legend`
- \* Moved `Tick`, `XTick`, `YTick`, `Axis`, `XAxis`, `YAxis` from `matplotlib.axes` to `matplotlib.axis`
- \* moved `process_text_args` to `matplotlib.text`
- \* After getting `Text` handled in a backend independent fashion, the import process is much cleaner since there are no longer cyclic dependencies
- \* `matplotlib.matlab._get_current_fig_manager` renamed to `matplotlib.matlab.get_current_fig_manager` to allow user access to the GUI window attribute, e.g., `figManager.window` for GTK and `figManager.frame` for wx

### 15.1.3 Changes for 0.50

- \* refactored `Figure` class so it is no longer backend dependent. `FigureCanvasBackend` takes over the backend specific duties of the `Figure`. `matplotlib.backend_bases.FigureBase` moved to `matplotlib.figure.Figure`.
- \* backends must implement `FigureCanvasBackend` (the thing that controls the figure and handles the events if any) and `FigureManagerBackend` (wraps the canvas and the window for MATLAB interface). `FigureCanvasBase` implements a backend switching mechanism
- \* `Figure` is now an `Artist` (like everything else in the figure) and is totally backend independent
- \* `GDFONTPATH` renamed to `TTFPATH`
- \* backend `faceColor` argument changed to `rgbFace`
- \* `colormap` stuff moved to `colors.py`
- \* `arg_to_rgb` in `backend_bases` moved to class `ColorConverter` in `colors.py`
- \* GD users must upgrade to `gd-2.0.22` and `gdmodule-0.52` since new gd features (clipping, antialiased lines) are now used.
- \* `Renderer` must implement `points_to_pixels`

Migrating code:

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## MATLAB interface:

The only API change for those using the MATLAB interface is in how you call figure redraws for dynamically updating figures. In the old API, you did

```
fig.draw()
```

In the new API, you do

```
manager = get_current_fig_manager()
manager.canvas.draw()
```

See the examples `system_monitor.py`, `dynamic_demo.py`, and `anim.py`

## API

There is one important API change for application developers. Figure instances used subclass GUI widgets that enabled them to be placed directly into figures. e.g., `FigureGTK` subclassed `gtk.DrawingArea`. Now the `Figure` class is independent of the backend, and `FigureCanvas` takes over the functionality formerly handled by `Figure`. In order to include figures into your apps, you now need to do, for example

```
# gtk example
fig = Figure(figsize=(5,4), dpi=100)
canvas = FigureCanvasGTK(fig) # a gtk.DrawingArea
canvas.show()
vbox.pack_start(canvas)
```

If you use the `NavigationToolbar`, this is now initialized with a `FigureCanvas`, not a `Figure`. The examples `embedding_in_gtk.py`, `embedding_in_gtk2.py`, and `mpl_with_glade.py` all reflect the new API so use these as a guide.

All prior calls to

```
figure.draw() and
figure.print_figure(args)
```

should now be

```
canvas.draw() and
canvas.print_figure(args)
```

Apologies for the inconvenience. This refactorization brings significant more freedom in developing matplotlib and should bring better plotting capabilities, so I hope the inconvenience is worth it.

## 15.1.4 Changes for 0.54

### MATLAB interface

#### dpi

Several of the backends used a `PIXELS_PER_INCH` hack that I added to try and make images render consistently across backends. This just complicated matters. So you may find that some font sizes and line widths appear different than before. Apologies for the inconvenience. You should set the dpi to an accurate value for your screen to get true sizes.

#### pcolor and scatter

There are two changes to the MATLAB interface API, both involving the patch drawing commands. For efficiency, `pcolor` and `scatter` have been rewritten to use polygon collections, which are a new set of objects from `matplotlib.collections` designed to enable efficient handling of large collections of objects. These new collections make it possible to build large scatter plots or `pcolor` plots with no loops at the python level, and are significantly faster than their predecessors. The original `pcolor` and `scatter` functions are retained as `pcolor_classic` and `scatter_classic`.

The return value from `pcolor` is a `PolyCollection`. Most of the properties that are available on rectangles or other patches are also available on `PolyCollections`, e.g., you can say:

```
c = scatter(blah, blah)
c.set_linewidth(1.0)
c.set_facecolor('r')
c.set_alpha(0.5)
```

or:

```
c = scatter(blah, blah)
set(c, 'linewidth', 1.0, 'facecolor', 'r', 'alpha', 0.5)
```

Because the collection is a single object, you no longer need to loop over the return value of `scatter` or `pcolor` to set properties for the entire list.

If you want the different elements of a collection to vary on a property, e.g., to have different line widths, see `matplotlib.collections` for a discussion on how to set the properties as a sequence.

For `scatter`, the size argument is now in `points2` (the area of the symbol in points) as in MATLAB and is not in data coords as before. Using sizes in data coords caused several problems. So you will need to adjust your size arguments accordingly or use `scatter_classic`.

#### mathtext spacing

For reasons not clear to me (and which I'll eventually fix) spacing no longer works in font groups. However, I added three new spacing commands which compensate for this " (regular space), "' (small space) and `'hspace{frac}'` where `frac` is a fraction of fontsize in points. You will need to quote spaces in font strings, is:

```
title(r'$\rm{Histogram\ of\ IQ:}\ \mu=100,\ \sigma=15$')
```

## Object interface - Application programmers

### Autoscaling

The x and y axis instances no longer have autoscale view. These are handled by `axes.autoscale_view`

### Axes creation

You should not instantiate your own Axes any more using the OO API. Rather, create a Figure as before and in place of:

```
f = Figure(figsize=(5,4), dpi=100)
a = Subplot(f, 111)
f.add_axis(a)
```

use:

```
f = Figure(figsize=(5,4), dpi=100)
a = f.add_subplot(111)
```

That is, `add_axis` no longer exists and is replaced by:

```
add_axes(rect, axisbg=defaultcolor, frameon=True)
add_subplot(num, axisbg=defaultcolor, frameon=True)
```

### Artist methods

If you define your own Artists, you need to rename the `_draw` method to `draw`

### Bounding boxes

`matplotlib.transforms.Bound2D` is replaced by `matplotlib.transforms.Bbox`. If you want to construct a `bbox` from left, bottom, width, height (the signature for `Bound2D`), use `matplotlib.transforms.lbwh_to_bbox`, as in

```
bbox = clickBBox = lbwh_to_bbox(left, bottom, width, height)
```

The `Bbox` has a different API than the `Bound2D`. e.g., if you want to get the width and height of the `bbox`

**OLD::** width = `fig.bbox.x.interval()` height = `fig.bbox.y.interval()`

**New::** width = `fig.bbox.width()` height = `fig.bbox.height()`

## Object constructors

You no longer pass the `bbox`, `dpi`, or `transforms` to the various Artist constructors. The old way of creating lines and rectangles was cumbersome because you had to pass so many attributes to the `Line2D` and `Rectangle` classes not related directly to the geometry and properties of the object. Now default values are added to the object when you call `axes.add_line` or `axes.add_patch`, so they are hidden from the user.

If you want to define a custom transformation on these objects, call `o.set_transform(trans)` where `trans` is a `Transformation` instance.

In prior versions of you wanted to add a custom line in data coords, you would have to do

```
l = Line2D(dpi, bbox, x, y, color = color, transx = transx, transy =
          transy, )
```

now all you need is

```
l = Line2D(x, y, color=color)
```

and the axes will set the transformation for you (unless you have set your own already, in which case it will leave it unchanged)

## Transformations

The entire transformation architecture has been rewritten. Previously the `x` and `y` transformations were stored in the `xaxis` and `yaxis` instances. The problem with this approach is it only allows for separable transforms (where the `x` and `y` transformations don't depend on one another). But for cases like polar, they do. Now transformations operate on `x,y` together. There is a new base class `matplotlib.transforms.Transformation` and two concrete implementations, `matplotlib.transforms.SeparableTransformation` and `matplotlib.transforms.Affine`. The `SeparableTransformation` is constructed with the bounding box of the input (this determines the rectangular coordinate system of the input, i.e., the `x` and `y` view limits), the bounding box of the display, and possibly nonlinear transformations of `x` and `y`. The 2 most frequently used transformations, data coordinates  $\rightarrow$  display and axes coordinates  $\rightarrow$  display are available as `ax.transData` and `ax.transAxes`. See `alignment_demo.py` which uses axes coords.

Also, the transformations should be much faster now, for two reasons

- they are written entirely in extension code
- because they operate on `x` and `y` together, they can do the entire transformation in one loop. Earlier I did something along the lines of:

```
xt = sx*func(x) + tx
yt = sy*func(y) + ty
```

Although this was done in `numerix`, it still involves 6 `length(x)` for-loops (the multiply, add, and function evaluation each for `x` and `y`). Now all of that is done in a single pass.

If you are using transformations and bounding boxes to get the cursor position in data coordinates, the method calls are a little different now. See the updated `examples/coords_demo.py` which shows you how to do this.

Likewise, if you are using the artist bounding boxes to pick items on the canvas with the GUI, the `bbox` methods are somewhat different. You will need to see the updated `examples/object_picker.py`.

See `unit/transforms_unit.py` for many examples using the new transformations.

### 15.1.5 Changes for 0.54.3

```
removed the set_default_font / get_default_font scheme from the
font_manager to unify customization of font defaults with the rest of
the rc scheme. See examples/font_properties_demo.py and help(rc) in
matplotlib.matlab.
```

### 15.1.6 Changes for 0.60

```
ColormapJet and Grayscale are deprecated. For backwards
compatibility, they can be obtained either by doing
```

```
from matplotlib.cm import ColormapJet
or
from matplotlib.matlab import *
```

```
They are replaced by cm.jet and cm.grey
```

### 15.1.7 Changes for 0.61

```
canvas.connect is now deprecated for event handling. use
mpl_connect and mpl_disconnect instead. The callback signature is
func(event) rather than func(widget, event)
```

### 15.1.8 Changes for 0.63

```
Dates are now represented internally as float days since 0001-01-01,
UTC.
```

```
All date tickers and formatters are now in matplotlib.dates, rather
than matplotlib.tickers
```

```
converters have been abolished from all functions and classes.
num2date and date2num are now the converter functions for all date
plots
```

```
Most of the date tick locators have a different meaning in their
constructors. In the prior implementation, the first argument was a
```

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base and multiples of the base were ticked. e.g.,

```
HourLocator(5) # old: tick every 5 minutes
```

In the new implementation, the explicit points you want to tick are provided as a number or sequence

```
HourLocator(range(0,5,61)) # new: tick every 5 minutes
```

This gives much greater flexibility. I have tried to make the default constructors (no args) behave similarly, where possible.

Note that YearLocator still works under the base/multiple scheme. The difference between the YearLocator and the other locators is that years are not recurrent.

Financial functions:

```
matplotlib.finance.quotes_historical_yahoo(ticker, date1, date2)
```

date1, date2 are now datetime instances. Return value is a list of quotes where the quote time is a float - days since gregorian start, as returned by date2num

See examples/finance\_demo.py for example usage of new API

### 15.1.9 Changes for 0.65

mpl\_connect and mpl\_disconnect in the MATLAB interface renamed to connect and disconnect

Did away with the text methods for angle since they were ambiguous. fontangle could mean fontstyle (oblique, etc) or the rotation of the text. Use style and rotation instead.

### 15.1.10 Changes for 0.65.1

removed add\_axes and add\_subplot from backend\_bases. Use figure.add\_axes and add\_subplot instead. The figure now manages the current axes with gca and sca for get and set current axes. If you have code you are porting which called, e.g., figmanager.add\_axes, you can now simply do figmanager.canvas.figure.add\_axes.

### 15.1.11 Changes for 0.70

MplEvent factored into a base class Event and derived classes  
MouseEvent and KeyEvent

Removed defunct set\_measurement in wx toolbar

### 15.1.12 Changes for 0.71

Significant numerix namespace changes, introduced to resolve  
namespace clashes between python built-ins and mlab names.  
Refactored numerix to maintain separate modules, rather than  
folding all these names into a single namespace. See the following  
mailing list threads for more information and background

[http://sourceforge.net/mailarchive/forum.php?thread\\_id=6398890&forum\\_id=36187](http://sourceforge.net/mailarchive/forum.php?thread_id=6398890&forum_id=36187)  
[http://sourceforge.net/mailarchive/forum.php?thread\\_id=6323208&forum\\_id=36187](http://sourceforge.net/mailarchive/forum.php?thread_id=6323208&forum_id=36187)

OLD usage

```
from matplotlib.numerix import array, mean, fft
```

NEW usage

```
from matplotlib.numerix import array
from matplotlib.numerix.mlab import mean
from matplotlib.numerix.fft import fft
```

numerix dir structure mirrors numarray (though it is an incomplete  
implementation)

```
numerix
numerix/mlab
numerix/linear_algebra
numerix/fft
numerix/random_array
```

but of course you can use 'numerix : Numeric' and still get the  
symbols.

pylab still imports most of the symbols from Numeric, MLab, fft,  
etc, but is more cautious. For names that clash with python names  
(min, max, sum), pylab keeps the builtins and provides the numeric  
versions with an a\* prefix, e.g., (amin, amax, asum)

### 15.1.13 Changes for 0.72

- Line2D, Text, and Patch copy\_properties renamed update\_from and moved into artist base class
- LineCollecitons.color renamed to LineCollections.set\_color for consistency with set/get introspection mechanism,
- pylab figure now defaults to num=None, which creates a new figure with a guaranteed unique number
- contour method syntax changed - now it is MATLAB compatible
  - unchanged: contour(Z)
  - old: contour(Z, x=Y, y=Y)
  - new: contour(X, Y, Z)

see <http://matplotlib.sf.net/matplotlib.pylab.html#-contour>
- Increased the default resolution for save command.
- Renamed the base attribute of the ticker classes to \_base to avoid conflict with the base method. Sitt for subs
- subs=None now does autosubbing in the tick locator.
- New subplots that overlap old will delete the old axes. If you do not want this behavior, use fig.add\_subplot or the axes command

### 15.1.14 Changes for 0.73

- Removed deprecated ColormapJet and friends
- Removed all error handling from the verbose object
- figure num of zero is now allowed

### 15.1.15 Changes for 0.80

- xlim/ylim/axis always return the new limits regardless of arguments. They now take kwargs which allow you to selectively change the upper or lower limits while leaving unnamed limits unchanged. See help(xlim) for example

### 15.1.16 Changes for 0.81

- pylab and artist "set" functions renamed to setp to avoid clash with python2.4 built-in set. Current version will issue a deprecation warning which will be removed in future versions
- imshow interpolation arguments changes for advanced interpolation schemes. See help imshow, particularly the interpolation, filternorm and filterrad kwargs
- Support for masked arrays has been added to the plot command and to the Line2D object. Only the valid points are plotted. A "valid\_only" kwarg was added to the get\_xdata() and get\_ydata() methods of Line2D; by default it is False, so that the original data arrays are returned. Setting it to True returns the plottable points.
- contour changes:

Masked arrays: contour and contourf now accept masked arrays as the variable to be contoured. Masking works correctly for contour, but a bug remains to be fixed before it will work for contourf. The "badmask" kwarg has been removed from both functions.

Level argument changes:

Old version: a list of levels as one of the positional arguments specified the lower bound of each filled region; the upper bound of the last region was taken as a very large number. Hence, it was not possible to specify that z values between 0 and 1, for example, be filled, and that values outside that range remain unfilled.

New version: a list of N levels is taken as specifying the boundaries of N-1 z ranges. Now the user has more control over what is colored and what is not. Repeated calls to contourf (with different colormaps or color specifications, for example) can be used to color different ranges of z. Values of z outside an expected range are left uncolored.

Example:

Old: contourf(z, [0, 1, 2]) would yield 3 regions: 0-1, 1-2, and >2.  
New: it would yield 2 regions: 0-1, 1-2. If the same 3 regions were desired, the equivalent list of levels would be [0, 1, 2, 1e38].

### 15.1.17 Changes for 0.82

- toolbar import change in GTKAgg, GTKCairo and WXAgg

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```
- Added subplot config tool to GTK* backends -- note you must now
import the NavigationToolbar2 from your backend of choice rather
than from backend_gtk because it needs to know about the backend
specific canvas -- see examples/embedding_in_gtk2.py. Ditto for
wx backend -- see examples/embedding_in_wxagg.py
```

```
- hist bin change
```

Sean Richards notes there was a problem in the way we created the binning for histogram, which made the last bin underrepresented. From his post:

I see that hist uses the linspace function to create the bins and then uses searchsorted to put the values in their correct bin. That's all good but I am confused over the use of linspace for the bin creation. I wouldn't have thought that it does what is needed, to quote the docstring it creates a "Linear spaced array from min to max". For it to work correctly shouldn't the values in the bins array be the same bound for each bin? (i.e. each value should be the lower bound of a bin). To provide the correct bins for hist would it not be something like

```
def bins(xmin, xmax, N):
    if N==1: return xmax
    dx = (xmax-xmin)/N # instead of N-1
    return xmin + dx*arange(N)
```

This suggestion is implemented in 0.81. My test script with these changes does not reveal any bias in the binning

```
from matplotlib.numerix.mlab import randn, rand, zeros, Float
from matplotlib.mlab import hist, mean
```

```
Nbins = 50
Ntests = 200
results = zeros((Ntests,Nbins), typecode=Float)
for i in range(Ntests):
    print 'computing', i
    x = rand(10000)
    n, bins = hist(x, Nbins)
    results[i] = n
print mean(results)
```

### 15.1.18 Changes for 0.83

```
- Made HOME/.matplotlib the new config dir where the matplotlibrc
file, the ttf.cache, and the tex.cache live. The new default
```

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filenames in `.matplotlib` have no leading dot and are not hidden. e.g., the new names are `matplotlibrc`, `tex.cache`, and `ttffont.cache`. This is how ipython does it so it must be right.

If old files are found, a warning is issued and they are moved to the new location.

- `backends/__init__.py` no longer imports `new_figure_manager`, `draw_if_interactive` and `show` from the default backend, but puts these imports into a call to `pylab_setup`. Also, the `Toolbar` is no longer imported from `WX/WXAgg`. New usage:

```
from backends import pylab_setup
new_figure_manager, draw_if_interactive, show = pylab_setup()
```

- Moved `Figure.get_width_height()` to `FigureCanvasBase`. It now returns `int` instead of `float`.

### 15.1.19 Changes for 0.84

Unified argument handling between `hlines` and `vlines`. Both now take optionally a `fmt` argument (as in `plot`) and a keyword args that can be passed onto `Line2D`.

Removed all references to "data clipping" in `rc` and `lines.py` since these were not used and not optimized. I'm sure they'll be resurrected later with a better implementation when needed.

'set' removed - no more deprecation warnings. Use 'setp' instead.

Backend developers: Added `flipud` method to `image` and removed it from `to_str`. Removed `origin` kwarg from `backend.draw_image`. `origin` is handled entirely by the frontend now.

### 15.1.20 Changes for 0.85

Made `xtick` and `ytick` separate props in `rc`

made `pos=None` the default for tick formatters rather than 0 to indicate "not supplied"

Removed "feature" of minor ticks which prevents them from overlapping major ticks. Often you want major and minor ticks at the same place, and can offset the major ticks with the `pad`. This could be made configurable

Changed the internal structure of `contour.py` to a more OO style. Calls to `contour` or `contourf` in `axes.py` or `pylab.py` now return

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a ContourSet object which contains references to the LineCollections or PolyCollections created by the call, as well as the configuration variables that were used. The ContourSet object is a "mappable" if a colormap was used.

Added a clip\_ends kwarg to contourf. From the docstring:

```
* clip_ends = True
    If False, the limits for color scaling are set to the
    minimum and maximum contour levels.
    True (default) clips the scaling limits. Example:
    if the contour boundaries are V = [-100, 2, 1, 0, 1, 2, 100],
    then the scaling limits will be [-100, 100] if clip_ends
    is False, and [-3, 3] if clip_ends is True.
```

Added kwargs linewidths, antialiased, and nchunk to contourf. These are experimental; see the docstring.

Changed Figure.colorbar():

```
kw argument order changed;
if mappable arg is a non-filled ContourSet, colorbar() shows
    lines instead of polygons.
if mappable arg is a filled ContourSet with clip_ends=True,
    the endpoints are not labelled, so as to give the
    correct impression of open-endedness.
```

Changed LineCollection.get\_linewidths to get\_linewidth, for consistency.

### 15.1.21 Changes for 0.86

Matplotlib data is installed into the matplotlib module. This is similar to package\_data. This should get rid of having to check for many possibilities in \_get\_data\_path(). The MATPLOTLIBDATA env key is still checked first to allow for flexibility.

- 1) Separated the color table data from cm.py out into a new file, \_cm.py, to make it easier to find the actual code in cm.py and to add new colormaps. Everything from \_cm.py is imported by cm.py, so the split should be transparent.
- 2) Enabled automatic generation of a colormap from a list of colors in contour; see modified examples/contour\_demo.py.
- 3) Support for imshow of a masked array, with the ability to specify colors (or no color at all) for masked regions, and for regions that are above or below the normally mapped region. See examples/image\_masked.py.
- 4) In support of the above, added two new classes, ListedColormap, and no\_norm, to colors.py, and modified

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the Colormap class to include common functionality. Added a clip kwarg to the normalize class.

### 15.1.22 Changes for 0.87.7

Completely reworked the annotations API because I found the old API cumbersome. The new design is much more legible and easy to read. See `matplotlib.text.Annotation` and `examples/annotation_demo.py`

`markeredgecolor` and `markerfacecolor` cannot be configured in `matplotlibrc` any more. Instead, markers are generally colored automatically based on the color of the line, unless marker colors are explicitly set as kwargs - NN

Changed default comment character for load to '#' - JDH

`math_parse_s_ft2font_svg` from `mathtext.py` & `mathtext2.py` now returns `width`, `height`, `svg_elements`. `svg_elements` is an instance of `Bunch` (`cmbook.py`) and has the attributes `svg_glyphs` and `svg_lines`, which are both lists.

`Renderer.draw_arc` now takes an additional parameter, `rotation`. It specifies to draw the artist rotated in degrees anti-clockwise. It was added for rotated ellipses.

Renamed `Figure.set_figsize_inches` to `Figure.set_size_inches` to better match the get method, `Figure.get_size_inches`.

Removed the `copy_bbox_transform` from `transforms.py`; added shallowcopy methods to all transforms. All transforms already had deepcopy methods.

`FigureManager.resize(width, height)`: resize the window specified in pixels

`barh`: `x` and `y` args have been renamed to `width` and `bottom` respectively, and their order has been swapped to maintain a (position, value) order.

`bar` and `barh`: now accept kwarg 'edgecolor'.

`bar` and `barh`: The left, height, width and bottom args can now all be scalars or sequences; see docstring.

`barh`: now defaults to edge aligned instead of center aligned bars

`bar`, `barh` and `hist`: Added a keyword arg 'align' that controls between edge or center bar alignment.

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Collections: PolyCollection and LineCollection now accept vertices or segments either in the original form [(x,y), (x,y), ...] or as a 2D numerix array, with X as the first column and Y as the second. Contour and quiver output the numerix form. The transforms methods Bbox.update() and Transformation.seq\_xy\_tups() now accept either form.

Collections: LineCollection is now a ScalarMappable like PolyCollection, etc.

Specifying a grayscale color as a float is deprecated; use a string instead, e.g., 0.75 -> '0.75'.

Collections: initializers now accept any mpl color arg, or sequence of such args; previously only a sequence of rgba tuples was accepted.

Colorbar: completely new version and api; see docstring. The original version is still accessible as colorbar\_classic, but is deprecated.

Contourf: "extend" kwarg replaces "clip\_ends"; see docstring. Masked array support added to pcolormesh.

Modified aspect-ratio handling:

Removed aspect kwarg from imshow

Axes methods:

set\_aspect(self, aspect, adjustable=None, anchor=None)

set\_adjustable(self, adjustable)

set\_anchor(self, anchor)

Pylab interface:

axis('image')

Backend developers: ft2font's load\_char now takes a flags argument, which you can OR together from the LOAD\_XXX constants.

### 15.1.23 Changes for 0.90.0

All artists now implement a "pick" method which users should not call. Rather, set the "picker" property of any artist you want to pick on (the epsilon distance in points for a hit test) and register with the "pick\_event" callback. See examples/pick\_event\_demo.py for details

Bar, barh, and hist have "log" binary kwarg: log=True sets the ordinate to a log scale.

Boxplot can handle a list of vectors instead of just

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an array, so vectors can have different lengths.

Plot can handle 2-D x and/or y; it plots the columns.

Added linewidth kwarg to bar and barh.

Made the default Artist.\_transform None (rather than invoking identity\_transform for each artist only to have it overridden later). Use artist.get\_transform() rather than artist.\_transform, even in derived classes, so that the default transform will be created lazily as needed

New LogNorm subclass of Normalize added to colors.py. All Normalize subclasses have new inverse() method, and the \_\_call\_\_() method has a new clip kwarg.

Changed class names in colors.py to match convention: normalize -> Normalize, no\_norm -> NoNorm. Old names are still available for now.

Removed obsolete pcolor\_classic command and method.

Removed lineprops and markerprops from the Annotation code and replaced them with an arrow configurable with kwarg arrowprops. See examples/annotation\_demo.py - JDH

### 15.1.24 Changes for 0.90.1

The file dviread.py has a (very limited and fragile) dvi reader for usetex support. The API might change in the future so don't depend on it yet.

Removed deprecated support for a float value as a gray-scale; now it must be a string, like '0.5'. Added alpha kwarg to ColorConverter.to\_rgba\_list.

New method set\_bounds(vmin, vmax) for formatters, locators sets the viewInterval and dataInterval from floats.

Removed deprecated colorbar\_classic.

Line2D.get\_xdata and get\_ydata valid\_only=False kwarg is replaced by orig=True. When True, it returns the original data, otherwise the processed data (masked, converted)

Some modifications to the units interface. units.ConversionInterface.tickers renamed to units.ConversionInterface.axisinfo and it now returns a units.AxisInfo object rather than a tuple. This will make it easier to add axis info functionality (e.g., I added a default label

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on this iteration) w/o having to change the tuple length and hence the API of the client code every time new functionality is added. Also, `units.ConversionInterface.convert_to_value` is now simply named `units.ConversionInterface.convert`.

`Axes.errorbar` uses `Axes.vlines` and `Axes.hlines` to draw its error limits in the vertical and horizontal direction. As you'll see in the changes below, these functions now return a `LineCollection` rather than a list of lines. The new return signature for `errorbar` is `ylines, caplines, errorcollections` where `errorcollections` is a `xerrcollection, yerrcollection`

`Axes.vlines` and `Axes.hlines` now create and return a `LineCollection`, not a list of lines. This is much faster. The kwarg signature has changed, so consult the docs

`MaxNLocator` accepts a new Boolean kwarg (`'integer'`) to force ticks to integer locations.

Commands that pass an argument to the `Text` constructor or to `Text.set_text()` now accept any object that can be converted with `'%s'`. This affects `xlabel()`, `title()`, etc.

`Barh` now takes a `**kwargs` dict instead of most of the old arguments. This helps ensure that `bar` and `barh` are kept in sync, but as a side effect you can no longer pass e.g., `color` as a positional argument.

`ft2font.get_charmap()` now returns a dict that maps character codes to glyph indices (until now it was reversed)

Moved data files into `lib/matplotlib` so that `setuptools'` `develop` mode works. Re-organized the `mpl-data` layout so that this source structure is maintained in the installation. (i.e., the `'fonts'` and `'images'` sub-directories are maintained in `site-packages`.) Suggest removing `site-packages/matplotlib/mpl-data` and `~/.matplotlib/ttffont.cache` before installing

### 15.1.25 Changes for 0.91.0

- Changed `cbook.is_file_like()` to `cbook.is_writable_file_like()` and corrected behavior.
- Added `ax` kwarg to `pyplot.colorbar()` and `Figure.colorbar()` so that one can specify the axes object from which space for the colorbar is to be taken, if one does not want to make the colorbar axes manually.
- Changed `cbook.reversed()` so it yields a tuple rather than a (index, tuple). This agrees with the python `reversed` builtin, and `cbook` only defines `reversed` if python doesn't provide the builtin.
- Made `skiprows=1` the default on `csv2rec()`
- The `gd` and `paint` backends have been deleted.

- The errorbar method and function now accept additional kwargs so that upper and lower limits can be indicated by capping the bar with a caret instead of a straight line segment.
- The `matplotlib.dviread` file now has a parser for files like `psfonts.map` and `pdftex.map`, to map TeX font names to external files.
- The file `matplotlib.type1font` contains a new class for Type 1 fonts. Currently it simply reads pfa and pfb format files and stores the data in a way that is suitable for embedding in pdf files. In the future the class might actually parse the font to allow e.g., subsetting.
- `matplotlib.FT2Font` now supports `FT_Attach_File()`. In practice this can be used to read an afm file in addition to a pfa/pfb file, to get metrics and kerning information for a Type 1 font.
- The AFM class now supports querying CapHeight and stem widths. The `get_name_char` method now has an `isord` kwarg like `get_width_char`.
- Changed `pcolor()` default to `shading='flat'`; but as noted now in the docstring, it is preferable to simply use the `edgecolor` kwarg.
- The `mathtext` font commands (`\cal`, `\rm`, `\it`, `\tt`) now behave as TeX does: they are in effect until the next font change command or the end of the grouping. Therefore uses of `$_{\cal R}$` should be changed to `$_{\cal R}$`. Alternatively, you may use the new LaTeX-style font commands (`\mathcal`, `\mathrm`, `\mathit`, `\mathtt`) which do affect the following group, e.g., `$_{\mathcal R}$`.
- Text creation commands have a new default `linespacing` and a new `linespacing` kwarg, which is a multiple of the maximum vertical extent of a line of ordinary text. The default is 1.2; `linespacing=2` would be like ordinary double spacing, for example.
- Changed default kwarg in `matplotlib.colors.Normalize.__init__()` to `clip=False`; clipping silently defeats the purpose of the special `over`, `under`, and `bad` values in the `colormap`, thereby leading to unexpected behavior. The new default should reduce such surprises.
- Made the `emit` property of `set_xlim()` and `set_ylim()` `True` by default; removed the Axes custom callback handling into a 'callbacks' attribute which is a `CallbackRegistry` instance. This now supports the 'xlim\_changed' and 'ylim\_changed' Axes events.

### 15.1.26 Changes for 0.91.2

- For `csv2rec()`, `checkrows=0` is the new default indicating all rows will be checked for type inference
- A warning is issued when an image is drawn on log-scaled axes, since it will not log-scale the image data.
- Moved `rec2gtk()` to `matplotlib.toolkits.gtktools`
- Moved `rec2excel()` to `matplotlib.toolkits.exceltools`
- Removed, dead/experimental `ExampleInfo`, `Namespace` and `Importer` code from `matplotlib.__init__`

### 15.1.27 Changes for 0.98.0

- `matplotlib.image.imread()` now no longer always returns RGBA data—if the image is luminance or RGB, it will return a MxN or MxNx3 array if possible. Also `uint8` is no longer

always forced to float.

- Rewrote the `matplotlib.cm.ScalarMappable` callback infrastructure to use `matplotlib.cbook.CallbackRegistry` rather than custom callback handling. Any users of `matplotlib.cm.ScalarMappable.add_observer()` of the `ScalarMappable` should use the `matplotlib.cm.ScalarMappable.callbacks CallbackRegistry` instead.
- New axes function and Axes method provide control over the plot color cycle: `matplotlib.axes.set_default_color_cycle()` and `matplotlib.axes.Axes.set_color_cycle()`.
- Matplotlib now requires Python 2.4, so `matplotlib.cbook` will no longer provide `set`, `enumerate()`, `reversed()` or `izip()` compatibility functions.
- In Numpy 1.0, bins are specified by the left edges only. The axes method `matplotlib.axes.Axes.hist()` now uses future Numpy 1.3 semantics for histograms. Providing `binedges`, the last value gives the upper-right edge now, which was implicitly set to `+infinity` in Numpy 1.0. This also means that the last bin doesn't contain upper outliers any more by default.
- New axes method and pyplot function, `hexbin()`, is an alternative to `scatter()` for large datasets. It makes something like a `pcolor()` of a 2-D histogram, but uses hexagonal bins.
- New kwarg, `symmetric`, in `matplotlib.ticker.MaxNLocator` allows one require an axis to be centered around zero.
- Toolkits must now be imported from `mpl_toolkits` (not `matplotlib.toolkits`)

### Notes about the transforms refactoring

A major new feature of the 0.98 series is a more flexible and extensible transformation infrastructure, written in Python/Numpy rather than a custom C extension.

The primary goal of this refactoring was to make it easier to extend matplotlib to support new kinds of projections. This is mostly an internal improvement, and the possible user-visible changes it allows are yet to come.

See `matplotlib.transforms` for a description of the design of the new transformation framework.

For efficiency, many of these functions return views into Numpy arrays. This means that if you hold on to a reference to them, their contents may change. If you want to store a snapshot of their current values, use the Numpy array method `copy()`.

The view intervals are now stored only in one place - in the `matplotlib.axes.Axes` instance, not in the locator instances as well. This means locators must get their limits from their `matplotlib.axis.Axis`, which in turn looks up its limits from the `Axes`. If a locator is used temporarily and not assigned to an `Axis` or `Axes`, (e.g., in `matplotlib.contour`), a dummy axis must be created to store its bounds. Call `matplotlib.ticker.Locator.create_dummy_axis()` to do so.

The functionality of `Pbox` has been merged with `Bbox`. Its methods now all return copies rather than modifying in place.

The following lists many of the simple changes necessary to update code from the old transformation framework to the new one. In particular, methods that return a copy are named with a verb in the past tense, whereas methods that alter an object in place are named with a verb in the present tense.

matplotlib.transforms

Old method	New method
Bbox.get_bounds()	transforms.Bbox.bounds
Bbox.width()	transforms.Bbox.width
Bbox.height()	transforms.Bbox.height
Bbox.intervalx(). get_bounds()	transforms.Bbox.intervalx
Bbox.intervalx(). set_bounds()	[Bbox.intervalx is now a property.]
Bbox.intervaly(). get_bounds()	transforms.Bbox.intervaly
Bbox.intervaly(). set_bounds()	[Bbox.intervaly is now a property.]
Bbox.xmin()	transforms.Bbox.x0 OR transforms.Bbox.xmin <sup>1</sup>
Bbox.ymin()	transforms.Bbox.y0 OR transforms.Bbox.ymin <sup>1</sup>
Bbox.xmax()	transforms.Bbox.x1 OR transforms.Bbox.xmax <sup>1</sup>
Bbox.ymax()	transforms.Bbox.y1 OR transforms.Bbox.ymax <sup>1</sup>
Bbox.overlaps(bboxes)	Bbox.count_overlaps(bboxes)
bbox_all(bboxes)	Bbox.union(bboxes) [transforms.Bbox.union() is a staticmethod.]
lbwh_to_bbox(l, b, w, h)	Bbox.from_bounds(x0, y0, w, h) [transforms.Bbox.from_bounds() is a staticmethod.]
inverse_transform_bbox(trans, bbox)	Bbox.inverse_transformed(trans)
Interval.contains_open(v)	interval_contains_open(tuple, v)
Interval.contains(v)	interval_contains(tuple, v)
identity_transform()	matplotlib.transforms.IdentityTransform
blend_xy_sep_transform(xtrans, ytrans)	blended_transform_factory(xtrans, ytrans)
scale_transform(xs, ys)	Affine2D().scale(xs[, ys])
get_bbox_transform(boxin, boxout)	BboxTransform(boxin, boxout) OR BboxTransformFrom(boxin) OR BboxTransformTo(boxout)
Transform. seq_xy_tup(points)	Transform.transform(points)
Transform. inverse_xy_tup(points)	Transform.inverted().transform(points)

matplotlib.axes

Old method	New method
Axes.get_position()	matplotlib.axes.Axes.get_position() <sup>2</sup>
Axes.set_position()	matplotlib.axes.Axes.set_position() <sup>3</sup>
Axes.toggle_log_linear()	matplotlib.axes.Axes.set_yscale() <sup>4</sup>
Subplot class	removed.

<sup>1</sup> The *Bbox* is bound by the points (x0, y0) to (x1, y1) and there is no defined order to these points, that is, x0 is not necessarily the left edge of the box. To get the left edge of the *Bbox*, use the read-only property *xmin*.

The Polar class has moved to `matplotlib.projections.polar`.

#### `matplotlib.artist`

Old method	New method
<code>Artist.set_clip_path(path)</code>	<code>Artist.set_clip_path(path, transform)</code> <sup>5</sup>

#### `matplotlib.collections`

Old method	New method
<code>linestyle</code>	<code>linestyles</code> <sup>6</sup>

#### `matplotlib.colors`

Old method	New method
<code>ColorConvertor.to_rgba_list(c)</code>	<code>ColorConvertor.to_rgba_array(c)</code> [ <code>matplotlib.colors.ColorConvertor.to_rgba_array()</code> returns an Nx4 Numpy array of RGBA color quadruples.]

#### `matplotlib.contour`

Old method	New method
<code>Contour._segments</code>	<code>matplotlib.contour.Contour.get_paths^()</code> [Returns a list of <code>matplotlib.path.Path</code> instances.]

#### `matplotlib.figure`

Old method	New method
<code>Figure.dpi.get()</code> / <code>Figure.dpi.set()</code>	<code>matplotlib.figure.Figure.dpi</code> (a property)

<sup>2</sup> `matplotlib.axes.Axes.get_position()` used to return a list of points, now it returns a `matplotlib.transforms.Bbox` instance.

<sup>3</sup> `matplotlib.axes.Axes.set_position()` now accepts either four scalars or a `matplotlib.transforms.Bbox` instance.

<sup>4</sup> Since the refactoring allows for more than two scale types ('log' or 'linear'), it no longer makes sense to have a toggle. `Axes.toggle_log_lineary()` has been removed.

<sup>5</sup> `matplotlib.artist.Artist.set_clip_path()` now accepts a `matplotlib.path.Path` instance and a `matplotlib.transforms.Transform` that will be applied to the path immediately before clipping.

<sup>6</sup> Linestyles are now treated like all other collection attributes, i.e. a single value or multiple values may be provided.

matplotlib.patches

Old method	New method
Patch.get_verts()	<i>matplotlib.patches.Patch.get_path()</i> [Returns a <i>matplotlib.path.Path</i> instance]

matplotlib.backend\_bases

Old method	New method
GraphicsContext.set_clip_rectangle(tuple)	GraphicsContext.set_clip_rectangle(bbox)
GraphicsContext.get_clip_path()	GraphicsContext.get_clip_path() <sup>7</sup>
GraphicsContext.set_clip_path()	GraphicsContext.set_clip_path() <sup>8</sup>

RendererBase

New methods:

- *draw\_path(self, gc, path, transform, rgbFace)*
- *draw\_markers(self, gc, marker\_path, marker\_trans, path, trans, rgbFace)*
- *draw\_path\_collection(self, master\_transform, cliprect, clippath, clippath\_trans, paths, all\_transforms, offsets, offsetTrans, facecolors, edgecolors, linewidths, linestyle, antialiaseds) [optional]*

Changed methods:

- *draw\_image(self, x, y, im, bbox)* is now *draw\_image(self, x, y, im, bbox, clippath, clippath\_trans)*

Removed methods:

- *draw\_arc*
- *draw\_line\_collection*
- *draw\_line*
- *draw\_lines*
- *draw\_point*
- *draw\_quad\_mesh*
- *draw\_poly\_collection*
- *draw\_polygon*
- *draw\_rectangle*
- *draw\_regpoly\_collection*

---

<sup>7</sup> *matplotlib.backend\_bases.GraphicsContext.get\_clip\_path()* returns a tuple of the form (*path*, *affine\_transform*), where *path* is a *matplotlib.path.Path* instance and *affine\_transform* is a *matplotlib.transforms.Affine2D* instance.

<sup>8</sup> *matplotlib.backend\_bases.GraphicsContext.set\_clip\_path()* now only accepts a *matplotlib.transforms.TransformPath* instance.

### 15.1.28 Changes for 0.98.1

- Removed broken `matplotlib.axes3d` support and replaced it with a non-implemented error pointing to 0.91.x

### 15.1.29 Changes for 0.98.x

- `psd()`, `csd()`, and `cohere()` will now automatically wrap negative frequency components to the beginning of the returned arrays. This is much more sensible behavior and makes them consistent with `specgram()`. The previous behavior was more of an oversight than a design decision.
- Added new keyword parameters `nonposx`, `nonposy` to `matplotlib.axes.Axes` methods that set log scale parameters. The default is still to mask out non-positive values, but the kwargs accept 'clip', which causes non-positive values to be replaced with a very small positive value.
- Added new `matplotlib.pyplot.fignum_exists()` and `matplotlib.pyplot.get_fignums()`; they merely expose information that had been hidden in `matplotlib._pylab_helpers`.
- Deprecated `numerix` package.
- Added new `matplotlib.image.imsave()` and exposed it to the `matplotlib.pyplot` interface.
- Remove support for `pyExcelerator` in `exceltools` - use `xlwt` instead
- Changed the defaults of `acorr` and `xcorr` to use `usevlines=True`, `maxlags=10` and `normed=True` since these are the best defaults
- Following keyword parameters for `matplotlib.label.Label` are now deprecated and new set of parameters are introduced. The new parameters are given as a fraction of the font-size. Also, `scatteryoffsets`, `fancybox` and `columnspacing` are added as keyword parameters.

Deprecated	New
<code>pad</code>	<code>borderpad</code>
<code>labelsep</code>	<code>labelspacing</code>
<code>handlelen</code>	<code>handlelength</code>
<code>handlestextsep</code>	<code>handletextpad</code>
<code>axespad</code>	<code>borderaxespad</code>

- Removed the `configobj` and experimental traits `rc` support
- Modified `matplotlib.mlab.psd()`, `matplotlib.mlab.csd()`, `matplotlib.mlab.cohere()`, and `matplotlib.mlab.specgram()` to scale one-sided densities by a factor of 2. Also, optionally scale the densities by the sampling frequency, which gives true values of densities that can be integrated by the returned frequency values. This also gives better MATLAB compatibility. The corresponding `matplotlib.axes.Axes` methods and `matplotlib.pyplot` functions were updated as well.
- Font lookup now uses a nearest-neighbor approach rather than an exact match. Some fonts may be different in plots, but should be closer to what was requested.
- `matplotlib.axes.Axes.set_xlim()`, `matplotlib.axes.Axes.set_ylim()` now return a copy of the `viewlim` array to avoid modify-in-place surprises.

- `matplotlib.afm.AFM.get_fullname()` and `matplotlib.afm.AFM.get_familyname()` no longer raise an exception if the AFM file does not specify these optional attributes, but returns a guess based on the required `FontName` attribute.
- Changed precision kwarg in `matplotlib.pyplot.spy()`; default is 0, and the string value 'present' is used for sparse arrays only to show filled locations.
- `matplotlib.collections.EllipseCollection` added.
- Added `angles` kwarg to `matplotlib.pyplot.quiver()` for more flexible specification of the arrow angles.
- Deprecated (raise `NotImplementedError`) all the `mlab2` functions from `matplotlib.mlab` out of concern that some of them were not clean room implementations.
- Methods `matplotlib.collections.Collection.get_offsets()` and `matplotlib.collections.Collection.set_offsets()` added to `Collection` base class.
- `matplotlib.figure.Figure.figurePatch` renamed `matplotlib.figure.Figure.patch`; `matplotlib.axes.Axes.axesPatch` renamed `matplotlib.axes.Axes.patch`; `matplotlib.axes.Axes.axesFrame` renamed `matplotlib.axes.Axes.frame`. `matplotlib.axes.Axes.get_frame()`, which returns `matplotlib.axes.Axes.patch`, is deprecated.
- Changes in the `matplotlib.contour.ContourLabeler` attributes (`matplotlib.pyplot.clabel()` function) so that they all have a form like `.labelAttribute`. The three attributes that are most likely to be used by end users, `.cl`, `.cl_xy` and `.cl_cvalues` have been maintained for the moment (in addition to their renamed versions), but they are deprecated and will eventually be removed.
- Moved several functions in `matplotlib.mlab` and `matplotlib.cbook` into a separate module `matplotlib.numerical_methods` because they were unrelated to the initial purpose of `mlab` or `cbook` and appeared more coherent elsewhere.

### 15.1.30 Changes in 0.99

- `pylab` no longer provides a load and save function. These are available in `matplotlib.mlab`, or you can use `numpy.loadtxt` and `numpy.savetxt` for text files, or `np.save` and `np.load` for binary numpy arrays.
- User-generated colormaps can now be added to the set recognized by `matplotlib.cm.get_cmap()`. Colormaps can be made the default and applied to the current image using `matplotlib.pyplot.set_cmap()`.
- changed `use_mrecords` default to `False` in `mlab.csv2rec` since this is partially broken
- Axes instances no longer have a "frame" attribute. Instead, use the new "spines" attribute. Spines is a dictionary where the keys are the names of the spines (e.g., 'left', 'right' and so on) and the values are the artists that draw the spines. For normal (rectilinear) axes, these artists are `Line2D` instances. For other axes (such as polar axes), these artists may be `Patch` instances.
- Polar plots no longer accept a resolution kwarg. Instead, each `Path` must specify its own number of interpolation steps. This is unlikely to be a user-visible change - if interpolation of data is required, that should be done before passing it to Matplotlib.

### 15.1.31 Changes beyond 0.99.x

- The default behavior of `matplotlib.axes.Axes.set_xlim()`, `matplotlib.axes.Axes.set_ylim()`, and `matplotlib.axes.Axes.axis()`, and their corresponding pyplot functions, has been changed: when view limits are set explicitly with one of these methods, autoscaling is turned off for the matching axis. A new `auto` kwarg is available to control this behavior. The limit kwargs have been renamed to `left` and `right` instead of `xmin` and `xmax`, and `bottom` and `top` instead of `ymin` and `ymax`. The old names may still be used, however.
- There are five new Axes methods with corresponding pyplot functions to facilitate autoscaling, tick location, and tick label formatting, and the general appearance of ticks and tick labels:
  - `matplotlib.axes.Axes.autoscale()` turns autoscaling on or off, and applies it.
  - `matplotlib.axes.Axes.margins()` sets margins used to autoscale the `matplotlib.axes.Axes.viewLim` based on the `matplotlib.axes.Axes.dataLim`.
  - `matplotlib.axes.Axes.locator_params()` allows one to adjust axes locator parameters such as `nbins`.
  - `matplotlib.axes.Axes.ticklabel_format()` is a convenience method for controlling the `matplotlib.ticker.ScalarFormatter` that is used by default with linear axes.
  - `matplotlib.axes.Axes.tick_params()` controls direction, size, visibility, and color of ticks and their labels.
- The `matplotlib.axes.Axes.bar()` method accepts a `error_kw` kwarg; it is a dictionary of kwargs to be passed to the errorbar function.
- The `matplotlib.axes.Axes.hist()` `color` kwarg now accepts a sequence of color specs to match a sequence of datasets.
- The `EllipseCollection` has been changed in two ways:
  - There is a new `units` option, 'xy', that scales the ellipse with the data units. This matches the `:class:~matplotlib.patches.Ellipse` scaling.
  - The `height` and `width` kwargs have been changed to specify the height and width, again for consistency with `Ellipse`, and to better match their names; previously they specified the half-height and half-width.
- There is a new rc parameter `axes.color_cycle`, and the color cycle is now independent of the rc parameter `lines.color`. `matplotlib.Axes.set_default_color_cycle()` is deprecated.
- You can now print several figures to one pdf file and modify the document information dictionary of a pdf file. See the docstrings of the class `matplotlib.backends.backend_pdf.PdfPages` for more information.
- Removed `configobj` and `enthought.traits` packages, which are only required by the experimental traitled config and are somewhat out of date. If needed, install them independently.
- The new rc parameter `savefig.extension` sets the filename extension that is used by `matplotlib.figure.Figure.savefig()` if its `fname` argument lacks an extension.
- In an effort to simplify the backend API, all clipping rectangles and paths are now passed in using `GraphicsContext` objects, even on collections and images. Therefore:

```

draw_path_collection(self, master_transform, cliprect, clippath,
                    clippath_trans, paths, all_transforms, offsets,
                    offsetTrans, facecolors, edgecolors, linewidths,
                    linestyles, antialiaseds, urls)

# is now

draw_path_collection(self, gc, master_transform, paths, all_transforms,
                    offsets, offsetTrans, facecolors, edgecolors,
                    linewidths, linestyles, antialiaseds, urls)

draw_quad_mesh(self, master_transform, cliprect, clippath,
               clippath_trans, meshWidth, meshHeight, coordinates,
               offsets, offsetTrans, facecolors, antialiased,
               showedges)

# is now

draw_quad_mesh(self, gc, master_transform, meshWidth, meshHeight,
               coordinates, offsets, offsetTrans, facecolors,
               antialiased, showedges)

draw_image(self, x, y, im, bbox, clippath=None, clippath_trans=None)

# is now

draw_image(self, gc, x, y, im)

```

- There are four new Axes methods with corresponding pyplot functions that deal with unstructured triangular grids:
  - `matplotlib.axes.Axes.tricontour()` draws contour lines on a triangular grid.
  - `matplotlib.axes.Axes.tricontourf()` draws filled contours on a triangular grid.
  - `matplotlib.axes.Axes.tripcolor()` draws a pseudocolor plot on a triangular grid.
  - `matplotlib.axes.Axes.triplot()` draws a triangular grid as lines and/or markers.

### 15.1.32 Changes in 1.1.x

- Added new `matplotlib.sankey.Sankey` for generating Sankey diagrams.
- In `imshow()`, setting `interpolation` to 'nearest' will now always mean that the nearest-neighbor interpolation is performed. If you want the no-op interpolation to be performed, choose 'none'.
- There were errors in how the tri-functions were handling input parameters that had to be fixed. If your tri-plots are not working correctly anymore, or you were working around apparent mistakes, please see issue #203 in the github tracker. When in doubt, use kwargs.
- The 'symlog' scale had some bad behavior in previous versions. This has now been fixed and users should now be able to use it without frustrations. The fixes did result in some

minor changes in appearance for some users who may have been depending on the bad behavior.

- There is now a common set of markers for all plotting functions. Previously, some markers existed only for `scatter()` or just for `plot()`. This is now no longer the case. This merge did result in a conflict. The string 'd' now means "thin diamond" while 'D' will mean "regular diamond".

### 15.1.33 Changes in 1.2.x

- The `classic` option of the `rc` parameter `toolbar` is deprecated and will be removed in the next release.
- The `isvector()` method has been removed since it is no longer functional.
- The `rasterization_zorder` property on `Axes` a `zorder` below which artists are rasterized. This has defaulted to `-30000.0`, but it now defaults to `None`, meaning no artists will be rasterized. In order to rasterize artists below a given `zorder` value, `set_rasterization_zorder` must be explicitly called.
- In `scatter()`, and `scatter`, when specifying a marker using a tuple, the angle is now specified in degrees, not radians.
- Using `twinx()` or `twiny()` no longer overrides the current locaters and formatters on the axes.
- In `contourf()`, the handling of the `extend` kwarg has changed. Formerly, the extended ranges were mapped after to 0, 1 after being normed, so that they always corresponded to the extreme values of the colormap. Now they are mapped outside this range so that they correspond to the special colormap values determined by the `set_under()` and `set_over()` methods, which default to the colormap end points.
- The new `rc` parameter `savefig.format` replaces `cairo.format` and `savefig.extension`, and sets the default file format used by `matplotlib.figure.Figure.savefig()`.
- In `pie()` and `pie()`, one can now set the radius of the pie; setting the `radius` to 'None' (the default value), will result in a pie with a radius of 1 as before.
- Use of `projection_factory()` is now deprecated in favour of axes class identification using `process_projection_requirements()` followed by direct axes class invocation (at the time of writing, functions which do this are: `add_axes()`, `add_subplot()` and `gca()`). Therefore:

```
key = figure._make_key(*args, **kwargs)
ispolar = kwargs.pop('polar', False)
projection = kwargs.pop('projection', None)
if ispolar:
    if projection is not None and projection != 'polar':
        raise ValueError('polar and projection args are inconsistent')
    projection = 'polar'
ax = projection_factory(projection, self, rect, **kwargs)
key = self._make_key(*args, **kwargs)

# is now

projection_class, kwargs, key = \
    process_projection_requirements(self, *args, **kwargs)
ax = projection_class(self, rect, **kwargs)
```

This change means that third party objects can expose themselves as Matplotlib axes by providing a `_as_mpl_axes` method. See *Developer's guide for creating scales and transformations* for more detail.

- A new keyword `extendfrac` in `colorbar()` and `ColorbarBase` allows one to control the size of the triangular minimum and maximum extensions on colorbars.
- A new keyword `capthick` in `errorbar()` has been added as an intuitive alias to the `markeredgewidth` and `mew` keyword arguments, which indirectly controlled the thickness of the caps on the errorbars. For backwards compatibility, specifying either of the original keyword arguments will override any value provided by `capthick`.
- Transform subclassing behaviour is now subtly changed. If your transform implements a non-affine transformation, then it should override the `transform_non_affine` method, rather than the generic `transform` method. Previously transforms would define `transform` and then copy the method into `transform_non_affine`:

```
class MyTransform(mtransforms.Transform):
    def transform(self, xy):
        ...
    transform_non_affine = transform
```

This approach will no longer function correctly and should be changed to:

```
class MyTransform(mtransforms.Transform):
    def transform_non_affine(self, xy):
        ...
```

- Artists no longer have `x_isdata` or `y_isdata` attributes; instead any artist's transform can be interrogated with `artist_instance.get_transform().contains_branch(ax.transData)`
- Lines added to an axes now take into account their transform when updating the data and view limits. This means transforms can now be used as a pre-transform. For instance:

```
>>> import matplotlib.pyplot as plt
>>> import matplotlib.transforms as mtransforms
>>> ax = plt.axes()
>>> ax.plot(range(10), transform=mtransforms.Affine2D().scale(10) + ax.transData)
>>> print(ax.viewLim)
Bbox('array([[ 0.,  0.],\n           [ 90.,  90.]])')
```

- One can now easily get a transform which goes from one transform's coordinate system to another, in an optimized way, using the new `subtract` method on a transform. For instance, to go from data coordinates to axes coordinates:

```
>>> import matplotlib.pyplot as plt
>>> ax = plt.axes()
>>> data2ax = ax.transData - ax.transAxes
>>> print(ax.transData.depth, ax.transAxes.depth)
3, 1
>>> print(data2ax.depth)
2
```

for versions before 1.2 this could only be achieved in a sub-optimal way, using `ax.transData + ax.transAxes.inverted()` (depth is a new concept, but had it existed it would return 4 for this example).

- `twinx` and `twiny` now returns an instance of `SubplotBase` if parent axes is an instance of `SubplotBase`.
- All Qt3-based backends are now deprecated due to the lack of py3k bindings. Qt and QtAgg backends will continue to work in v1.2.x for py2.6 and py2.7. It is anticipated that the Qt3 support will be completely removed for the next release.
- `ColorConverter`, `Colormap` and `Normalize` now subclasses `object`
- `ContourSet` instances no longer have a `transform` attribute. Instead, access the transform with the `get_transform` method.

### 15.1.34 Changes in 1.3.x

#### Changes in 1.3.1

It is rare that we make an API change in a bugfix release, however, for 1.3.1 since 1.3.0 the following change was made:

- `text.Text.cached` (used to cache font objects) has been made into a private variable. Among the obvious encapsulation benefit, this removes this confusing-looking member from the documentation.
- The method `hist()` now always returns bin occupancies as an array of type `float`. Previously, it was sometimes an array of type `int`, depending on the call.

#### Code removal

- The following items that were deprecated in version 1.2 or earlier have now been removed completely.
  - The Qt 3.x backends (`qt` and `qtagg`) have been removed in favor of the Qt 4.x backends (`qt4` and `qt4agg`).
  - The `FltkAgg` and `Emf` backends have been removed.
  - The `matplotlib.nxutils` module has been removed. Use the functionality on `matplotlib.path.Path.contains_point` and friends instead.
  - Instead of `axes.Axes.get_frame`, use `axes.Axes.patch`.
  - The following `kwargs` to the `legend` function have been renamed:
    - \* `pad` -> `borderpad`
    - \* `labelsep` -> `labelspacing`
    - \* `handlelen` -> `handlelength`
    - \* `handletextsep` -> `handletextpad`
    - \* `axespad` -> `borderaxespad`

Related to this, the following `rcParams` have been removed:

- \* `legend.pad`, `legend.labelsep`, `legend.handlelen`, `legend.handletextsep` and `legend.axespad`
- For the `hist` function, instead of `width`, use `rwidth` (relative width).

- On `patches.Circle`, the resolution kwarg has been removed. For a circle made up of line segments, use `patches.CirclePolygon`.
- The printing functions in the Wx backend have been removed due to the burden of keeping them up-to-date.
- `mlab.liaupunov` has been removed.
- `mlab.save`, `mlab.load`, `pylab.save` and `pylab.load` have been removed. We recommend using `numpy.savetxt` and `numpy.loadtxt` instead.
- `widgets.HorizontalSpanSelector` has been removed. Use `widgets.SpanSelector` instead.

### Code deprecation

- The CocoaAgg backend has been deprecated, with the possibility for deletion or resurrection in a future release.
- The top-level functions in `matplotlib.path` that are implemented in C++ were never meant to be public. Instead, users should use the Pythonic wrappers for them in the `path.Path` and `collections.Collection` classes. Use the following mapping to update your code:
  - `point_in_path` -> `path.Path.contains_point`
  - `get_path_extents` -> `path.Path.get_extents`
  - `point_in_path_collection` -> `collection.Collection.contains`
  - `path_in_path` -> `path.Path.contains_path`
  - `path_intersects_path` -> `path.Path.intersects_path`
  - `convert_path_to_polygons` -> `path.Path.to_polygons`
  - `cleanup_path` -> `path.Path.cleaned`
  - `points_in_path` -> `path.Path.contains_points`
  - `clip_path_to_rect` -> `path.Path.clip_to_bbox`
- `matplotlib.colors.normalize` and `matplotlib.colors.no_norm` have been deprecated in favour of `matplotlib.colors.Normalize` and `matplotlib.colors.NoNorm` respectively.
- The `ScalarMappable` class' `set_colorbar` is now deprecated. Instead, the `matplotlib.cm.ScalarMappable.colorbar` attribute should be used. In previous Matplotlib versions this attribute was an undocumented tuple of (`colorbar_instance`, `colorbar_axes`) but is now just `colorbar_instance`. To get the colorbar axes it is possible to just use the `ax` attribute on a colorbar instance.
- The `mpl` module is now deprecated. Those who relied on this module should transition to simply using `import matplotlib as mpl`.

### Code changes

- `Patch` now fully supports using RGBA values for its `facecolor` and `edgecolor` attributes, which enables faces and edges to have different alpha values. If the `Patch` object's `alpha` attribute is set to anything other than `None`, that value will override any alpha-channel

value in both the face and edge colors. Previously, if *Patch* had `alpha=None`, the alpha component of `edgecolor` would be applied to both the edge and face.

- The optional `isRGB` argument to `set_foreground()` (and the other `GraphicsContext` classes that descend from it) has been renamed to `isRGBA`, and should now only be set to `True` if the `fg` color argument is known to be an `RGBA` tuple.
- For *Patch*, the `capstyle` used is now `butt`, to be consistent with the default for most other objects, and to avoid problems with non-solid `linestyle` appearing solid when using a large `linewidth`. Previously, *Patch* used `capstyle='projecting'`.
- `Path` objects can now be marked as `readonly` by passing `readonly=True` to its constructor. The built-in path singletons, obtained through `Path.unit*` class methods return `readonly` paths. If you have code that modified these, you will need to make a `deepcopy` first, using either:

```
import copy
path = copy.deepcopy(Path.unit_circle())

# or

path = Path.unit_circle().deepcopy()
```

Deep copying a `Path` always creates an editable (i.e. non-readonly) `Path`.

- The list at `Path.NUM_VERTICES` was replaced by a dictionary mapping `Path` codes to the number of expected vertices at `NUM_VERTICES_FOR_CODE`.
- To support XKCD style plots, the `matplotlib.path.cleanup_path()` method's signature was updated to require a `sketch` argument. Users of `matplotlib.path.cleanup_path()` are encouraged to use the new `cleaned()` `Path` method.
- Data limits on a plot now start from a state of having "null" limits, rather than limits in the range (0, 1). This has an effect on artists that only control limits in one direction, such as `axvline` and `axhline`, since their limits will not longer also include the range (0, 1). This fixes some problems where the computed limits would be dependent on the order in which artists were added to the axes.
- Fixed a bug in setting the position for the right/top spine with data position type. Previously, it would draw the right or top spine at +1 data offset.
- In *FancyArrow*, the default arrow head width, `head_width`, has been made larger to produce a visible arrow head. The new value of this kwarg is `head_width = 20 * width`.
- It is now possible to provide number of levels + 1 colors in the case of `extend='both'` for `contourf` (or just number of levels colors for an `extend` value `min` or `max`) such that the resulting `colormap`'s `set_under` and `set_over` are defined appropriately. Any other number of colors will continue to behave as before (if more colors are provided than levels, the colors will be unused). A similar change has been applied to `contour`, where `extend='both'` would expect number of levels + 2 colors.
- A new keyword `extendrect` in `colorbar()` and `ColorbarBase` allows one to control the shape of colorbar extensions.
- The extension of *MultiCursor* to both vertical (default) and/or horizontal cursor implied that `self.line` is replaced by `self.vline` for vertical cursors lines and `self.hline` is added for the horizontal cursors lines.
- On POSIX platforms, the `report_memory()` function raises `NotImplementedError` instead of `OSError` if the `ps` command cannot be run.

- The `matplotlib.cbook.check_output()` function has been moved to `matplotlib.compat.subprocess()`.

### Configuration and rcParams

- On Linux, the user-specific `matplotlibrc` configuration file is now located in `config/matplotlib/matplotlibrc` to conform to the [XDG Base Directory Specification](#).
- The `font.*` rcParams now affect only text objects created after the rcParam has been set, and will not retroactively affect already existing text objects. This brings their behavior in line with most other rcParams.
- Removed call of `grid()` in `plotfile()`. To draw the axes grid, set the `axes.grid` rcParam to `True`, or explicitly call `grid()`.

## 15.1.35 Changes in 1.4.x

### Code changes

- A major refactoring of the axes module was made. The axes module has been split into smaller modules:
  - the `_base` module, which contains a new private `_AxesBase` class. This class contains all methods except plotting and labelling methods.
  - the `axes` module, which contains the `Axes` class. This class inherits from `_AxesBase`, and contains all plotting and labelling methods.
  - the `_subplot` module, with all the classes concerning subplotting.

There are a couple of things that do not exist in the `axes` module's namespace anymore. If you use them, you need to import them from their original location:

- `math` -> `import math`
- `ma` -> `from numpy import ma`
- `cbook` -> `from matplotlib import cbook`
- `docstring` -> `from matplotlib import docstring`
- `is_sequence_of_strings` -> `from matplotlib.cbook import is_sequence_of_strings`
- `is_string_like` -> `from matplotlib.cbook import is_string_like`
- `iterable` -> `from matplotlib.cbook import iterable`
- `itertools` -> `import itertools`
- `matplotlib` -> `from matplotlib import artist as matplotlib`
- `matplotlib` -> `import matplotlib`
- `mcoll` -> `from matplotlib import collections as mcoll`
- `mcolors` -> `from matplotlib import colors as mcolors`
- `mcontour` -> `from matplotlib import contour as mcontour`
- `mpatches` -> `from matplotlib import patches as mpatches`
- `mpath` -> `from matplotlib import path as mpath`

- `mquiver` -> `from matplotlib import quiver as mquiver`
- `mstack` -> `from matplotlib import stack as mstack`
- `mstream` -> `from matplotlib import stream as mstream`
- `mtable` -> `from matplotlib import table as mtable`
- As part of the refactoring to enable Qt5 support, the module `matplotlib.backends.qt4_compat` was renamed to `matplotlib.qt_compat`. `qt4_compat` is deprecated in 1.4 and will be removed in 1.5.
- The `errorbar()` method has been changed such that the upper and lower limits (*lolims*, *uplims*, *xlolims*, *xuplims*) now point in the correct direction.
- The `fmt` kwarg for `plot()` defaults.
- A bug has been fixed in the path effects rendering of fonts, which now means that the font size is consistent with non-path effect fonts. See <https://github.com/matplotlib/matplotlib/issues/2889> for more detail.
- The Sphinx extensions `ipython_directive` and `ipython_console_highlighting` have been moved to the IPython project itself. While they remain in Matplotlib for this release, they have been deprecated. Update your extensions in `conf.py` to point to `IPython.sphinxext.ipython_directive` instead of `matplotlib.sphinxext.ipython_directive`.
- In `finance`, almost all functions have been deprecated and replaced with a pair of functions name `*_ochl` and `*_ohlc`. The former is the 'open-close-high-low' order of quotes used previously in this module, and the latter is the 'open-high-low-close' order that is standard in finance.
- For consistency the `face_alpha` keyword to `matplotlib.patheffects.SimplePatchShadow` has been deprecated in favour of the `alpha` keyword. Similarly, the keyword `offset_xy` is now named `offset` across all `_Base`` has been renamed to `matplotlib.patheffects.AbstractPathEffect`. `matplotlib.patheffect.ProxyRenderer` has been renamed to `matplotlib.patheffects.PathEffectRenderer` and is now a full `RendererBase` subclass.
- The artist used to draw the outline of a `colorbar` has been changed from a `matplotlib.lines.Line2D` to `matplotlib.patches.Polygon`, thus `colorbar.ColorbarBase.outline` is now a `matplotlib.patches.Polygon` object.
- The legend handler interface has changed from a callable, to any object which implements the `legend_artists` method (a deprecation phase will see this interface be maintained for v1.4). See *Legend guide* for further details. Further legend changes include:
  - `matplotlib.axes.Axes._get_legend_handles()` now returns a generator of handles, rather than a list.
  - The `legend()` function's "loc" positional argument has been deprecated. Use the "loc" keyword instead.
- The `rcParams.savefig.transparent` has been added to control default transparency when saving figures.
- Slightly refactored the `Annotation` family. The text location in `Annotation` is now handled entirely handled by the underlying `Text` object so `set_position` works as expected. The attributes `xytext` and `textcoords` have been deprecated in favor of `xyann` and `anncoords` so that `Annotation` and `AnnotationBbox` can share a common sensibly named api for getting/setting the location of the text or box.
  - `xyann` -> set the location of the annotation
  - `xy` -> set where the arrow points to

- `anncoords` -> set the units of the annotation location
- `xycoords` -> set the units of the point location
- `set_position()` -> Annotation only set location of annotation
- `matplotlib.mlab.specgram`, `matplotlib.mlab.psd`, `matplotlib.mlab.csd`, `matplotlib.mlab.cohere`, `matplotlib.mlab.cohere_pairs`, `matplotlib.pyplot.specgram`, `matplotlib.pyplot.psd`, `matplotlib.pyplot.csd`, and `matplotlib.pyplot.cohere` now raise `ValueError` where they previously raised `AssertionError`.
- For `matplotlib.mlab.psd`, `matplotlib.mlab.csd`, `matplotlib.mlab.cohere`, `matplotlib.mlab.cohere_pairs`, `matplotlib.pyplot.specgram`, `matplotlib.pyplot.psd`, `matplotlib.pyplot.csd`, and `matplotlib.pyplot.cohere`, in cases where a shape `(n, 1)` array is returned, this is now converted to a `(n, )` array. Previously, `(n, m)` arrays were averaged to an `(n, )` array, but `(n, 1)` arrays were returned unchanged. This change makes the dimensions consistent in both cases.
- Added the rcParam `axes.formatter.useoffset` to control the default value of `useOffset` in `ticker.ScalarFormatter`
- Added `Formatter` sub-class `StrMethodFormatter` which does the exact same thing as `FormatStrFormatter`, but for new-style formatting strings.
- Deprecated `matplotlib.testing.image_util` and the only function within, `matplotlib.testing.image_util.autocontrast`. These will be removed completely in v1.5.0.
- The `fmt` argument of `plot_date()` has been changed from `bo` to just `o`, so color cycling can happen by default.
- Removed the class `FigureManagerQTAgg` and deprecated `NavigationToolbar2QTAgg` which will be removed in 1.5.
- Removed formerly public (non-prefixed) attributes `rect` and `drawRect` from `FigureCanvasQTAgg`; they were always an implementation detail of the (preserved) `drawRectangle()` function.
- The function signatures of `tight_bbox.adjust_bbox` and `tight_bbox.process_figure_for_rasterizing` have been changed. A new `fixed_dpi` parameter allows for overriding the `figure.dpi` setting instead of trying to deduce the intended behaviour from the file format.
- Added support for horizontal/vertical axes padding to `mpl_toolkits.axes_grid1.ImageGrid` — argument `axes_pad` can now be tuple-like if separate axis padding is required. The original behavior is preserved.
- Added support for skewed transforms to `matplotlib.transforms.Affine2D`, which can be created using the `skew` and `skew_deg` methods.
- Added clockwise parameter to control sectors direction in `axes.pie`
- In `matplotlib.lines.Line2D` the `markevery` functionality has been extended. Previously an integer start-index and stride-length could be specified using either a two-element-list or a two-element-tuple. Now this can only be done using a two-element-tuple. If a two-element-list is used then it will be treated as numpy fancy indexing and only the two markers corresponding to the given indexes will be shown.
- removed prop kwarg from `mpl_toolkits.axes_grid1.anchored_artists.AnchoredSizeBar` call. It was passed through to the base-class `__init__` and is only used for setting padding. Now `fontproperties` (which is what is really used to set the font properties of `AnchoredSizeBar`) is passed through in place of `prop`. If `fontproperties` is not passed

in, but `prop` is, then `prop` is used in place of `fontproperties`. If both are passed in, `prop` is silently ignored.

- The use of the index 0 in `plt.subplot` and related commands is deprecated. Due to a lack of validation calling `plt.subplots(2, 2, 0)` does not raise an exception, but puts an axes in the `_last_` position. This is due to the indexing in subplot being 1-based (to mirror MATLAB) so before indexing into the `GridSpec` object used to determine where the axes should go, 1 is subtracted off. Passing in 0 results in passing -1 to `GridSpec` which results in getting the last position back. Even though this behavior is clearly wrong and not intended, we are going through a deprecation cycle in an abundance of caution that any users are exploiting this 'feature'. The use of 0 as an index will raise a warning in 1.4 and an exception in 1.5.
- Clipping is now off by default on offset boxes.
- Matplotlib now uses a less-aggressive call to `gc.collect(1)` when closing figures to avoid major delays with large numbers of user objects in memory.
- The default clip value of *all* pie artists now defaults to `False`.

### Code removal

- Removed `mlab.levypdf`. The code raised a numpy error (and has for a long time) and was not the standard form of the Levy distribution. `scipy.stats.levy` should be used instead

## 15.1.36 Changes in 1.5.0

### Code Changes

Reversed `matplotlib.cbook.ls_mapper`, added `ls_mapper_r`

Formerly, `matplotlib.cbook.ls_mapper` was a dictionary with the long-form line-style names ("solid") as keys and the short forms ("-") as values. This long-to-short mapping is now done by `ls_mapper_r`, and the short-to-long mapping is done by the `ls_mapper`.

### Prevent moving artists between Axes, Property-ify Artist.axes, deprecate Artist.{get,set}\_axes

This was done to prevent an Artist that is already associated with an Axes from being moved/added to a different Axes. This was never supported as it causes havoc with the transform stack. The apparent support for this (as it did not raise an exception) was the source of multiple bug reports and questions on SO.

For almost all use-cases, the assignment of the axes to an artist should be taken care of by the axes as part of the `Axes.add_*` method, hence the deprecation of `{get,set}_axes`.

Removing the `set_axes` method will also remove the 'axes' line from the ACCEPTS kwarg tables (assuming that the removal date gets here before that gets overhauled).

### Tightened input validation on 'pivot' kwarg to quiver

Tightened validation so that only {'tip', 'tail', 'mid', and 'middle'} (but any capitalization) are valid values for the 'pivot' kwarg in the `Quiver.__init__` (and hence `Axes.quiver` and `plt.`

quiver which both fully delegate to Quiver). Previously any input matching 'mid.\*' would be interpreted as 'middle', 'tip.\*' as 'tip' and any string not matching one of those patterns as 'tail'.

The value of `Quiver.pivot` is normalized to be in the set {'tip', 'tail', 'middle'} in `Quiver.__init__`.

### Reordered `Axes.get_children`

The artist order returned by `Axes.get_children` did not match the one used by `Axes.draw`. They now use the same order, as `Axes.draw` now calls `Axes.get_children`.

### Changed behaviour of contour plots

The default behaviour of `contour()` and `contourf()` when using a masked array is now determined by the new keyword argument `corner_mask`, or if this is not specified then the new rcParam `contour.corner_mask` instead. The new default behaviour is equivalent to using `corner_mask=True`; the previous behaviour can be obtained using `corner_mask=False` or by changing the rcParam. The example [http://matplotlib.org/examples/pylab\\_examples/contour\\_corner\\_mask.html](http://matplotlib.org/examples/pylab_examples/contour_corner_mask.html) demonstrates the difference. Use of the old contouring algorithm, which is obtained with `corner_mask='legacy'`, is now deprecated.

Contour labels may now appear in different places than in earlier versions of Matplotlib.

In addition, the keyword argument `nchunk` now applies to `contour()` as well as `contourf()`, and it subdivides the domain into subdomains of exactly `nchunk` by `nchunk` quads, whereas previously it was only roughly `nchunk` by `nchunk` quads.

The C/C++ object that performs contour calculations used to be stored in the public attribute `QuadContourSet.Cntr`, but is now stored in a private attribute and should not be accessed by end users.

### Added `set_params` function to all Locator types

This was a bug fix targeted at making the api for Locators more consistent.

In the old behavior, only locators of type `MaxNLocator` have `set_params()` defined, causing its use on any other Locator to raise an `AttributeError` (*aside: `set_params(args)` is a function that sets the parameters of a Locator instance to be as specified within args*). The fix involves moving `set_params()` to the Locator class such that all subtypes will have this function defined.

Since each of the Locator subtypes have their own modifiable parameters, a universal `set_params()` in Locator isn't ideal. Instead, a default no-operation function that raises a warning is implemented in Locator. Subtypes extending Locator will then override with their own implementations. Subtypes that do not have a need for `set_params()` will fall back onto their parent's implementation, which raises a warning as intended.

In the new behavior, Locator instances will not raise an `AttributeError` when `set_params()` is called. For Locators that do not implement `set_params()`, the default implementation in Locator is used.

**Disallow `None` as x or y value in `ax.plot`**

Do not allow `None` as a valid input for the x or y args in `ax.plot`. This may break some user code, but this was never officially supported (ex documented) and allowing `None` objects through can lead to confusing exceptions downstream.

To create an empty line use

```
ln1, = ax.plot([], [], ...)
ln2, = ax.plot([], ...)
```

In either case to update the data in the `Line2D` object you must update both the x and y data.

**Removed args and kwargs from `MicrosecondLocator.__call__`**

The call signature of `__call__()` has changed from `__call__(self, *args, **kwargs)` to `__call__(self)`. This is consistent with the superclass `Locator` and also all the other `Locators` derived from this superclass.

**No `ValueError` for the `MicrosecondLocator` and `YearLocator`**

The `MicrosecondLocator` and `YearLocator` objects when called will return an empty list if the axes have no data or the view has no interval. Previously, they raised a `ValueError`. This is consistent with all the `Date Locators`.

**'`OffsetBox.DrawingArea`' respects the 'clip' keyword argument**

The call signature was `OffsetBox.DrawingArea(..., clip=True)` but nothing was done with the `clip` argument. The object did not do any clipping regardless of that parameter. Now the object can and does clip the child `Artists` if they are set to be clipped.

You can turn off the clipping on a per-child basis using `child.set_clip_on(False)`.

**Add salt to `clipPath` id**

Add salt to the hash used to determine the id of the `clipPath` nodes. This is to avoid conflicts when two `svg` documents with the same clip path are included in the same document (see <https://github.com/ipython/ipython/issues/8133> and <https://github.com/matplotlib/matplotlib/issues/4349>), however this means that the `svg` output is no longer deterministic if the same figure is saved twice. It is not expected that this will affect any users as the current ids are generated from an md5 hash of properties of the clip path and any user would have a very difficult time anticipating the value of the id.

**Changed snap threshold for circle markers to `inf`**

When drawing circle markers above some marker size (previously 6.0) the path used to generate the marker was snapped to pixel centers. However, this ends up distorting the marker away from a circle. By setting the snap threshold to `inf` snapping is never done on circles.

This change broke several tests, but is an improvement.

### Preserve units with Text position

Previously the 'get\_position' method on Text would strip away unit information even though the units were still present. There was no inherent need to do this, so it has been changed so that unit data (if present) will be preserved. Essentially a call to 'get\_position' will return the exact value from a call to 'set\_position'.

If you wish to get the old behaviour, then you can use the new method called 'get\_unitless\_position'.

### New API for custom Axes view changes

Interactive pan and zoom were previously implemented using a Cartesian-specific algorithm that was not necessarily applicable to custom Axes. Three new private methods, `_get_view()`, `_set_view()`, and `_set_view_from_bbox()`, allow for custom Axes classes to override the pan and zoom algorithms. Implementors of custom Axes who override these methods may provide suitable behaviour for both pan and zoom as well as the view navigation buttons on the interactive toolbars.

### MathTex visual changes

The spacing commands in `mathtext` have been changed to more closely match vanilla TeX.

### Improved spacing in mathtext

The extra space that appeared after subscripts and superscripts has been removed.

### No annotation coordinates wrap

In #2351 for 1.4.0 the behavior of ['axes points', 'axes pixel', 'figure points', 'figure pixel'] as coordinates was change to no longer wrap for negative values. In 1.4.3 this change was reverted for 'axes points' and 'axes pixel' and in addition caused 'axes fraction' to wrap. For 1.5 the behavior has been reverted to as it was in 1.4.0-1.4.2, no wrapping for any type of coordinate.

### Deprecation

#### Deprecated `GraphicsContextBase.set_graylevel`

The `GraphicsContextBase.set_graylevel` function has been deprecated in 1.5 and will be removed in 1.6. It has been unused. The `GraphicsContextBase.set_foreground` could be used instead.

### deprecated `idle_event`

The `idle_event` was broken or missing in most backends and causes spurious warnings in some cases, and its use in creating animations is now obsolete due to the `animations` module. Therefore code involving it has been removed from all but the `wx` backend (where it partially works), and its use is deprecated. The `animations` module may be used instead to create animations.

### `color_cycle` deprecated

In light of the new property cycling feature, the Axes method `set_color_cycle` is now deprecated. Calling this method will replace the current property cycle with one that cycles just the given colors.

Similarly, the rc parameter `axes.color_cycle` is also deprecated in lieu of the new `axes.prop_cycle` parameter. Having both parameters in the same rc file is not recommended as the result cannot be predicted. For compatibility, setting `axes.color_cycle` will replace the cycler in `axes.prop_cycle` with a color cycle. Accessing `axes.color_cycle` will return just the color portion of the property cycle, if it exists.

Timeline for removal has not been set.

### Bundled jquery

The version of jquery bundled with the webagg backend has been upgraded from 1.7.1 to 1.11.3. If you are using the version of jquery bundled with webagg you will need to update your html files as such

```
- <script src="_static/jquery/js/jquery-1.7.1.min.js"></script>
+ <script src="_static/jquery/js/jquery-1.11.3.min.js"></script>
```

### Code Removed

#### Removed `Image` from main namespace

`Image` was imported from `PIL/pillow` to test if `PIL` is available, but there is no reason to keep `Image` in the namespace once the availability has been determined.

#### Removed `lod` from `Artist`

Removed the method `set_lod` and all references to the attribute `_lod` as they are not used anywhere else in the code base. It appears to be a feature stub that was never built out.

#### Removed threading related classes from `cbook`

The classes `Scheduler`, `Timeout`, and `Idle` were in `cbook`, but are not used internally. They appear to be a prototype for the idle event system which was not working and has recently been pulled out.

### Removed Lena images from `sample_data`

The `lena.png` and `lena.jpg` images have been removed from Matplotlib's `sample_data` directory. The images are also no longer available from `matplotlib.cbook.get_sample_data`. We suggest using `matplotlib.cbook.get_sample_data('grace_hopper.png')` or `matplotlib.cbook.get_sample_data('grace_hopper.jpg')` instead.

### Legend

Removed handling of `loc` as a positional argument to `Legend`

### Legend handlers

Remove code to allow legend handlers to be callable. They must now implement a method `legend_artist`.

### Axis

Removed method `set_scale`. This is now handled via a private method which should not be used directly by users. It is called via `Axes.set_{x,y}scale` which takes care of ensuring the related changes are also made to the `Axis` object.

### `finance.py`

Removed functions with ambiguous argument order from `finance.py`

### Annotation

Removed `textcoords` and `xytext` properties from `Annotation` objects.

### `sphinxext.ipython_*.py`

Both `ipython_console_highlighting` and `ipython_directive` have been moved to `IPython`.

Change your import from `'matplotlib.sphinxext.ipython_directive'` to `'IPython.sphinxext.ipython_directive'` and from `'matplotlib.sphinxext.ipython_directive'` to `'IPython.sphinxext.ipython_directive'`

### `LineCollection.color`

Deprecated in 2005, use `set_color`

### remove 'faceted' as a valid value for shading in `tri.tripcolor`

Use `edgecolor` instead. Added validation on shading to only be valid values.

**Remove faceted kwarg from scatter**

Remove support for the faceted kwarg. This was deprecated in d48b34288e9651ff95c3b8a071ef5ac5cf50bae7 (2008-04-18!) and replaced by `edgecolor`.

**Remove `set_colorbar` method from `ScalarMappable`**

Remove `set_colorbar` method, use `colorbar` attribute directly.

**patheffects.svg**

- remove `get_proxy_renderer` method from `AbstractPathEffect` class
- remove `patch_alpha` and `offset_xy` from `SimplePatchShadow`

**Remove `testing.image_util.py`**

Contained only a no-longer used port of functionality from PIL

**Remove `mlab.FIFOBuffer`**

Not used internally and not part of core mission of mpl.

**Remove `mlab.prepca`**

Deprecated in 2009.

**Remove `NavigationToolbar2QTAgg`**

Added no functionality over the base `NavigationToolbar2Qt`

**mpl.py**

Remove the module `matplotlib.mpl`. Deprecated in 1.3 by PR #1670 and commit 78ce67d161625833cacff23cfe5d74920248c5b2

**15.1.37 Changes in 1.5.2****Default Behavior Changes**

### Changed default autorange behavior in boxplots

Prior to v1.5.2, the whiskers of boxplots would extend to the minimum and maximum values if the quartiles were all equal (i.e.,  $Q1 = \text{median} = Q3$ ). This behavior has been disabled by default to restore consistency with other plotting packages.

To restore the old behavior, simply set `autorange=True` when calling `plt.boxplot`.

### 15.1.38 Changes in 1.5.3

#### `ax.plot(..., marker=None)` gives default marker

Prior to 1.5.3 kwargs passed to `plot` were handled in two parts - default kwargs generated internal to `plot` (such as the cycled styles) and user supplied kwargs. The internally generated kwargs were passed to the `matplotlib.lines.Line2D.__init__` and the user kwargs were passed to `ln.set(**kwargs)` to update the artist after it was created. Now both sets of kwargs are merged and passed to `__init__`. This change was made to allow `None` to be passed in via the user kwargs to mean 'do the default thing' as is the convention through out mpl rather than raising an exception.

Unlike most `Line2D` setter methods `set_marker` did accept `None` as a valid input which was mapped to 'no marker'. Thus, by routing this `marker=None` through `__init__` rather than `set(...)` the meaning of `ax.plot(..., marker=None)` changed from 'no markers' to 'default markers from rcparams'.

This change is only evident if `mpl.rcParams['lines.marker']` has a value other than 'None' (which is string 'None' which means 'no marker').

### 15.1.39 API Changes in 2.0.0

#### Deprecation and removal

##### Color of Axes

The `axisbg` and `axis_bgcolor` properties on `Axes` have been deprecated in favor of `facecolor`.

##### GTK and GDK backends deprecated

The GDK and GTK backends have been deprecated. These obsolete backends allow figures to be rendered via the GDK API to files and GTK2 figures. They are untested and known to be broken, and their use has been discouraged for some time. Instead, use the `GTKAgg` and `GTKCairo` backends for rendering to GTK2 windows.

##### WX backend deprecated

The WX backend has been deprecated. It is untested, and its use has been discouraged for some time. Instead, use the `WXAgg` backend for rendering figures to WX windows.

### CocoaAgg backend removed

The deprecated and not fully functional CocoaAgg backend has been removed.

### round removed from TkAgg Backend

The TkAgg backend had its own implementation of the `round` function. This was unused internally and has been removed. Instead, use either the `round` builtin function or `numpy.round`.

### 'hold' functionality deprecated

The 'hold' keyword argument and all functions and methods related to it are deprecated, along with the 'axes.hold' rcParams entry. The behavior will remain consistent with the default `hold=True` state that has long been in place. Instead of using a function or keyword argument (`hold=False`) to change that behavior, explicitly clear the axes or figure as needed prior to subsequent plotting commands.

### Artist.update has return value

The methods `matplotlib.artist.Artist.set`, `matplotlib.Artist.update`, and the function `matplotlib.artist.setp` now use a common codepath to look up how to update the given artist properties (either using the setter methods or an attribute/property).

The behavior of `matplotlib.Artist.update` is slightly changed to return a list of the values returned from the setter methods to avoid changing the API of `matplotlib.Artist.set` and `matplotlib.artist.setp`.

The keys passed into `matplotlib.Artist.update` are now converted to lower case before being processed, to match the behavior of `matplotlib.Artist.set` and `matplotlib.artist.setp`. This should not break any user code because there are no set methods with capitals in their names, but this puts a constraint on naming properties in the future.

### Legend initializers gain edgecolor and facecolor kwargs

The `Legend` background patch (or 'frame') can have its `edgecolor` and `facecolor` determined by the corresponding keyword arguments to the `matplotlib.legend.Legend` initializer, or to any of the methods or functions that call that initializer. If left to their default values of `None`, their values will be taken from `matplotlib.rcParams`. The previously-existing `framealpha` kwarg still controls the alpha transparency of the patch.

### Qualitative colormaps

Colorbrewer's qualitative/discrete colormaps ("Accent", "Dark2", "Paired", "Pastel1", "Pastel2", "Set1", "Set2", "Set3") are now implemented as `ListedColormap` instead of `LinearSegmentedColormap`.

To use these for images where categories are specified as integers, for instance, use:

```
plt.imshow(x, cmap='Dark2', norm=colors.NoNorm())
```

### Change in the `draw_image` backend API

The `draw_image` method implemented by backends has changed its interface.

This change is only relevant if the backend declares that it is able to transform images by returning `True` from `option_scale_image`. See the `draw_image` docstring for more information.

### `matplotlib.ticker.LinearLocator` algorithm update

The `matplotlib.ticker.LinearLocator` is used to define the range and location of axis ticks when the user wants an exact number of ticks. `LinearLocator` thus differs from the default locator `MaxNLocator`, for which the user specifies a maximum number of intervals rather than a precise number of ticks.

The view range algorithm in `matplotlib.ticker.LinearLocator` has been changed so that more convenient tick locations are chosen. The new algorithm returns a plot view range that is a multiple of the user-requested number of ticks. This ensures tick marks will be located at whole integers more consistently. For example, when both y-axes of a “twinx” plot use `matplotlib.ticker.LinearLocator` with the same number of ticks, their y-tick locations and grid lines will coincide.

### `matplotlib.ticker.LogLocator` gains `numticks` kwarg

The maximum number of ticks generated by the `LogLocator` can now be controlled explicitly via setting the new ‘`numticks`’ kwarg to an integer. By default the kwarg is `None` which internally sets it to the ‘`auto`’ string, triggering a new algorithm for adjusting the maximum according to the axis length relative to the ticklabel font size.

### `matplotlib.ticker.LogFormatter`: two new kwargs

Previously, minor ticks on log-scaled axes were not labeled by default. An algorithm has been added to the `LogFormatter` to control the labeling of ticks between integer powers of the base. The algorithm uses two parameters supplied in a kwarg tuple named ‘`minor_thresholds`’. See the docstring for further explanation.

To improve support for axes using `SymmetricLogLocator`, a ‘`linthresh`’ kwarg was added.

### New defaults for 3D quiver function in `mpl_toolkits.mplot3d.axes3d.py`

Matplotlib has both a 2D and a 3D quiver function. These changes affect only the 3D function and make the default behavior of the 3D function match the 2D version. There are two changes:

- 1) The 3D quiver function previously normalized the arrows to be the same length, which makes it unusable for situations where the arrows should be different lengths and does not match the behavior of the 2D function. This normalization behavior is now controlled with the `normalize` keyword, which defaults to `False`.
- 2) The `pivot` keyword now defaults to `tail` instead of `tip`. This was done in order to match the default behavior of the 2D quiver function.

To obtain the previous behavior with the 3D quiver function, one can call the function with

```
ax.quiver(x, y, z, u, v, w, normalize=True, pivot='tip')
```

where "ax" is an Axes3d object created with something like

```
import mpl_toolkits.mplot3d.axes3d
ax = plt.subplot(111, projection='3d')
```

### Stale figure behavior

Attempting to draw the figure will now mark it as not stale (independent if the draw succeeds). This change is to prevent repeatedly trying to re-draw a figure which is raising an error on draw. The previous behavior would only mark a figure as not stale after a full re-draw succeeded.

### The spectral colormap is now nipy\_spectral

The colormaps formerly known as `spectral` and `spectral_r` have been replaced by `nipy_spectral` and `nipy_spectral_r` since Matplotlib 1.3.0. Even though the colormap was deprecated in Matplotlib 1.3.0, it never raised a warning. As of Matplotlib 2.0.0, using the old names raises a deprecation warning. In the future, using the old names will raise an error.

### Default install no longer includes test images

To reduce the size of wheels and source installs, the tests and baseline images are no longer included by default.

To restore installing the tests and images, use a `setup.cfg` with

```
[packages]
tests = True
toolkits_tests = True
```

in the source directory at build/install time.

## 15.1.40 API Changes in 2.0.1

### Extensions to `matplotlib.backend_bases.GraphicsContextBase`

To better support controlling the color of hatches, the method `matplotlib.backend_bases.GraphicsContextBase.set_hatch_color` was added to the expected API of `GraphicsContext` classes. Calls to this method are currently wrapped with a `try:...except Attribute:` block to preserve back-compatibility with any third-party backends which do not extend `GraphicsContextBase`.

This value can be accessed in the backends via `matplotlib.backend_bases.GraphicsContextBase.get_hatch_color` (which was added in 2.0 see *Extension to matplotlib.backend\_bases.GraphicsContextBase*) and should be used to color the hatches.

In the future there may also be `hatch_linewidth` and `hatch_density` related methods added. It is encouraged, but not required that third-party backends extend `GraphicsContextBase` to make adapting to these changes easier.

`afm.get_fontconfig_fonts` returns a list of paths and does not check for existence

`afm.get_fontconfig_fonts` used to return a set of paths encoded as a {key: 1, ...} dict, and checked for the existence of the paths. It now returns a list and dropped the existence check, as the same check is performed by the caller (`afm.findSystemFonts`) as well.

`bar` now returns rectangles of negative height or width if the corresponding input is negative

`plt.bar` used to normalize the coordinates of the rectangles that it created, to keep their height and width positives, even if the corresponding input was negative. This normalization has been removed to permit a simpler computation of the correct `sticky_edges` to use.

**Do not clip line width when scaling dashes**

The algorithm to scale dashes was changed to no longer clip the scaling factor: the dash patterns now continue to shrink at thin line widths. If the line width is smaller than the effective pixel size, this may result in dashed lines turning into solid gray-ish lines. This also required slightly tweaking the default patterns for '-', ':', and '-.' so that with the default line width the final patterns would not change.

There is no way to restore the old behavior.

**Deprecate 'Vega' color maps**

The "Vega" colormaps are deprecated in Matplotlib 2.0.1 and will be removed in Matplotlib 2.2. Use the "tab" colormaps instead: "tab10", "tab20", "tab20b", "tab20c".

### 15.1.41 API Changes in 2.1.0

**Default behavior of log scales changed to mask  $\leq 0$  values**

Calling `matplotlib.axes.Axes.set_xscale` OR `matplotlib.axes.Axes.set_yscale` now uses 'mask' as the default method to handle invalid values (as opposed to 'clip'). This means that any values  $\leq 0$  on a log scale will not be shown.

Previously they were clipped to a very small number and shown.

`matplotlib.cbook.CallbackRegistry.process()` suppresses exceptions by default

Matplotlib uses instances of `CallbackRegistry` as a bridge between user input event from the GUI and user callbacks. Previously, any exceptions raised in a user call back would bubble out of the `process` method, which is typically in the GUI event loop. Most GUI frameworks simply print the traceback to the screen and continue as there is not always a clear method of getting the exception back to the user. However PyQt5 now exits the process when it receives an un-handled python exception in the event loop. Thus, `process()` now suppresses and prints tracebacks to `stderr` by default.

What `process()` does with exceptions is now user configurable via the `exception_handler` attribute and `kwarg`. To restore the previous behavior pass `None`

```
cb = CallbackRegistry(exception_handler=None)
```

A function which take and `Exception` as its only argument may also be passed

```
def maybe_reraise(exc):
    if isinstance(exc, RuntimeError):
        pass
    else:
        raise exc

cb = CallbackRegistry(exception_handler=maybe_reraise)
```

### Improved toggling of the axes grids

The `g` key binding now switches the states of the `x` and `y` grids independently (by cycling through all four on/off combinations).

The new `G` key binding switches the states of the minor grids.

Both bindings are disabled if only a subset of the grid lines (in either direction) is visible, to avoid making irreversible changes to the figure.

### Ticklabels are turned off instead of being invisible

Internally, the `Tick`'s `label10n()` attribute is now used to hide tick labels instead of setting the visibility on the tick label objects. This improves overall performance and fixes some issues. As a consequence, in case those labels ought to be shown, `tick_params()` needs to be used, e.g.

```
ax.tick_params(labelbottom=True)
```

### Removal of warning on empty legends

`plt.legend` used to issue a warning when no labeled artist could be found. This warning has been removed.

### More accurate legend autopositioning

Automatic positioning of legends now prefers using the area surrounded by a `Line2D` rather than placing the legend over the line itself.

### Cleanup of stock sample data

The sample data of stocks has been cleaned up to remove redundancies and increase portability. The `AAPL.dat.gz`, `INTC.dat.gz` and `aapl.csv` files have been removed entirely and will also no longer be available from `matplotlib.cbook.get_sample_data`. If a CSV file is required, we suggest using the `msft.csv` that continues to be shipped in the sample data. If a NumPy binary file is acceptable, we suggest using one of the following two new files. The `aapl.npy.gz` and `goog.npy` files have been replaced by `aapl.npz` and `goog.npz`, wherein the first column's type

has changed from `datetime.date` to `np.datetime64` for better portability across Python versions. Note that Matplotlib does not fully support `np.datetime64` as yet.

### Updated qhull to 2015.2

The version of qhull shipped with Matplotlib, which is used for Delaunay triangulation, has been updated from version 2012.1 to 2015.2.

### Improved Delaunay triangulations with large offsets

Delaunay triangulations now deal with large x,y offsets in a better way. This can cause minor changes to any triangulations calculated using Matplotlib, i.e. any use of `matplotlib.tri.Triangulation` that requests that a Delaunay triangulation is calculated, which includes `matplotlib.pyplot.tricontour`, `matplotlib.pyplot.tricontourf`, `matplotlib.pyplot.tripcolor`, `matplotlib.pyplot.triplot`, `matplotlib.mlab.griddata` and `mpl_toolkits.mplot3d.axes3d.Axes3D.plot_trisurf`.

### Use `backports.functools_lru_cache` instead of `functools32`

It's better maintained and more widely used (by pylint, jaraco, etc).

### `cbook.is_numlike` only performs an instance check

`is_numlike()` now only checks that its argument is an instance of (`numbers.Number`, `np.Number`). In particular, this means that arrays are now not num-like.

### Elliptical arcs now drawn between correct angles

The `matplotlib.patches.Arc` patch is now correctly drawn between the given angles.

Previously a circular arc was drawn and then stretched into an ellipse, so the resulting arc did not lie between `theta1` and `theta2`.

### `-d$backend` no longer sets the backend

It is no longer possible to set the backend by passing `-d$backend` at the command line. Use the `MPLBACKEND` environment variable instead.

### `Path.intersects_bbox` always treats the bounding box as filled

Previously, when `Path.intersects_bbox` was called with `filled` set to `False`, it would treat both the path and the bounding box as unfilled. This behavior was not well documented and it is usually not the desired behavior, since bounding boxes are used to represent more complex shapes located inside the bounding box. This behavior has now been changed: when `filled` is `False`, the path will be treated as unfilled, but the bounding box is still treated as filled. The old behavior was arguably an implementation bug.

When `Path.intersects_bbox` is called with `filled` set to `True` (the default value), there is no change in behavior. For those rare cases where `Path.intersects_bbox` was called with `filled` set to `False` and where the old behavior is actually desired, the suggested workaround is to call `Path.intersects_path` with a rectangle as the path:

```
from matplotlib.path import Path
from matplotlib.transforms import Bbox, BboxTransformTo
rect = Path.unit_rectangle().transformed(BboxTransformTo(bbox))
result = path.intersects_path(rect, filled=False)
```

### WX no longer calls generates `IdleEvent` events or calls `idle_event`

Removed unused private method `_onIdle` from `FigureCanvasWx`.

The `IdleEvent` class and `FigureCanvasBase.idle_event` method will be removed in 2.2

### Correct scaling of `magnitude_spectrum()`

The functions `matplotlib.mlab.magnitude_spectrum()` and `matplotlib.pyplot.magnitude_spectrum()` implicitly assumed the sum of windowing function values to be one. In Matplotlib and Numpy the standard windowing functions are scaled to have maximum value of one, which usually results in a sum of the order of  $n/2$  for a  $n$ -point signal. Thus the amplitude scaling `magnitude_spectrum()` was off by that amount when using standard windowing functions (Bug 8417). Now the behavior is consistent with `matplotlib.pyplot.psd()` and `scipy.signal.welch()`. The following example demonstrates the new and old scaling:

```
import matplotlib.pyplot as plt
import numpy as np

tau, n = 10, 1024 # 10 second signal with 1024 points
T = tau/n # sampling interval
t = np.arange(n)*T

a = 4 # amplitude
x = a*np.sin(40*np.pi*t) # 20 Hz sine with amplitude a

# New correct behavior: Amplitude at 20 Hz is a/2
plt.magnitude_spectrum(x, Fs=1/T, sides='onesided', scale='linear')

# Original behavior: Amplitude at 20 Hz is (a/2)*(n/2) for a Hanning window
w = np.hanning(n) # default window is a Hanning window
plt.magnitude_spectrum(x*np.sum(w), Fs=1/T, sides='onesided', scale='linear')
```

### Change to signatures of `bar()` & `barh()`

For 2.0 the *default value of `*align*`* changed to `'center'`. However this caused the signature of `bar()` and `barh()` to be misleading as the first parameters were still *left* and *bottom* respectively:

```
bar(left, height, *, align='center', **kwargs)
barh(bottom, width, *, align='center', **kwargs)
```

despite behaving as the center in both cases. The methods now take *\*args*, *\*\*kwargs* as input and are documented to have the primary signatures of:

```
bar(x, height, *, align='center', **kwargs)
barh(y, width, *, align='center', **kwargs)
```

Passing *left* and *bottom* as keyword arguments to *bar()* and *barh()* respectively will warn. Support will be removed in Matplotlib 3.0.

### Font cache as json

The font cache is now saved as json, rather than a pickle.

### Invalid (Non-finite) Axis Limit Error

When using *set\_xlim()* and *set\_ylim()*, passing non-finite values now results in a `ValueError`. The previous behavior resulted in the limits being erroneously reset to `(-0.001, 0.001)`.

### scatter and Collection offsets are no longer implicitly flattened

*Collection* (and thus both 2D *scatter* and 3D *scatter*) no longer implicitly flattens its offsets. As a consequence, *scatter*'s *x* and *y* arguments can no longer be 2+-dimensional arrays.

### Deprecations

#### GraphicsContextBase's `linestyle` property.

The `GraphicsContextBase.get_linestyle` and `GraphicsContextBase.set_linestyle` methods, which had no effect, have been deprecated. All of the backends Matplotlib ships use `GraphicsContextBase.get_dashes` and `GraphicsContextBase.set_dashes` which are more general. Third-party backends should also migrate to the `*_dashes` methods.

#### `NavigationToolbar2.dynamic_update`

Use `draw_idle()` method on the Canvas instance instead.

### Testing

`matplotlib.testing.noseclasses` is deprecated and will be removed in 2.3

#### `EngFormatter` *num* arg as string

Passing a string as *num* argument when calling an instance of `matplotlib.ticker.EngFormatter` is deprecated and will be removed in 2.3.

### `mpl_toolkits.axes_grid` module

All functionality from `mpl_toolkits.axes_grid` can be found in either `mpl_toolkits.axes_grid1` or `mpl_toolkits.axisartist`. Axes classes from `mpl_toolkits.axes_grid` based on `Axis` from `mpl_toolkits.axisartist` can be found in `mpl_toolkits.axisartist`.

### Axes collision in `Figure.add_axes`

Adding an axes instance to a figure by using the same arguments as for a previous axes instance currently reuses the earlier instance. This behavior has been deprecated in Matplotlib 2.1. In a future version, a *new* instance will always be created and returned. Meanwhile, in such a situation, a deprecation warning is raised by `AxesStack`.

This warning can be suppressed, and the future behavior ensured, by passing a *unique* label to each axes instance. See the docstring of `add_axes()` for more information.

Additional details on the rationale behind this deprecation can be found in [#7377](#) and [#9024](#).

### Former validators for `contour.negative_linestyle`

The former public validation functions `validate_negative_linestyle` and `validate_negative_linestyle_legacy` will be deprecated in 2.1 and may be removed in 2.3. There are no public functions to replace them.

### `cbook`

Many unused or near-unused `matplotlib.cbook` functions and classes have been deprecated: `converter`, `tostr`, `todatetime`, `todate`, `tofloat`, `toint`, `unique`, `is_string_like`, `is_sequence_of_strings`, `is_scalar`, `Sorter`, `Xlator`, `soundex`, `Null`, `dict_delall`, `RingBuffer`, `get_split_ind`, `wrap`, `get_recursive_filelist`, `pieces`, `exception_to_str`, `allequal`, `alltrue`, `onetrue`, `allpairs`, `finddir`, `reverse_dict`, `restrict_dict`, `issubclass_safe`, `recursive_remove`, `unmasked_index_ranges`.

### Code Removal

#### `qt4_compat.py`

Moved to `qt_compat.py`. Renamed because it now handles Qt5 as well.

### Previously Deprecated methods

The `GraphicsContextBase.set_graylevel`, `FigureCanvasBase.onHilite` and `mpl_toolkits.axes_grid1.mpl_axes.Axes.toggle_axisline` methods have been removed.

The `ArtistInspector.findobj` method, which was never working due to the lack of a `get_children` method, has been removed.

The deprecated `point_in_path`, `get_path_extents`, `point_in_path_collection`, `path_intersects_path`, `convert_path_to_polygons`, `cleanup_path` and `clip_path_to_rect` functions in the `matplotlib.path` module have been removed. Their functionality remains exposed as methods on the `Path` class.

The deprecated `Artist.get_axes` and `Artist.set_axes` methods have been removed

The `matplotlib.backends.backend_ps.seq_allequal` function has been removed. Use `np.array_equal` instead.

The deprecated `matplotlib.rcsetup.validate_maskedarray`, `matplotlib.rcsetup.deprecate_savefig_extension` and `matplotlib.rcsetup.validate_tkpythoninspect` functions, and associated `savefig.extension` and `tk.pythoninspect.rcparams` entries have been removed.

The kwarg resolution of `matplotlib.projections.polar.PolarAxes` has been removed. It has deprecation with no effect from version 0.98.x.

```
Axes.set_aspect("normal")
```

Support for setting an Axes's aspect to "normal" has been removed, in favor of the synonym "auto".

shading kwarg to `pcolor`

The shading kwarg to `pcolor` has been removed. Set `edgecolors` appropriately instead.

### Functions removed from the `lines` module

The `matplotlib.lines` module no longer imports the `pts_to_prestep`, `pts_to_midstep` and `pts_to_poststep` functions from `matplotlib.cbook`.

### PDF backend functions

The methods `embedTeXFont` and `tex_font_mapping` of `matplotlib.backend_pdf.PdfFile` have been removed. It is unlikely that external users would have called these methods, which are related to the font system internal to the PDF backend.

### `matplotlib.delaunay`

Remove the delaunay triangulation code which is now handled by Qhull via `matplotlib.tri`.

## 15.1.42 API Changes in 2.1.1

### Default behavior of log scales reverted to `clip <= 0` values

The change in 2.1.0 to mask in logscale by default had more disruptive changes than anticipated and has been reverted, however the clipping is now done in a way that fixes the issues that motivated changing the default behavior to 'mask'.

As a side effect of this change, error bars which go negative now work as expected on log scales.

### 15.1.43 API Changes in 2.1.2

#### Figure.legend no longer checks for repeated lines to ignore

`matplotlib.Figure.legend` used to check if a line had the same label as an existing legend entry. If it also had the same line color or marker color legend didn't add a new entry for that line. However, the list of conditions was incomplete, didn't handle RGB tuples, didn't handle linewidths or linestyle etc.

This logic did not exist in `Axes.legend`. It was included (erroneously) in Matplotlib 2.1.1 when the legend argument parsing was unified [#9324](<https://github.com/matplotlib/matplotlib/pull/9324>). This change removes that check in `Axes.legend` again to restore the old behavior.

This logic has also been dropped from `Figure.legend`, where it was previously undocumented. Repeated lines with the same label will now each have an entry in the legend. If you do not want the duplicate entries, don't add a label to the line, or prepend the label with an underscore.

### 15.1.44 API Changes in 2.2.0

#### New dependency

`kiwisolver` is now a required dependency to support the new `constrained_layout`, see *Constrained Layout Guide* for more details.

#### Deprecations

##### Classes, functions, and methods

The unused and untested `Artist.onRemove` and `Artist.hitlist` methods have been deprecated.

The now unused `mlab.less_simple_linear_interpolation` function is deprecated.

The unused `ContourLabeler.get_real_label_width` method is deprecated.

The unused `FigureManagerBase.show_popup` method is deprecated. This introduced in e945059b327d42a99938b939a1be867fa023e7ba in 2005 but never built out into any of the backends.

`backend_tkagg.AxisMenu` is deprecated, as it has become unused since the removal of "classic" toolbars.

#### Changed function signatures

kwarg `fig` to `GridSpec.get_subplot_params` is deprecated, use `figure` instead.

Using `pyplot.axes` with an `Axes` as argument is deprecated. This sets the current axes, i.e. it has the same effect as `pyplot.sca`. For clarity `plt.sca(ax)` should be preferred over `plt.axes(ax)`.

Using strings instead of booleans to control grid and tick visibility is deprecated. Using "on", "off", "true", or "false" to control grid and tick visibility has been deprecated. Instead, use normal booleans (True/False) or boolean-likes. In the future, all non-empty strings may be interpreted as True.

When given 2D inputs with non-matching numbers of columns, `plot` currently cycles through the columns of the narrower input, until all the columns of the wider input have been plotted. This behavior is deprecated; in the future, only broadcasting (1 column to  $n$  columns) will be performed.

### rcparams

The `rcParams["backend.qt4"]` and `rcParams["backend.qt5"]` `rcParams` were deprecated in version 2.2. In order to force the use of a specific Qt binding, either import that binding first, or set the `QT_API` environment variable.

Deprecation of the `nbagg.transparent` `rcParam`. To control transparency of figure patches in the `nbagg` (or any other) backend, directly set `figure.patch.facecolor`, or the `figure.facecolor` `rcParam`.

### Deprecated `Axis.unit_data`

Use `Axis.units` (which has long existed) instead.

### Removals

#### Function Signatures

Contouring no longer supports legacy corner masking. The deprecated `ContourSet.vmin` and `ContourSet.vmax` properties have been removed.

Passing `None` instead of "none" as `format` to `errorbar` is no longer supported.

The `bgcolor` keyword argument to `Axes` has been removed.

### Modules, methods, and functions

The `matplotlib.finance`, `mpl_toolkits.exceltools` and `mpl_toolkits.gtktools` modules have been removed. `matplotlib.finance` remains available at [https://github.com/matplotlib/mpl\\_finance](https://github.com/matplotlib/mpl_finance).

The `mpl_toolkits.mplot3d.art3d.iscolor` function has been removed.

The `Axes.get_axis_bgcolor`, `Axes.set_axis_bgcolor`, `Bbox.update_from_data`, `Bbox.update_datalim_numerix`, `MaxNLocator.bin_boundaries` methods have been removed.

`mencoder` can no longer be used to encode animations.

The unused `FONT_SCALE` and `fontd` attributes of the `RendererSVG` class have been removed.

## color maps

The spectral colormap has been removed. The Vega\* colormaps, which were aliases for the tab\* colormaps, have been removed.

## rcparams

The following deprecated rcParams have been removed:

- `axes.color_cycle` (see `axes.prop_cycle`),
- `legend.isaxes`,
- `svg.embed_char_paths` (see `svg.fonttype`),
- `text.fontstyle`, `text.fontangle`, `text.fontvariant`, `text.fontweight`, `text.fontsize` (renamed to `text.style`, etc.),
- `tick.size` (renamed to `tick.major.size`).

## Only accept string-like for Categorical input

Do not accept mixed string / float / int input, only strings are valid categoricals.

## Removal of unused imports

Many unused imports were removed from the codebase. As a result, trying to import certain classes or functions from the "wrong" module (e.g. `Figure` from `matplotlib.backends.backend_agg` instead of `matplotlib.figure`) will now raise an `ImportError`.

## Axes3D.get\_xlim, get\_ylim and get\_zlim now return a tuple

They previously returned an array. Returning a tuple is consistent with the behavior for 2D axes.

## Exception type changes

If `MovieWriterRegistry` can't find the requested `MovieWriter`, a more helpful `RuntimeError` message is now raised instead of the previously raised `KeyError`.

`auto_adjust_subplotpars` now raises `ValueError` instead of `RuntimeError` when sizes of input lists don't match

## Figure.set\_figwidth and Figure.set\_figheight default forward to True

`matplotlib.Figure.set_figwidth` and `matplotlib.Figure.set_figheight` had the kwarg `forward=False` by default, but `Figure.set_size_inches` now defaults to `forward=True`. This makes these functions consistent.

### Do not truncate svg sizes to nearest point

There is no reason to size the SVG out put in integer points, change to out putting floats for the *height*, *width*, and *viewBox* attributes of the *svg* element.

### Fontsizes less than 1 pt are clipped to be 1 pt.

FreeType doesn't allow fonts to get smaller than 1 pt, so all Agg backends were silently rounding up to 1 pt. PDF (other vector backends?) were letting us write fonts that were less than 1 pt, but they could not be placed properly because position information comes from FreeType. This change makes it so no backends can use fonts smaller than 1 pt, consistent with FreeType and ensuring more consistent results across backends.

### Changes to Qt backend class MRO

To support both Agg and cairo rendering for Qt backends all of the non-Agg specific code previously in `backend_qt5agg.FigureCanvasQTAggBase` has been moved to `backend_qt5.FigureCanvasQT` so it can be shared with the cairo implementation. The `FigureCanvasQTAggBase.paintEvent()`, `FigureCanvasQTAggBase.blit()`, and `FigureCanvasQTAggBase.print_figure()` methods have moved to `FigureCanvasQTAgg.paintEvent()`, `FigureCanvasQTAgg.blit()`, and `FigureCanvasQTAgg.print_figure()`. The first two methods assume that the instance is also a `QWidget` so to use `FigureCanvasQTAggBase` it was required to multiple inherit from a `QWidget` sub-class.

Having moved all of its methods either up or down the class hierarchy `FigureCanvasQTAggBase` has been deprecated. To do this with out warning and to preserve as much API as possible, `backend_qt5.FigureCanvasQTAggBase` now inherits from `backend_qt5.FigureCanvasQTAgg`.

The MRO for `FigureCanvasQTAgg` and `FigureCanvasQTAggBase` used to be

```
[matplotlib.backends.backend_qt5agg.FigureCanvasQTAgg,
matplotlib.backends.backend_qt5agg.FigureCanvasQTAggBase,
matplotlib.backends.backend_agg.FigureCanvasAgg,
matplotlib.backends.backend_qt5.FigureCanvasQT,
PyQt5.QtWidgets.QWidget,
PyQt5.QtCore.QObject,
sip.wrapper,
PyQt5.QtGui.QPaintDevice,
sip.simplewrapper,
matplotlib.backend_bases.FigureCanvasBase,
object]
```

and

```
[matplotlib.backends.backend_qt5agg.FigureCanvasQTAggBase,
matplotlib.backends.backend_agg.FigureCanvasAgg,
matplotlib.backend_bases.FigureCanvasBase,
object]
```

respectively. They are now

```
[matplotlib.backends.backend_qt5agg.FigureCanvasQTAgg,
matplotlib.backends.backend_agg.FigureCanvasAgg,
```

(continues on next page)

(continued from previous page)

```
matplotlib.backends.backend_qt5.FigureCanvasQT,
PyQt5.QtWidgets.QWidget,
PyQt5.QtCore.QObject,
sip.wrapper,
PyQt5.QtGui.QPaintDevice,
sip.simplewrapper,
matplotlib.backend_bases.FigureCanvasBase,
object]
```

and

```
[matplotlib.backends.backend_qt5agg.FigureCanvasQTAggBase,
matplotlib.backends.backend_qt5agg.FigureCanvasQTAgg,
matplotlib.backends.backend_agg.FigureCanvasAgg,
matplotlib.backends.backend_qt5.FigureCanvasQT,
PyQt5.QtWidgets.QWidget,
PyQt5.QtCore.QObject,
sip.wrapper,
PyQt5.QtGui.QPaintDevice,
sip.simplewrapper,
matplotlib.backend_bases.FigureCanvasBase,
object]
```

**Axes.imshow clips RGB values to the valid range**

When `Axes.imshow` is passed an RGB or RGBA value with out-of-range values, it now logs a warning and clips them to the valid range. The old behaviour, wrapping back in to the range, often hid outliers and made interpreting RGB images unreliable.

**GTKAgg and GTKCairo backends deprecated**

The `GTKAgg` and `GTKCairo` backends have been deprecated. These obsolete backends allow figures to be rendered via the GTK+ 2 toolkit. They are untested, known to be broken, will not work with Python 3, and their use has been discouraged for some time. Instead, use the `GTK3Agg` and `GTK3Cairo` backends for rendering to GTK+ 3 windows.

**15.1.45 API Changes for 3.0.0****Drop support for python 2**

Matplotlib 3 only supports python 3.5 and higher.

**Changes to backend loading**

Failure to load backend modules (`macosx` on non-framework builds and `gtk3` when running headless) now raises `ImportError` (instead of `RuntimeError` and `TypeError`, respectively).

Third-party backends that integrate with an interactive framework are now encouraged to define the `required_interactive_framework` global value to one of the following values: "qt5", "qt4", "gtk3", "wx", "tk", or "macosx". This information will be used to determine whether it is possible to switch from a backend to another (specifically, whether they use the same interactive framework).

#### **`Axes.hist2d` now uses `pcolormesh` instead of `pcolorfast`**

`Axes.hist2d` now uses `pcolormesh` instead of `pcolorfast`, which will improve the handling of log-axes. Note that the returned *image* now is of type `QuadMesh` instead of `AxesImage`.

#### **`matplotlib.axes.Axes.get_tightbbox` now includes all artists**

For Matplotlib 3.0, *all* artists are now included in the bounding box returned by `matplotlib.axes.Axes.get_tightbbox`.

`matplotlib.axes.Axes.get_tightbbox` adds a new kwarg `bbox_extra_artists` to manually specify the list of artists on the axes to include in the tight bounding box calculation.

Layout tools like `Figure.tight_layout`, `constrained_layout`, and `fig.savefig('fname.png', bbox_inches="tight")` use `matplotlib.axes.Axes.get_tightbbox` to determine the bounds of each axes on a figure and adjust spacing between axes.

In Matplotlib 2.2 `get_tightbbox` started to include legends made on the axes, but still excluded some other artists, like text that may overflow an axes. This has been expanded to include *all* artists.

This new default may be overridden in either of three ways:

1. Make the artist to be excluded a child of the figure, not the axes. E.g., call `fig.legend()` instead of `ax.legend()` (perhaps using `get_legend_handles_labels` to gather handles and labels from the parent axes).
2. If the artist is a child of the axes, set the artist property `artist.set_in_layout(False)`.
3. Manually specify a list of artists in the new kwarg `bbox_extra_artists`.

#### **`Text.set_text` with string argument `None` sets string to empty**

`Text.set_text` when passed a string value of `None` would set the string to "None", so subsequent calls to `Text.get_text` would return the ambiguous "None" string.

This change sets text objects passed `None` to have empty strings, so that `Text.get_text` returns an empty string.

#### **`Axes3D.get_xlim`, `get_ylim` and `get_zlim` now return a tuple**

They previously returned an array. Returning a tuple is consistent with the behavior for 2D axes.

#### **`font_manager.list_fonts` now follows the platform's casefolding semantics**

i.e., it behaves case-insensitively on Windows only.

**bar / barh no longer accepts left / bottom as first named argument**

These arguments were renamed in 2.0 to `x / y` following the change of the default alignment from edge to center.

**Different exception types for undocumented options**

- Passing `style='comma'` to `ticklabel_format()` was never supported. It now raises `ValueError` like all other unsupported styles, rather than `NotImplementedError`.
- Passing the undocumented `xmin` or `xmax` arguments to `set_xlim()` would silently override the `left` and `right` arguments. `set_ylim()` and the 3D equivalents (e.g. `set_zlim3d()`) had a corresponding problem. A `TypeError` will be raised if they would override the earlier limit arguments. In 3.0 these were kwargs were deprecated, but in 3.1 the deprecation was undone.

**Improved call signature for `Axes.margins`**

`matplotlib.axes.Axes.margins()` and `mpl_toolkits.mplot3d.Axes3D.margins()` no longer accept arbitrary keywords. `TypeError` will therefore be raised if unknown kwargs are passed; previously they would be silently ignored.

If too many positional arguments are passed, `TypeError` will be raised instead of `ValueError`, for consistency with other call-signature violations.

`Axes3D.margins` now raises `TypeError` instead of emitting a deprecation warning if only two positional arguments are passed. To supply only `x` and `y` margins, use keyword arguments.

**Explicit arguments instead of `*args`, `**kwargs`**

**PEP 3102** describes keyword-only arguments, which allow Matplotlib to provide explicit call signatures - where we previously used `*args`, `**kwargs` and `kwargs.pop`, we can now expose named arguments. In some places, unknown kwargs were previously ignored but now raise `TypeError` because `**kwargs` has been removed.

- `matplotlib.axes.Axes.stem()` no longer accepts unknown keywords, and raises `TypeError` instead of emitting a deprecation.
- `matplotlib.axes.Axes.stem()` now raises `TypeError` when passed unhandled positional arguments. If two or more arguments are passed (ie `X`, `Y`, [`linefmt`], ...) and `Y` cannot be cast to an array, an error will be raised instead of treating `X` as `Y` and `Y` as `linefmt`.
- `mpl_toolkits.axes_grid1.axes_divider.SubPlotDivider()` raises `TypeError` instead of `Exception` when passed unknown kwargs.

**Cleanup decorators and test classes no longer destroy warnings filter on exit**

The decorators and classes in `matplotlib.testing.decorators` no longer destroy the warnings filter on exit. Instead, they restore the warnings filter that existed before the test started using `warnings.catch_warnings`.

### Non-interactive FigureManager classes are now aliases of FigureManagerBase

The `FigureManagerPdf`, `FigureManagerPS`, and `FigureManagerSVG` classes, which were previously empty subclasses of `FigureManagerBase` (i.e., not adding or overriding any attribute or method), are now direct aliases for `FigureManagerBase`.

### Change to the output of `image.thumbnail`

When called with `preview=False`, `image.thumbnail` previously returned a figure whose canvas class was set according to the output file extension. It now returns a figure whose canvas class is the base `FigureCanvasBase` (and relies on `FigureCanvasBase.print_figure`) to handle the canvas switching properly).

As a side effect of this change, `image.thumbnail` now also supports `.ps`, `.eps`, and `.svgz` output.

### `FuncAnimation` now draws artists according to their zorder when blitting

`FuncAnimation` now draws artists returned by the user- function according to their zorder when using blitting, instead of using the order in which they are being passed. However, note that only zorder of passed artists will be respected, as they are drawn on top of any existing artists (see [#11369](#)).

### Contour color autoscaling improvements

Selection of contour levels is now the same for `contour` and `contourf`; previously, for `contour`, levels outside the data range were deleted. (Exception: if no contour levels are found within the data range, the `levels` attribute is replaced with a list holding only the minimum of the data range.)

When `contour` is called with levels specified as a target number rather than a list, and the 'extend' kwarg is used, the levels are now chosen such that some data typically will fall in the extended range.

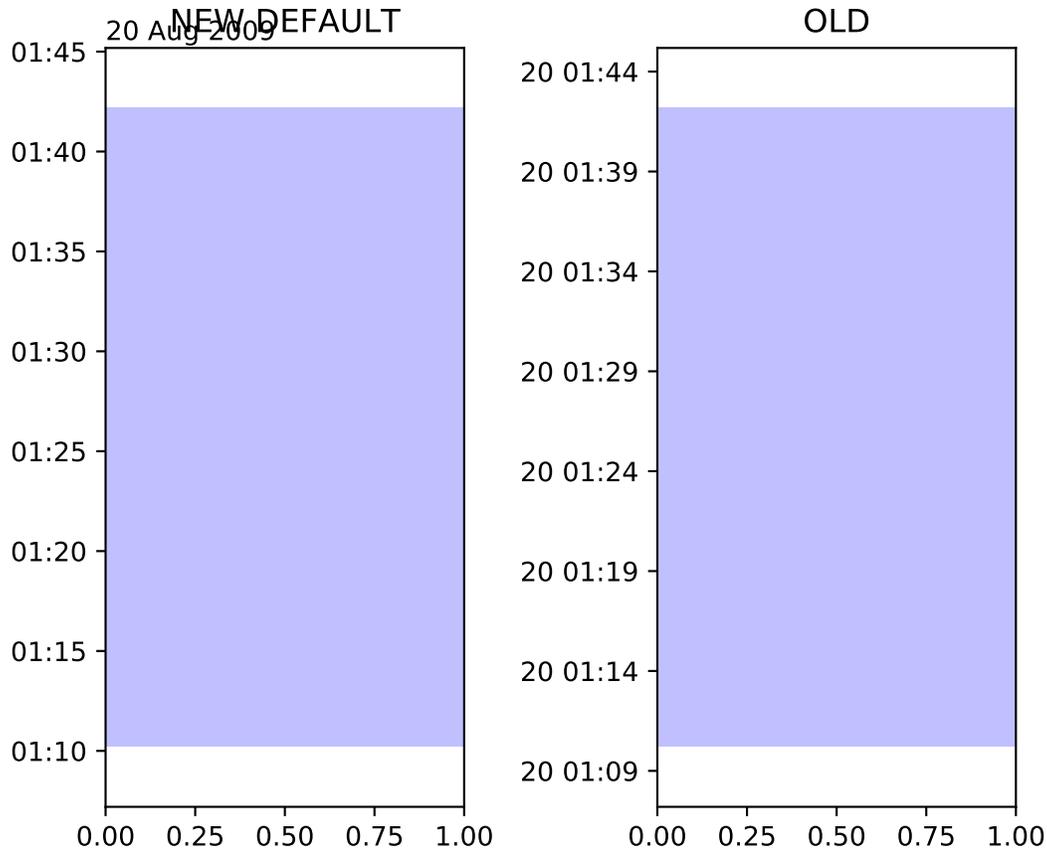
When `contour` is called with a `LogNorm` or a `LogLocator`, it will now select colors using the geometric mean rather than the arithmetic mean of the contour levels.

### Streamplot last row and column fixed

A bug was fixed where the last row and column of data in `streamplot` were being dropped.

### Changed default `AutoDateLocator` kwarg `interval_multiples` to `True`

The default value of the tick locator for dates, `dates.AutoDateLocator` kwarg `interval_multiples` was set to `False` which leads to not-nice looking automatic ticks in many instances. The much nicer `interval_multiples=True` is the new default. See below to get the old behavior back:



#### **Axes.get\_position now returns actual position if aspect changed**

*Axes.get\_position* used to return the original position unless a draw had been triggered or *Axes.apply\_aspect* had been called, even if the kwarg *original* was set to `False`. Now *Axes.apply\_aspect* is called so `ax.get_position()` will return the new modified position. To get the old behavior use `ax.get_position(original=True)`.

#### **The ticks for colorbar now adjust for the size of the colorbar**

Colorbar ticks now adjust for the size of the colorbar if the colorbar is made from a mappable that is not a contour or doesn't have a `BoundaryNorm`, or boundaries are not specified. If boundaries, etc are specified, the colorbar maintains the original behavior.

#### **Colorbar for log-scaled hexbin**

When using `hexbin` and plotting with a logarithmic color scale, the colorbar ticks are now correctly log scaled. Previously the tick values were linear scaled  $\log(\text{number of counts})$ .

#### **PGF backend now explicitly makes black text black**

Previous behavior with the pgf backend was for text specified as black to actually be the default color of whatever was rendering the pgf file (which was of course usually black). The

new behavior is that black text is black, regardless of the default color. However, this means that there is no way to fall back on the default color of the renderer.

#### Blacklisted rcparams no longer updated by rcdefaults, rc\_file\_defaults, rc\_file

The rc modifier functions `rcdefaults`, `rc_file_defaults` and `rc_file` now ignore rcParams in the `matplotlib.style.core.STYLE_BLACKLIST` set. In particular, this prevents the backend and interactive rcParams from being incorrectly modified by these functions.

#### CallbackRegistry now stores callbacks using stdlib's WeakMethods

In particular, this implies that `CallbackRegistry.callbacks[signal]` is now a mapping of callback ids to `WeakMethods` (i.e., they need to be first called with no arguments to retrieve the method itself).

#### Changes regarding the text.latex.unicode rcParam

The rcParam now defaults to True and is deprecated (i.e., in future versions of Matplotlib, unicode input will always be supported).

Moreover, the underlying implementation now uses `\usepackage[utf8]{inputenc}` instead of `\usepackage{ucs}\usepackage[utf8x]{inputenc}`.

#### Return type of ArtistInspector.get\_aliases changed

`ArtistInspector.get_aliases` previously returned the set of aliases as `{fullname: {alias1: None, alias2: None, ...}}`. The dict-to-None mapping was used to simulate a set in earlier versions of Python. It has now been replaced by a set, i.e. `{fullname: {alias1, alias2, ...}}`.

This value is also stored in `ArtistInspector.aliasd`, which has likewise changed.

#### Removed pytz as a dependency

Since `dateutil` and `pytz` both provide time zones, and `matplotlib` already depends on `dateutil`, `matplotlib` will now use `dateutil` time zones internally and drop the redundant dependency on `pytz`. While `dateutil` time zones are preferred (and currently recommended in the Python documentation), the explicit use of `pytz` zones is still supported.

## Deprecations

### Modules

The following modules are deprecated:

- `matplotlib.compat.subprocess`. This was a python 2 workaround, but all the functionality can now be found in the python 3 standard library `subprocess`.
- `matplotlib.backends.wx_compat`. Python 3 is only compatible with wxPython 4, so support for wxPython 3 or earlier can be dropped.

## Classes, methods, functions, and attributes

The following classes, methods, functions, and attributes are deprecated:

- `RcParams.msg_depr`, `RcParams.msg_depr_ignore`, `RcParams.msg_depr_set`, `RcParams.msg_obsolete`, `RcParams.msg_backend_obsolete`
- `afm.parse_afm`
- `backend_pdf.PdfFile.texFontMap`
- `backend_pgf.get_texcommand`
- `backend_ps.get_bbox`
- `backend_qt5.FigureCanvasQT.keyAutoRepeat` (directly check `event.guiEvent.isAutoRepeat()` in the event handler to decide whether to handle autorepeated key presses).
- `backend_qt5.error_msg_qt`, `backend_qt5.exception_handler`
- `backend_wx.FigureCanvasWx.macros`
- `backends.pylab_setup`
- `cbook.GetRealpathAndStat`, `cbook.Locked`
- `cbook.is_numlike` (use `isinstance(..., numbers.Number)` instead), `cbook.listFiles`, `cbook.unicode_safe`
- `container.Container.set_remove_method`,
- `contour.ContourLabeler.cl`, `.cl_xy`, and `.cl_cvalues`
- `dates.DateFormatter.strptime_pre_1900`, `dates.DateFormatter.strptime`
- `font_manager.TempCache`
- `image._ImageBase.iterpnames`, use the `interpolation_names` property instead. (this affects classes that inherit from `_ImageBase` including `FigureImage`, `BboxImage`, and `AxesImage`)
- `matplotlib.text.unichr_safe` (use `chr` instead)
- `patches.Polygon.xy`
- `table.Table.get_child_artists` (use `get_children` instead)
- `testing.compare.ImageComparisonTest`, `testing.compare.compare_float`
- `testing.decorators.CleanupTest`, `testing.decorators.skip_if_command_unavailable`
- `FigureCanvasQT.keyAutoRepeat` (directly check `event.guiEvent.isAutoRepeat()` in the event handler to decide whether to handle autorepeated key presses)
- `FigureCanvasWx.macros`
- `_ImageBase.iterpnames`, use the `interpolation_names` property instead. (this affects classes that inherit from `_ImageBase` including `FigureImage`, `BboxImage`, and `AxesImage`)
- `patches.Polygon.xy`
- `texmanager.dvipng_hack_alpha`
- `text.Annotation.arrow`
- `Legend.draggable()`, **in favor of** `Legend.set_draggable()` (`Legend.draggable` may be reintroduced as a property in future releases)
- `textpath.TextToPath.tex_font_map`

- `matplotlib.cbook.deprecation.mplDeprecation` will be removed in future versions. It is just an alias for `matplotlib.cbook.deprecation.MatplotlibDeprecationWarning`. Please use the `MatplotlibDeprecationWarning` directly if necessary.
- The `matplotlib.cbook.Bunch` class has been deprecated. Instead, use `types.SimpleNamespace` from the standard library which provides the same functionality.
- `Axes.mouseover_set` is now a frozenset, and deprecated. Directly manipulate the artist's `.mouseover` attribute to change their mouseover status.

The following keyword arguments are deprecated:

- passing `verts` to `Axes.scatter` (use `marker` instead)
- passing `obj_type` to `cbook.deprecated`

The following call signatures are deprecated:

- passing a `wx.EvtHandler` as first argument to `backend_wx.TimerWx`

### rcParams

The following rcParams are deprecated:

- `examples.directory` (use `datapath` instead)
- `pgf.debug` (the `pgf` backend relies on logging)
- `text.latex.unicode` (always `True` now)

### marker styles

- Using `(n, 3)` as marker style to specify a circle marker is deprecated. Use `"o"` instead.
- Using `[(x0, y0), (x1, y1), ...], 0)` as marker style to specify a custom marker path is deprecated. Use `[(x0, y0), (x1, y1), ...]` instead.

### Deprecation of `LocatableAxes` in toolkits

The `LocatableAxes` classes in toolkits have been deprecated. The base `Axes` classes provide the same functionality to all subclasses, thus these mixins are no longer necessary. Related functions have also been deprecated. Specifically:

- `mpl_toolkits.axes_grid1.axes_divider.LocatableAxesBase`: no specific replacement; use any other `Axes`-derived class directly instead.
- `mpl_toolkits.axes_grid1.axes_divider.locatable_axes_factory`: no specific replacement; use any other `Axes`-derived class directly instead.
- `mpl_toolkits.axes_grid1.axes_divider.Axes`: use `mpl_toolkits.axes_grid1.mpl_axes.Axes` directly.
- `mpl_toolkits.axes_grid1.axes_divider.LocatableAxes`: use `mpl_toolkits.axes_grid1.mpl_axes.Axes` directly.
- `mpl_toolkits.axisartist.axes_divider.Axes`: use `mpl_toolkits.axisartist.axislines.Axes` directly.

- `mpl_toolkits.axisartist.axes_divider.LocatableAxes`: USE `mpl_toolkits.axisartist.axislines.Axes` directly.

## Removals

### Hold machinery

Setting or unsetting `hold` (*deprecated in version 2.0*) has now been completely removed. Matplotlib now always behaves as if `hold=True`. To clear an axes you can manually use `cla()`, or to clear an entire figure use `clf()`.

### Removal of deprecated backends

Deprecated backends have been removed:

- GTKAgg
- GTKCairo
- GTK
- GDK

### Deprecated APIs

The following deprecated API elements have been removed:

- The deprecated methods `knownfailureif` and `remove_text` have been removed from `matplotlib.testing.decorators`.
- The entire contents of `testing.noseclasses` have also been removed.
- `matplotlib.checkdep_tex`, `matplotlib.checkdep_xmllint`
- `backend_bases.IdleEvent`
- `cbook.converter`, `cbook.tostr`, `cbook.todatetime`, `cbook.to date`, `cbook.tofloat`, `cbook.toint`, `cbook.unique`, `cbook.is_string_like`, `cbook.is_sequence_of_strings`, `cbook.is_scalar`, `cbook.soundex`, `cbook.dict_delall`, `cbook.get_split_ind`, `cbook.wrap`, `cbook.get_recursive_filelist`, `cbook.pieces`, `cbook.exception_to_str`, `cbook.allequal`, `cbook.alltrue`, `cbook.onetrue`, `cbook.allpairs`, `cbook.finddir`, `cbook.reverse_dict`, `cbook.restrict_dict`, `cbook.issubclass_safe`, `cbook.recursive_remove`, `cbook.unmasked_index_ranges`, `cbook.Null`, `cbook.RingBuffer`, `cbook.Sorter`, `cbook.Xlator`,
- `font_manager.weight_as_number`, `font_manager.ttfdict_to_fnames`
- `pyplot.colors`, `pyplot.spectral`
- `rcsetup.validate_negative_linestyle`, `rcsetup.validate_negative_linestyle_legacy`,
- `testing.compare.verifiers`, `testing.compare.verify`
- `testing.decorators.knownfailureif`, `testing.decorators.ImageComparisonTest.remove_text`
- `tests.assert_str_equal`, `tests.test_tinypages.file_same`
- `texmanager.dvipng_hack_alpha`,

- `_AxesBase.axesPatch`, `_AxesBase.set_color_cycle`, `_AxesBase.get_cursor_props`, `_AxesBase.set_cursor_props`
- `_ImageBase.iterpnames`
- `FigureCanvasBase.start_event_loop_default`;
- `FigureCanvasBase.stop_event_loop_default`;
- `Figure.figurePatch`,
- `FigureCanvasBase.dynamic_update`, `FigureCanvasBase.idle_event`, `FigureCanvasBase.get_linestyle`, `FigureCanvasBase.set_linestyle`
- `FigureCanvasQTAggBase`
- `FigureCanvasQTAgg.blitbox`
- `FigureCanvasTk.show` (alternative: `FigureCanvasTk.draw`)
- `FigureManagerTkAgg` (alternative: `FigureManagerTk`)
- `NavigationToolbar2TkAgg` (alternative: `NavigationToolbar2Tk`)
- `backend_wxagg.Toolbar` (alternative: `backend_wxagg.NavigationToolbar2WxAgg`)
- `RendererAgg.debug()`
- passing non-numbers to `EngFormatter.format_eng`
- passing `frac` to `PolarAxes.set_theta_grids`
- any mention of idle events

The following API elements have been removed:

- `backend_cairo.HAS_CAIRO_CFFI`
- `sphinxext.sphinx_version`

### Proprietary sphinx directives

The matplotlib documentation used the proprietary sphinx directives `htmlonly::`, and `latexonly::`. These have been replaced with the standard sphinx directives `only:: html` and `only:: latex`. This change will not affect any users. Only downstream package maintainers, who have used the proprietary directives in their docs, will have to switch to the sphinx directives.

### lib/mpl\_examples symlink

The symlink from `lib/mpl_examples` to `../examples` has been removed. This is not installed as an importable package and should not affect end users, however this may require downstream packagers to adjust. The content is still available top-level examples directory.

### 15.1.46 API Changes for 3.0.1

`tight_layout.auto_adjust_subplotpars` can return `None` now if the new subplotparams will collapse axes to zero width or height. This prevents `tight_layout` from being executed. Similarly `tight_layout.get_tight_layout_figure` will return `None`.

To improve import (startup) time, private modules are now imported lazily. These modules are no longer available at these locations:

- `matplotlib.backends.backend_agg._png`
- `matplotlib.contour._contour`
- `matplotlib.image._png`
- `matplotlib.mathtext._png`
- `matplotlib.testing.compare._png`
- `matplotlib.texmanager._png`
- `matplotlib.tri.triangulation._tri`
- `matplotlib.tri.triangulation._qhull`
- `matplotlib.tri.tricontour._tri`
- `matplotlib.tri.trifinder._tri`

### 15.1.47 API Changes for 3.1.0

- *Behavior changes*
- *pgi support dropped*
- *rcParam changes*
- *Exception changes*
- *Removals*
- *matplotlib.mlab removals*
- *matplotlib.pyplot removals*
- *mplot3d changes*
- *Testing*
- *Dependency changes*
- *Mathtext changes*
- *Signature deprecations*
- *Changes in parameter names*
- *Class/method/attribute deprecations*
- *Undeprecations*
- *New features*
- *Invalid inputs*

#### Behavior changes

## Matplotlib.use

Switching backends via `matplotlib.use` is now allowed by default, regardless of whether `matplotlib.pyplot` has been imported. If the user tries to switch from an already-started interactive backend to a different interactive backend, an `ImportError` will be raised.

## mplot3d auto-registration

`mpl_toolkits.mplot3d` is always registered by default now. It is no longer necessary to import `mplot3d` to create 3d axes with

```
ax = fig.add_subplot(111, projection="3d")
```

## Invalid points in PathCollections

`PathCollections` created with `scatter` now keep track of invalid points. Previously, points with nonfinite (infinite or nan) coordinates would not be included in the offsets (as returned by `PathCollection.get_offsets`) of a `PathCollection` created by `scatter`, and points with nonfinite values (as specified by the `c` kwarg) would not be included in the array (as returned by `PathCollection.get_array`)

Such points are now included, but masked out by returning a masked array.

If the `plotnonfinite` kwarg to `scatter` is set, then points with nonfinite values are plotted using the bad color of the `collections.PathCollection`'s colormap (as set by `colors.Colormap.set_bad()`).

## Alpha blending in imshow of RBGA input

The alpha-channel of RBGA images is now re-sampled independently of RGB channels. While this is a bug fix, it does change the output and may result in some down-stream image comparison tests to fail.

## Autoscaling

On log-axes where a single value is plotted at a "full" decade (1, 10, 100, etc.), the autoscaling now expands the axis symmetrically around that point, instead of adding a decade only to the right.

## Log-scaled axes

When the default `LogLocator` would generate no ticks for an axis (e.g., an axis with limits from 0.31 to 0.39) or only a single tick, it now instead falls back on the linear `AutoLocator` to pick reasonable tick positions.

### Figure.add\_subplot with no arguments

Calling `Figure.add_subplot()` with no positional arguments used to do nothing; this now is equivalent to calling `add_subplot(111)` instead.

### bxp and rcparams

`bxp` now respects `rcParams["boxplot.boxprops.linewidth"]` even when `patch_artist` is set. Previously, when the `patch_artist` parameter was set, `bxp` would ignore `rcParams["boxplot.boxprops.linewidth"]`. This was an oversight - in particular, `boxplot` did not ignore it.

### Major/minor tick collisions

Minor ticks that collide with major ticks are now hidden by default. Previously, certain locator classes (`LogLocator`, `AutoMinorLocator`) contained custom logic to avoid emitting tick locations that collided with major ticks when they were used as minor locators. This logic has now moved to the `Axis` class, and is used regardless of the locator class. You can control this behavior via the `remove_overlapping_locs` attribute on `Axis`.

If you were relying on both the major and minor tick labels to appear on the same tick, you may need to update your code. For example, the following snippet

```
import numpy as np
import matplotlib.dates as mdates
import matplotlib.pyplot as plt

t = np.arange("2018-11-03", "2018-11-06", dtype="datetime64")
x = np.random.rand(len(t))

fig, ax = plt.subplots()
ax.plot(t, x)
ax.xaxis.set(
    major_locator=mdates.DayLocator(),
    major_formatter=mdates.DateFormatter("%n%a"),
    minor_locator=mdates.HourLocator((0, 6, 12, 18)),
    minor_formatter=mdates.DateFormatter("%H:%M"),
)
# disable removing overlapping locations
ax.xaxis.remove_overlapping_locs = False
plt.show()
```

labeled days using major ticks, and hours and minutes using minor ticks and added a newline to the major ticks labels to avoid them crashing into the minor tick labels. Setting the `remove_overlapping_locs` property (also accessible via `set_remove_overlapping_locs` / `get_remove_overlapping_locs` and `setp`) disables removing overlapping tick locations.

The major tick labels could also be adjusted include hours and minutes, as the minor ticks are gone, so the `major_formatter` would be:

```
mdates.DateFormatter("%H:%M\n%a")
```

### usetex support

Previously, if `rcParams["text.usetex"]` was `True`, then constructing a `TextPath` on a non-mathtext string with `usetex=False` would rely on the mathtext parser (but not on usetex support!) to parse the string. The mathtext parser is not invoked anymore, which may cause slight changes in glyph positioning.

### get\_window\_extents

`matplotlib.axes.Axes.get_window_extent` used to return a bounding box that was slightly larger than the axes, presumably to take into account the ticks that may be on a spine. However, it was not scaling the tick sizes according to the dpi of the canvas, and it did not check if the ticks were visible, or on the spine.

Now `matplotlib.axes.Axes.get_window_extent` just returns the axes extent with no padding for ticks.

This affects `matplotlib.axes.Axes.get_tightbbox` in cases where there are outward ticks with no tick labels, and it also removes the (small) pad around axes in that case.

`spines.Spine.get_window_extent` now takes into account ticks that are on the spine.

### Sankey

Previously, `Sankey.add` would only accept a single string as the `labels` argument if its length is equal to the number of flows, in which case it would use one character of the string for each flow.

The behavior has been changed to match the documented one: when a single string is passed, it is used to label all the flows.

### FontManager scores

`font_manager.FontManager.score_weight` is now more strict with its inputs. Previously, when a weight string was passed to `font_manager.FontManager.score_weight`,

- if the weight was the string representation of an integer, it would be converted to that integer,
- otherwise, if the weight was not a standard weight name, it would be silently replaced by a value of 500 ("normal" weight).

`font_manager.FontManager.score_weight` now raises an exception on such inputs.

### Text alignment

Text alignment was previously incorrect, in particular for multiline text objects with large descenders (i.e. subscripts) and rotated text. These have been fixed and made more consistent, but could make old code that has compensated for this no longer have the correct alignment.

### Upper case color strings

Support for passing single-letter colors (one of "rgbcmykw") as UPPERCASE characters is deprecated; these colors will become case-sensitive (lowercase) after the deprecation period has passed.

The goal is to decrease the number of ambiguous cases when using the `data` keyword to plotting methods; e.g. `plot("X", "Y", data={"X": ..., "Y": ...})` will not warn about "Y" possibly being a color anymore after the deprecation period has passed.

### Degenerate limits

When bounds passed to `set_xlim` are degenerate (i.e. the lower and upper value are equal), the method used to "expand" the bounds now matches the expansion behavior of autoscaling when the plot contains a single x-value, and should in particular produce nicer limits for non-linear scales.

### plot format string parsing

In certain cases, `plot` would previously accept format strings specifying more than one linestyle (e.g. "---." which specifies both "---" and "-."); only use one of them would be used. This now raises a `ValueError` instead.

### HTMLWriter

The `HTMLWriter` constructor is more strict: it no longer normalizes unknown values of `default_mode` to 'loop', but errors out instead.

### AFM parsing

In accordance with the AFM spec, the AFM parser no longer truncates the `UnderlinePosition` and `UnderlineThickness` fields to integers.

The `Notice` field (which can only be publicly accessed by the deprecated `afm.parse_afm` API) is no longer decoded to a `str`, but instead kept as `bytes`, to support non-conformant AFM files that use non-ASCII characters in that field.

### Artist.set keyword normalisation

`Artist.set` now normalizes keywords before sorting them. Previously it sorted its keyword arguments in reverse alphabetical order (with a special-case to put `color` at the end) before applying them.

It now normalizes aliases (and, as above, emits a warning on duplicate properties) before doing the sorting (so `c` goes to the end too).

### Axes.tick\_params argument checking

Previously `Axes.tick_params` silently did nothing when an invalid `axis` parameter was supplied. This behavior has been changed to raise a `ValueError` instead.

### Axes.hist output

Input that consists of multiple empty lists will now return a list of histogram values for each one of the lists. For example, an input of `[[], []]` will return 2 lists of histogram values. Previously, a single list was returned.

### backend\_bases.Timer.remove\_callback future signature change

Currently, `backend_bases.Timer.remove_callback(func, *args, **kwargs)` removes a callback previously added by `backend_bases.Timer.add_callback(func, *args, **kwargs)`, but if `*args, **kwargs` is not passed in (ex, `Timer.remove_callback(func)`), then the first callback with a matching `func` is removed, regardless of whether it was added with or without `*args, **kwargs`.

In a future version, `Timer.remove_callback` will always use the latter behavior (not consider `*args, **kwargs`); to specifically consider them, add the callback as a `functools.partial` object

```
cb = timer.add_callback(functools.partial(func, *args, **kwargs))
# ...
# later
timer.remove_callback(cb)
```

`backend_bases.Timer.add_callback` was modified to return `func` to simplify the above usage (previously it returned `None`); this also allows using it as a decorator.

The new API is modelled after `atexit.register / atexit.unregister`.

### StemContainer performance increase

`StemContainer` objects can now store a `LineCollection` object instead of a list of `Line2D` objects for stem lines plotted using `stem`. This gives a very large performance boost to displaying and moving stem plots.

This will become the default behaviour in Matplotlib 3.3. To use it now, the `use_line_collection` keyword argument to `stem` can be set to `True`

```
ax.stem(..., use_line_collection=True)
```

Individual line segments can be extracted from the `LineCollection` using `get_segments()`. See the `LineCollection` documentation for other methods to retrieve the collection properties.

### ColorbarBase inheritance

`matplotlib.colorbar.ColorbarBase` is no longer a subclass of `cm.ScalarMappable`. This inheritance lead to a confusing situation where the `cm.ScalarMappable` passed to `matplotlib.colorbar.Colorbar` (`colorbar`) had a `set_norm` method, as did the `colorbar`. The `colorbar` is now purely a follower to the `ScalarMappable` norm and `colormap`, and the old inherited methods

`set_norm`, `set_cmap`, `set_clim` are deprecated, as are the getter versions of those calls. To set the norm associated with a colorbar do `colorbar.mappable.set_norm()` etc.

### FreeType and libpng search paths

The `MPLBASEDIRLIST` environment variables and `basedirlist` entry in `setup.cfg` have no effect anymore. Instead, if building in situations where FreeType or libpng are not in the compiler or linker's default path, set the standard environment variables `CFLAGS/LDFLAGS` on Linux or OSX, or `CL/LINK` on Windows, to indicate the relevant paths.

See details in [Installing](#).

### Setting artist properties twice or more in the same call

Setting the same artist property multiple time via aliases is deprecated. Previously, code such as

```
plt.plot([0, 1], c="red", color="blue")
```

would emit a warning indicating that `c` and `color` are aliases of one another, and only keep the `color` kwarg. This behavior has been deprecated; in a future version, this will raise a `TypeError`, similar to Python's behavior when a keyword argument is passed twice

```
plt.plot([0, 1], c="red", c="blue")
```

This warning is raised by `normalize_kwargs`.

### Path code types

Path code types like `Path.MOVETO` are now `np.uint8` instead of `int`. `Path.STOP`, `Path.MOVETO`, `Path.LINEETO`, `Path.CURVE3`, `Path.CURVE4` and `Path.CLOSEPOLY` are now of the type `Path.code_type` (`np.uint8` by default) instead of plain `int`. This makes their type match the array value type of the `Path.codes` array.

### LaTeX code in matplotlibrc file

Previously, the rc file keys `pgf.preamble` and `text.latex.preamble` were parsed using commas as separators. This would break valid LaTeX code, such as:

```
\usepackage[protrusion=true, expansion=false]{microtype}
```

The parsing has been modified to pass the complete line to the LaTeX system, keeping all commas. Passing a list of strings from within a Python script still works as it used to. Passing a list containing non-strings now fails, instead of coercing the results to strings.

### Axes.spy

The method `Axes.spy` now raises a `TypeError` for the keyword arguments `interpolation` and `linestyle` instead of silently ignoring them.

Furthermore, `Axes.spy` now allow for an `extent` argument (was silently ignored so far).

A bug with `Axes.spy(..., origin='lower')` is fixed. Previously this flipped the data but not the y-axis resulting in a mismatch between axes labels and actual data indices. Now, `origin='lower'` flips both the data and the y-axis labels.

### Boxplot tick methods

The `manage_xticks` parameter of `boxplot` and `bxp` has been renamed (with a deprecation period) to `manage_ticks`, to take into account the fact that it manages either x or y ticks depending on the `vert` parameter.

When `manage_ticks=True` (the default), these methods now attempt to take previously drawn boxplots into account when setting the axis limits, ticks, and tick labels.

### MouseEvent

`MouseEvent` now include the event name in their `str()`. Previously they contained the prefix "MPL MouseEvent".

### RGBA buffer return type

`FigureCanvasAgg.buffer_rgba` and `RendererAgg.buffer_rgba` now return a memoryview. The `buffer_rgba` method now allows direct access to the renderer's underlying buffer (as a (m, n, 4)-shape memoryview) rather than copying the data to a new bytestring. This is consistent with the behavior on Py2, where a buffer object was returned.

### `matplotlib.font_manager.win32InstalledFonts` return type

`matplotlib.font_manager.win32InstalledFonts` returns an empty list instead of `None` if no fonts are found.

### `Axes.fmt_xdata` and `Axes.fmt_ydata` error handling

Previously, if the user provided a `Axes.fmt_xdata` or `Axes.fmt_ydata` function that raised a `TypeError` (or set them to a non-callable), the exception would be silently ignored and the default formatter be used instead. This is no longer the case; the exception is now propagated out.

### Deprecation of redundant Tick attributes

The `grid0n`, `tick10n`, `tick20n`, `label10n`, and `label20n` *Tick* attributes have been deprecated. Directly get and set the visibility of the underlying artists, available as the `gridline`, `tick1line`, `tick2line`, `label1`, and `label2` attributes.

The `label` attribute, which was an alias for `label1`, has been deprecated.

Subclasses that relied on setting the above visibility attributes needs to be updated; see e.g. `examples/api/skewt.py`.

### Passing a Line2D's drawstyle together with the linestyle is deprecated

Instead of `plt.plot(..., linestyle="steps--"),` use `plt.plot(..., linestyle="--", drawstyle="steps").` `ds` is now an alias for `drawstyle`.

### pgi support dropped

Support for `pgi` in the GTK3 backends has been dropped. `pgi` is an alternative implementation to `PyGObject`. `PyGObject` should be used instead.

### rcParam changes

#### Removed

The following deprecated rcParams have been removed:

- `text.dvipnghack`
- `nbagg.transparent` (use `rcParams["figure.facecolor"]` instead)
- `plugins.directory`
- `axes.hold`
- `backend.qt4` and `backend.qt5` (set the `QT_API` environment variable instead)

#### Deprecated

The associated validator functions `rcsetup.validate_qt4` and `validate_qt5` are deprecated.

The `verbose.fileo` and `verbose.level` rcParams have been deprecated. These have had no effect since the switch from Matplotlib's old custom Verbose logging to the `stdlib`'s `logging` module. In addition the `rcsetup.validate_verbose` function is deprecated.

The `text.latex.unicode` rcParam now defaults to `True` and is deprecated (i.e., in future versions of Matplotlib, unicode input will always be supported). Moreover, the underlying implementation now uses `\usepackage[utf8]{inputenc}` instead of `\usepackage{ucs}\usepackage[utf8x]{inputenc}`.

#### Exception changes

- `mpl_toolkits.axes_grid1.axes_size.GetExtentHelper` now raises `ValueError` for invalid directions instead of `KeyError`.
- Previously, subprocess failures in the animation framework would raise either in a `RuntimeError` or a `ValueError` depending on when the error occurred. They now raise a `subprocess.CalledProcessError` with attributes set as documented by the exception class.

- In certain cases, Axes methods (and pyplot functions) used to raise a `RuntimeError` if they were called with a data kwarg and otherwise mismatched arguments. They now raise a `TypeError` instead.
- `Axes.streamplot` does not support irregularly gridded x and y values. So far, it used to silently plot an incorrect result. This has been changed to raise a `ValueError` instead.
- The `streamplot.Grid` class, which is internally used by streamplot code, also throws a `ValueError` when irregularly gridded values are passed in.

## Removals

The following deprecated APIs have been removed:

### Classes and methods

- `Verbose` (replaced by python logging library)
- `artist.Artist.hitlist` (no replacement)
- `artist.Artist.is_figure_set` (use `artist.figure` is not `None` instead)
- `axis.Axis.unit_data` (use `axis.Axis.units` instead)
- `backend_bases.FigureCanvasBase.onRemove` (no replacement)      `backend_bases.FigureManagerBase.show_popup` (this never did anything)
- `backend_wx.SubplotToolWx` (no replacement)
- `backend_wx.Toolbar` (use `backend_wx.NavigationToolbar2Wx` instead)
- `cbook.align_iterators` (no replacement)
- `contour.ContourLabeler.get_real_label_width` (no replacement)
- `legend.Legend.draggable` (use `legend.Legend.set_draggable()` instead)
- `texmanager.TexManager.postscriptd`, `texmanager.TexManager.pscnt`, `texmanager.TexManager.make_ps`, `texmanager.TexManager.get_ps_bbox` (no replacements)

### Arguments

- The `fig` kwarg to `GridSpec.get_subplot_params` and `GridSpecFromSubplotSpec.get_subplot_params` (use the argument `figure` instead)
- Passing 'box-forced' to `Axes.set_adjustable` (use 'box' instead)
- Support for the strings 'on'/'true'/'off'/'false' to mean `True` / `False` (directly use `True` / `False` instead). The following functions are affected:
  - `axes.Axes.grid`
  - `Axes3D.grid`
  - `Axis.set_tick_params`
  - `pyplot.box`
- Using `pyplot.axes` with an `axes.Axes` type argument (use `pyplot.sca` instead)

## Other

The following miscellaneous API elements have been removed

- `svgfont` support (in `rcParams["svg.fonttype"]`)
- Logging is now done with the standard python logging library. `matplotlib.verbose` and the command line switches `--verbose-LEVEL` have been removed.

To control the logging output use:

```
import logging
logger = logging.getLogger('matplotlib')
logger.setLevel(logging.INFO)
```

- `__version__numpy__`
- `collections.CIRCLE_AREA_FACTOR`
- `font_manager.USE_FONTCONFIG`
- `font_manager.cachedir`

### `matplotlib.mlab` removals

Lots of code inside the `matplotlib.mlab` module which was deprecated in Matplotlib 2.2 has been removed. See below for a list:

- `mlab.exp_safe` (use `numpy.exp` instead)
- `mlab.amap`
- `mlab.logspace` (use `numpy.logspace` instead)
- `mlab.rms_flat`
- `mlab.l1norm` (use `numpy.linalg.norm(a, ord=1)` instead)
- `mlab.l2norm` (use `numpy.linalg.norm(a, ord=2)` instead)
- `mlab.norm_flat` (use `numpy.linalg.norm(a.flat, ord=2)` instead)
- `mlab.frange` (use `numpy.arange` instead)
- `mlab.identity` (use `numpy.identity` instead)
- `mlab.base_repr`
- `mlab.binary_repr`
- `mlab.ispower2`
- `mlab.log2` (use `numpy.log2` instead)
- `mlab.isvector`
- `mlab.movavg`
- `mlab.safe_isinf` (use `numpy.isinf` instead)
- `mlab.safe_isnan` (use `numpy.isnan` instead)
- `mlab.cohere_pairs` (use `scipy.signal.coherence` instead)
- `mlab.entropy` (use `scipy.stats.entropy` instead)

- `mlab.normpdf` (use `scipy.stats.norm.pdf` instead)
- `mlab.find` (use `np.nonzero(np.ravel(condition))` instead)
- `mlab.longest_contiguous_ones`
- `mlab.longest_ones`
- `mlab.PCA`
- `mlab.prctile` (use `numpy.percentile` instead)
- `mlab.prctile_rank`
- `mlab.center_matrix`
- `mlab.rk4` (use `scipy.integrate.ode` instead)
- `mlab.bivariate_normal`
- `mlab.get_xyz_where`
- `mlab.get_sparse_matrix`
- `mlab.dist` (use `numpy.hypot` instead)
- `mlab.dist_point_to_segment`
- `mlab.griddata` (use `scipy.interpolate.griddata`)
- `mlab.less_simple_linear_interpolation` (use `numpy.interp`)
- `mlab.slopes`
- `mlab.stineman_interp`
- `mlab.segments_intersect`
- `mlab.fftsurr`
- `mlab.offset_line`
- `mlab.quad2cubic`
- `mlab.vector_lengths`
- `mlab.distances_along_curve`
- `mlab.path_length`
- `mlab.cross_from_above`
- `mlab.cross_from_below`
- `mlab.contiguous_regions` (use `cbook.contiguous_regions` instead)
- `mlab.is_closed_polygon`
- `mlab.poly_between`
- `mlab.poly_below`
- `mlab.inside_poly`
- `mlab.csv2rec`
- `mlab.rec2csv` (use `numpy.recarray.tofile` instead)
- `mlab.rec2text` (use `numpy.recarray.tofile` instead)
- `mlab.rec_summarize`

- `mlab.rec_join`
- `mlab.recs_join`
- `mlab.rec_groupby`
- `mlab.rec_keep_fields`
- `mlab.rec_drop_fields`
- `mlab.rec_append_fields`
- `mlab.csvformat_factory`
- `mlab.get_formatd`
- `mlab.FormatDatetime` (use `datetime.datetime.strftime` instead)
- `mlab.FormatDate` (use `datetime.date.strftime` instead)
- `mlab.FormatMillions`, `mlab.FormatThousands`, `mlab.FormatPercent`, `mlab.FormatBool`, `mlab.FormatInt`, `mlab.FormatFloat`, `mlab.FormatFormatStr`, `mlab.FormatString`, `mlab.FormatObj`
- `mlab.donothing_callback`

#### `matplotlib.pyplot` removals

Lots of code inside the `matplotlib.mlab` module which was deprecated in Matplotlib 2.2 has been removed. This means the following functions are no longer available in the `matplotlib.pyplot` module:

- `amap`
- `base_repr`
- `binary_repr`
- `bivariate_normal`
- `center_matrix`
- `csv2rec` (use `numpy.recarray.tofile` instead)
- `dist` (use `numpy.hypot` instead)
- `dist_point_to_segment`
- `distances_along_curve`
- `entropy` (use `scipy.stats.entropy` instead)
- `exp_safe` (use `numpy.exp` instead)
- `fftsurr`
- `find` (use `np.nonzero(np.ravel(condition))` instead)
- `frange` (use `numpy.arange` instead)
- `get_sparse_matrix`
- `get_xyz_where`
- `griddata` (use `scipy.interpolate.griddata` instead)
- `identity` (use `numpy.identity` instead)
- `inside_poly`

- `is_closed_polygon`
- `ispower2`
- `isvector`
- `l1norm` (use `numpy.linalg.norm(a, ord=1)` instead)
- `l2norm` (use `numpy.linalg.norm(a, ord=2)` instead)
- `log2` (use `numpy.log2` instead)
- `longest_contiguous_ones`
- `longest_ones`
- `movavg`
- `norm_flat` (use `numpy.linalg.norm(a.flat, ord=2)` instead)
- `normpdf` (use `scipy.stats.norm.pdf` instead)
- `path_length`
- `poly_below`
- `poly_between`
- `prctile` (use `numpy.percentile` instead)
- `prctile_rank`
- `rec2csv` (use `numpy.recarray.tofile` instead)
- `rec_append_fields`
- `rec_drop_fields`
- `rec_join`
- `rk4` (use `scipy.integrate.ode` instead)
- `rms_flat`
- `segments_intersect`
- `slopes`
- `stineman_interp`
- `vector_lengths`

### **mplot3d changes**

#### **Voxel shading**

*Axes3D.voxels* now shades the resulting voxels; for more details see [What's new](#). The previous behavior can be achieved by passing

```
ax.voxels(..., shade=False)
```

## Equal aspect axes disabled

Setting the aspect on 3D axes previously returned non-sensical results (e.g. see #1077). Calling `ax.set_aspect('equal')` or `ax.set_aspect(num)` on a 3D axes now raises a `NotImplementedError`.

## `Poly3DCollection.set_zsort`

`Poly3DCollection.set_zsort` no longer silently ignores invalid inputs, or `False` (which was always broken). Passing `True` to mean "average" is deprecated.

## Testing

The `--no-network` flag to `tests.py` has been removed (no test requires internet access anymore). If it is desired to disable internet access both for old and new versions of Matplotlib, use `tests.py -m 'not network'` (which is now a no-op).

The image comparison test decorators now skip (rather than xfail) the test for uncomparable formats. The affected decorators are `image_comparison` and `check_figures_equal`. The deprecated `ImageComparisonTest` class is likewise changed.

## Dependency changes

### numpy

Matplotlib 3.1 now requires `numpy>=1.11`.

### ghostscript

Support for ghostscript 8.60 (released in 2007) has been removed. The oldest supported version of ghostscript is now 9.0 (released in 2010).

## Mathtext changes

- In constructs such as `"$1~2$"`, `mathtext` now interprets the tilde as a space, consistently with TeX (this was previously a parse error).

## Deprecations

- The `\stackrel` `mathtext` command has been deprecated (it behaved differently from LaTeX's `\stackrel`. To stack two `mathtext` expressions, use `\genfrac{left-delim}{right-delim}{fraction-bar-thickness}{}{top}{bottom}`.
- The `mathcircled` `mathtext` command (which is not a real TeX command) is deprecated. Directly use unicode characters (e.g. `"\N{CIRCLED LATIN CAPITAL LETTER A}"` or `"\u24b6"`) instead.
- Support for setting `rcParams["mathtext.default"]` to `circled` is deprecated.

## Signature deprecations

The following signature related behaviours are deprecated:

- The *withdash* keyword argument to *Axes.text()*. Consider using *Axes.annotate()* instead.
- Passing (n, 1)-shaped error arrays to *Axes.errorbar()*, which was not documented and did not work for n = 2. Pass a 1D array instead.
- The *frameon* kwarg to *savefig* and the `rcParams["savefig.frameon"]` rcParam. To emulate `frameon = False`, set *facecolor* to fully transparent ("none", or (0, 0, 0, 0)).
- Passing a non-1D (typically, (n, 1)-shaped) input to *Axes.pie*. Pass a 1D array instead.
- The *TextPath* constructor used to silently drop ignored arguments; this behavior is deprecated.
- The *usetex* parameter of *TextToPath.get\_text\_path* is deprecated and folded into the *ismath* parameter, which can now take the values `False`, `True`, and "TeX", consistently with other low-level text processing functions.
- Passing 'normal' to *axes.Axes.axis()* is deprecated, use `ax.axis('auto')` instead.
- Passing the *block* argument of *pyplot.show* positionally is deprecated; it should be passed by keyword.
- When using the nbagg backend, *pyplot.show* used to silently accept and ignore all combinations of positional and keyword arguments. This behavior is deprecated.
- The unused *shape* and *imlim* parameters to *Axes.imshow* are deprecated. To avoid triggering the deprecation warning, the *filternorm*, *filterrad*, *resample*, and *url* arguments should be passed by keyword.
- The *interp\_at\_native* parameter to *BboxImage*, which has had no effect since Matplotlib 2.0, is deprecated.
- All arguments to the `cbook.deprecated` decorator and `cbook.warn_deprecated` function, except the first one (the version where the deprecation occurred), are now keyword-only. The goal is to avoid accidentally setting the "message" argument when the "name" (or "alternative") argument was intended, as this has repeatedly occurred in the past.
- The arguments of `matplotlib.testing.compare.calculate_rms` have been renamed from `expectedImage`, `actualImage`, to `expected_image`, `actual_image`.
- Passing positional arguments to *Axis.set\_ticklabels* beyond *ticklabels* itself has no effect, and support for them is deprecated.
- Passing `shade=None` to *plot\_surface* is deprecated. This was an unintended implementation detail with the same semantics as `shade=False`. Please use the latter code instead.
- *matplotlib.ticker.MaxNLocator* and its *set\_params* method will issue a warning on unknown keyword arguments instead of silently ignoring them. Future versions will raise an error.

## Changes in parameter names

- The *arg* parameter to *matplotlib.use* has been renamed to *backend*.

This will only affect cases where that parameter has been set as a keyword argument. The common usage pattern as a positional argument `matplotlib.use('Qt5Agg')` is not affected.

- The *normed* parameter to `Axes.hist2d` has been renamed to *density*.
- The *s* parameter to `Annotation` (and indirectly `Axes.annotation`) has been renamed to *text*.
- The *tolerance* parameter to `bezier.find_bezier_t_intersecting_with_closedpath`, `bezier.split_bezier_intersecting_with_closedpath`, `bezier.find_r_to_boundary_of_closedpath`, `bezier.split_path_inout` and `bezier.check_if_parallel` has been renamed to *tolerance*.

In each case, the old parameter name remains supported (it cannot be used simultaneously with the new name), but support for it will be dropped in Matplotlib 3.3.

### Class/method/attribute deprecations

Support for custom backends that do not provide a `GraphicsContextBase.set_hatch_color` method is deprecated. We suggest that custom backends let their `GraphicsContext` class inherit from `GraphicsContextBase`, to at least provide stubs for all required methods.

- `spine.Spine.is_frame_like`

This has not been used in the codebase since its addition in 2009.

- `axis3d.Axis.get_tick_positions`

This has never been used internally, there is no equivalent method exists on the 2D `Axis` classes, and despite the similar name, it has a completely different behavior from the 2D `Axis`' `axis.Axis.get_ticks_position` method.

- `backend_pgf.LatexManagerFactory`
- `mpl_toolkits.axisartist.axislines.SimpleChainedObjects`
- `mpl_toolkits.Axes.AxisDict`

### Internal Helper Functions

- `checkdep_dvipng`
- `checkdep_ghostscript`
- `checkdep_pdftops`
- `checkdep_inkscape`
- `ticker.decade_up`
- `ticker.decade_down`
- `cbook.dedent`
- `docstring.Appender`
- `docstring.dedent`
- `docstring.copy_dedent`

Use the standard library's docstring manipulation tools instead, such as `inspect.cleandoc` and `inspect.getdoc`.

- `matplotlib.scale.get_scale_docs()`
- `matplotlib.pyplot.get_scale_docs()`

These are considered internal and will be removed from the public API in a future version.

- `projections.process_projection_requirements`
- `backend_ps.PsBackendHelper``
- `backend_ps.ps_backend_helper``,
- `cbook.iterable`
- `cbook.get_label`
- `cbook.safezip` Manually check the lengths of the inputs instead, or rely on numpy to do it.
- `cbook.is_hashable` Use `isinstance(..., collections.abc.Hashable)` instead.
- The `backend_bases.RendererBase.strip_math`. Use `cbook.strip_math` instead.

Multiple internal functions that were exposed as part of the public API of `mpl_toolkits.mplot3d` are deprecated,

### **mpl\_toolkits.mplot3d.art3d**

- `mpl_toolkits.mplot3d.art3d.norm_angle()`
- `mpl_toolkits.mplot3d.art3d.norm_text_angle()`
- `mpl_toolkits.mplot3d.art3d.path_to_3d_segment()`
- `mpl_toolkits.mplot3d.art3d.paths_to_3d_segments()`
- `mpl_toolkits.mplot3d.art3d.path_to_3d_segment_with_codes()`
- `mpl_toolkits.mplot3d.art3d.paths_to_3d_segments_with_codes()`
- `mpl_toolkits.mplot3d.art3d.get_patch_verts()`
- `mpl_toolkits.mplot3d.art3d.get_colors()`
- `mpl_toolkits.mplot3d.art3d.zalpha()`

### **mpl\_toolkits.mplot3d.proj3d**

- `mpl_toolkits.mplot3d.proj3d.line2d()`
- `mpl_toolkits.mplot3d.proj3d.line2d_dist()`
- `mpl_toolkits.mplot3d.proj3d.line2d_seg_dist()`
- `mpl_toolkits.mplot3d.proj3d.mod()`
- `mpl_toolkits.mplot3d.proj3d.proj_transform_vec()`
- `mpl_toolkits.mplot3d.proj3d.proj_transform_vec_clip()`
- `mpl_toolkits.mplot3d.proj3d.vec_pad_ones()`
- `mpl_toolkits.mplot3d.proj3d.proj_trans_clip_points()`

If your project relies on these functions, consider vendoring them.

### **Font Handling**

- `backend_pdf.RendererPdf.afm_font_cache`
- `backend_ps.RendererPS.afmfontd`
- `font_manager.OSXInstalledFonts`

- `TextToPath.glyph_to_path` (Instead call `font.get_path()` and manually transform the path.)

### Date related functions

- `dates.seconds()`
- `dates.minutes()`
- `dates.hours()`
- `dates.weeks()`
- `dates.strptime2num`
- `dates.bytespdate2num`

These are brittle in the presence of locale changes. Use standard datetime parsers such as `time.strptime` or `dateutil.parser.parse`, and additionally call `matplotlib.dates.date2num` if you need to convert to Matplotlib's internal datetime representation; or use `dates.datestr2num`.

### Axes3D

- `axes3d.Axes3D.w_xaxis`
- `axes3d.Axes3D.w_yaxis`
- `axes3d.Axes3D.w_zaxis`

Use `axes3d.Axes3D.xaxis`, `axes3d.Axes3D.yaxis`, and `axes3d.Axes3D.zaxis` instead.

### Testing

- `matplotlib.testing.decorators.switch_backend` decorator

Test functions should use `pytest.mark.backend(...)`, and the mark will be picked up by the `matplotlib.testing.conf.test.mpl_test_settings` fixture.

### Quiver

- `.color` attribute of Quiver objects

Instead, use (as for any `Collection`) the `get_facecolor` method. Note that setting to the `.color` attribute did not update the quiver artist, whereas calling `set_facecolor` does.

### GUI / backend details

- `get_py2exe_datafiles``
- `tk_window_focus``
- `backend_gtk3.FileChooserDialog`
- `backend_gtk3.NavigationToolBar2GTK3.get_filechooser`
- `backend_gtk3.SaveFigureGTK3.get_filechooser`

- `NavigationToolbar2QT.adj_window` attribute. This is unused and always `None`.
- `backend_wx.IDLE_DELAY` global variable This is unused and only relevant to the now removed wx "idling" code (note that as it is a module-level global, no deprecation warning is emitted when accessing it).
- `mlab.demean`
- `backend_gtk3cairo.FigureCanvasGTK3Cairo`,
- `backend_wx.debug_on_error`, `backend_wx.fake_stderr`, `backend_wx.raise_msg_to_str`, `backend_wx.MenuButtonWx`, `backend_wx.PrintoutWx`,
- `matplotlib.backends.qt_editor.formlayout` module

This module is a vendored, modified version of the official `formlayout` module available on PyPI. Install that module separately if you need it.

- `GraphicsContextPS.shouldstroke`

### Transforms / scales

- `LogTransformBase`
- `Log10Transform`
- `Log2Transform`,
- `NaturalLogTransformLog`
- `InvertedLogTransformBase`
- `InvertedLog10Transform`
- `InvertedLog2Transform`
- `InvertedNaturalLogTransform`

These classes defined in `matplotlib.scales` are deprecated. As a replacement, use the general `LogTransform` and `InvertedLogTransform` classes, whose constructors take a *base* argument.

### Locators / Formatters

- `OldScalarFormatter.pprint_val`
- `ScalarFormatter.pprint_val`
- `LogFormatter.pprint_val`

These are helper methods that do not have a consistent signature across formatter classes.

### Path tools

- `path.get_paths_extents`

Use `get_path_collection_extents` instead.

- `Path.has_nonfinite` attribute

Use not `np.isfinite(path.vertices).all()` instead.

- `bezier.find_r_to_boundary_of_closedpath` function is deprecated

This has always returned `None` instead of the requested radius.

## Text

- `text.TextWithDash`
- `Text.is_math_text`
- `TextPath.is_math_text`
- `TextPath.text_get_vertices_codes` (As an alternative, construct a new `TextPath` object.)

## Unused attributes

- `NavigationToolbar2QT.buttons`
- `Line2D.verticalOffset`
- `Quiver.keytext`
- `Quiver.keyvec`
- `SpanSelector.buttonDown`

These are unused and never updated.

## Sphinx extensions

- `matplotlib.sphinxext.mathmpl.math_directive`
- `matplotlib.sphinxext.plot_directive.plot_directive`

This is because the `matplotlib.sphinxext.mathmpl` and `matplotlib.sphinxext.plot_directive` interfaces have changed from the (Sphinx-)deprecated function-based interface to a class-based interface; this should not affect end users.

- `mpl_toolkits.axisartist.axis_artist.UnimplementedException`

## Environmental Variables

- The `MATPLOTLIBDATA` environment variable

## Axis

- `Axis.iter_ticks`

This only served as a helper to the private `Axis._update_ticks`

## Undeprecations

The following API elements have been un-deprecated:

- The `obj_type` kwarg to the `book.deprecated` decorator.
- `xmin`, `xmax` kwargs to `Axes.set_xlim` and `ymin`, `ymax` kwargs to `Axes.set_ylim`

## New features

### Text now has a `c` alias for the `color` property

For consistency with *Line2D*, the *Text* class has gained the `c` alias for the `color` property. For example, one can now write

```
ax.text(.5, .5, "foo", c="red")
```

### C<sub>n</sub> colors now support `n` ≥ 10

It is now possible to go beyond the tenth color in the property cycle using C<sub>n</sub> syntax, e.g.

```
plt.plot([1, 2], color="C11")
```

now uses the 12th color in the cycle.

Note that previously, a construct such as:

```
plt.plot([1, 2], "C11")
```

would be interpreted as a request to use color C1 and marker 1 (an "inverted Y"). To obtain such a plot, one should now use

```
plt.plot([1, 2], "1C1")
```

(so that the first "1" gets correctly interpreted as a marker specification), or, more explicitly:

```
plt.plot([1, 2], marker="1", color="C1")
```

### New `Formatter.format_ticks` method

The *Formatter* class gained a new `format_ticks` method, which takes the list of all tick locations as a single argument and returns the list of all formatted values. It is called by the axis tick handling code and, by default, first calls `set_locs` with all locations, then repeatedly calls `__call__` for each location.

Tick-handling code in the codebase that previously performed this sequence (`set_locs` followed by repeated `__call__`) have been updated to use `format_ticks`.

`format_ticks` is intended to be overridden by *Formatter* subclasses for which the formatting of a tick value depends on other tick values, such as *ConciseDateFormatter*.

### Added support for RGB(A) images in pcolorfast

pcolorfast now accepts 3D images (RGB or RGBA) arrays if the X and Y specifications allow image or pcolorimage rendering; they remain unsupported by the more general quadmesh rendering

### Invalid inputs

Passing invalid locations to *legend* and *table* used to fallback on a default location. This behavior is deprecated and will throw an exception in a future version.

*offsetbox.AnchoredText* is unable to handle the *horizontalalignment* or *verticalalignment* kwargs, and used to ignore them with a warning. This behavior is deprecated and will throw an exception in a future version.

Passing steps less than 1 or greater than 10 to *MaxNLocator* used to result in undefined behavior. It now throws a *ValueError*.

The signature of the (private) *Axis.\_update\_ticks* has been changed to not take the *renderer* as argument anymore (that argument is unused).

## 15.1.48 API Changes for 3.1.1

- *Behavior changes*

### Behavior changes

#### Locator.nonsingular return order

*Locator.nonsingular* (introduced in mpl 3.1) now returns a range  $v_0, v_1$  with  $v_0 \leq v_1$ . This behavior is consistent with the implementation of *nonsingular* by the *LogLocator* and *LogitLocator* subclasses.

Changes for the latest version are listed below. For new features that were added to Matplotlib, see *Whats New*.

## 15.2 API Changes for 3.1.1

- *Behavior changes*

## 15.2.1 Behavior changes

### Locator.nonsingular return order

`Locator.nonsingular` (introduced in mpl 3.1) now returns a range  $v_0, v_1$  with  $v_0 \leq v_1$ . This behavior is consistent with the implementation of `nonsingular` by the `LogLocator` and `LogitLocator` subclasses.

## 15.3 API Changes for 3.1.0

- *Behavior changes*
- *pgi support dropped*
- *rcParam changes*
- *Exception changes*
- *Removals*
- *matplotlib.mlab removals*
- *matplotlib.pyplot removals*
- *mplot3d changes*
- *Testing*
- *Dependency changes*
- *Mathtext changes*
- *Signature deprecations*
- *Changes in parameter names*
- *Class/method/attribute deprecations*
- *Undeprecations*
- *New features*
- *Invalid inputs*

### 15.3.1 Behavior changes

#### Matplotlib.use

Switching backends via `matplotlib.use` is now allowed by default, regardless of whether `matplotlib.pyplot` has been imported. If the user tries to switch from an already-started interactive backend to a different interactive backend, an `ImportError` will be raised.

### mplot3d auto-registration

`mpl_toolkits.mplot3d` is always registered by default now. It is no longer necessary to import `mplot3d` to create 3d axes with

```
ax = fig.add_subplot(111, projection="3d")
```

### Invalid points in PathCollections

`PathCollections` created with `scatter` now keep track of invalid points. Previously, points with nonfinite (infinite or nan) coordinates would not be included in the offsets (as returned by `PathCollection.get_offsets`) of a `PathCollection` created by `scatter`, and points with nonfinite values (as specified by the `c` kwarg) would not be included in the array (as returned by `PathCollection.get_array`)

Such points are now included, but masked out by returning a masked array.

If the `plotnonfinite` kwarg to `scatter` is set, then points with nonfinite values are plotted using the bad color of the `collections.PathCollection`'s colormap (as set by `colors.Colormap.set_bad()`).

### Alpha blending in imshow of RGBA input

The alpha-channel of RGBA images is now re-sampled independently of RGB channels. While this is a bug fix, it does change the output and may result in some down-stream image comparison tests to fail.

### Autoscaling

On log-axes where a single value is plotted at a "full" decade (1, 10, 100, etc.), the autoscaling now expands the axis symmetrically around that point, instead of adding a decade only to the right.

### Log-scaled axes

When the default `LogLocator` would generate no ticks for an axis (e.g., an axis with limits from 0.31 to 0.39) or only a single tick, it now instead falls back on the linear `AutoLocator` to pick reasonable tick positions.

### Figure.add\_subplot with no arguments

Calling `Figure.add_subplot()` with no positional arguments used to do nothing; this now is equivalent to calling `add_subplot(111)` instead.

### bxp and rcparams

`bxp` now respects `rcParams["boxplot.boxprops.linewidth"]` even when `patch_artist` is set. Previously, when the `patch_artist` parameter was set, `bxp` would ignore `rcParams["boxplot.boxprops.linewidth"]`. This was an oversight – in particular, `boxplot` did not ignore it.

### Major/minor tick collisions

Minor ticks that collide with major ticks are now hidden by default. Previously, certain locator classes (*LogLocator*, *AutoMinorLocator*) contained custom logic to avoid emitting tick locations that collided with major ticks when they were used as minor locators. This logic has now moved to the *Axis* class, and is used regardless of the locator class. You can control this behavior via the `remove_overlapping_locs` attribute on *Axis*.

If you were relying on both the major and minor tick labels to appear on the same tick, you may need to update your code. For example, the following snippet

```
import numpy as np
import matplotlib.dates as mdates
import matplotlib.pyplot as plt

t = np.arange("2018-11-03", "2018-11-06", dtype="datetime64")
x = np.random.rand(len(t))

fig, ax = plt.subplots()
ax.plot(t, x)
ax.xaxis.set(
    major_locator=mdates.DayLocator(),
    major_formatter=mdates.DateFormatter("%n%a"),
    minor_locator=mdates.HourLocator((0, 6, 12, 18)),
    minor_formatter=mdates.DateFormatter("%H:%M"),
)
# disable removing overlapping locations
ax.xaxis.remove_overlapping_locs = False
plt.show()
```

labeled days using major ticks, and hours and minutes using minor ticks and added a newline to the major ticks labels to avoid them crashing into the minor tick labels. Setting the `remove_overlapping_locs` property (also accessible via `set_remove_overlapping_locs` / `get_remove_overlapping_locs` and `setp`) disables removing overlapping tick locations.

The major tick labels could also be adjusted include hours and minutes, as the minor ticks are gone, so the `major_formatter` would be:

```
mdates.DateFormatter("%H:%M\n%a")
```

### usetex support

Previously, if `rcParams["text.usetex"]` was `True`, then constructing a `TextPath` on a non-mathtext string with `usetex=False` would rely on the mathtext parser (but not on usetex support!) to parse the string. The mathtext parser is not invoked anymore, which may cause slight changes in glyph positioning.

### get\_window\_extents

`matplotlib.axes.Axes.get_window_extent` used to return a bounding box that was slightly larger than the axes, presumably to take into account the ticks that may be on a spine. However, it was not scaling the tick sizes according to the dpi of the canvas, and it did not check if the ticks were visible, or on the spine.

Now `matplotlib.axes.Axes.get_window_extent` just returns the axes extent with no padding for ticks.

This affects `matplotlib.axes.Axes.get_tightbbox` in cases where there are outward ticks with no tick labels, and it also removes the (small) pad around axes in that case.

`spines.Spine.get_window_extent` now takes into account ticks that are on the spine.

## Sankey

Previously, `Sankey.add` would only accept a single string as the `labels` argument if its length is equal to the number of flows, in which case it would use one character of the string for each flow.

The behavior has been changed to match the documented one: when a single string is passed, it is used to label all the flows.

## FontManager scores

`font_manager.FontManager.score_weight` is now more strict with its inputs. Previously, when a weight string was passed to `font_manager.FontManager.score_weight`,

- if the weight was the string representation of an integer, it would be converted to that integer,
- otherwise, if the weight was not a standard weight name, it would be silently replaced by a value of 500 ("normal" weight).

`font_manager.FontManager.score_weight` now raises an exception on such inputs.

## Text alignment

Text alignment was previously incorrect, in particular for multiline text objects with large descenders (i.e. subscripts) and rotated text. These have been fixed and made more consistent, but could make old code that has compensated for this no longer have the correct alignment.

## Upper case color strings

Support for passing single-letter colors (one of "rgbcmykw") as UPPERCASE characters is deprecated; these colors will become case-sensitive (lowercase) after the deprecation period has passed.

The goal is to decrease the number of ambiguous cases when using the `data` keyword to plotting methods; e.g. `plot("X", "Y", data={"X": ..., "Y": ...})` will not warn about "Y" possibly being a color anymore after the deprecation period has passed.

## Degenerate limits

When bounds passed to `set_xlim` are degenerate (i.e. the lower and upper value are equal), the method used to "expand" the bounds now matches the expansion behavior of autoscaling when the plot contains a single x-value, and should in particular produce nicer limits for non-linear scales.

### plot format string parsing

In certain cases, `plot` would previously accept format strings specifying more than one linestyle (e.g. `"---."` which specifies both `"---"` and `"-."`); only use one of them would be used. This now raises a `ValueError` instead.

### HTMLWriter

The `HTMLWriter` constructor is more strict: it no longer normalizes unknown values of `default_mode` to `'loop'`, but errors out instead.

### AFM parsing

In accordance with the AFM spec, the AFM parser no longer truncates the `UnderlinePosition` and `UnderlineThickness` fields to integers.

The `Notice` field (which can only be publicly accessed by the deprecated `afm.parse_afm` API) is no longer decoded to a `str`, but instead kept as `bytes`, to support non-conformant AFM files that use non-ASCII characters in that field.

### Artist.set keyword normalisation

`Artist.set` now normalizes keywords before sorting them. Previously it sorted its keyword arguments in reverse alphabetical order (with a special-case to put `color` at the end) before applying them.

It now normalizes aliases (and, as above, emits a warning on duplicate properties) before doing the sorting (so `c` goes to the end too).

### Axes.tick\_params argument checking

Previously `Axes.tick_params` silently did nothing when an invalid `axis` parameter was supplied. This behavior has been changed to raise a `ValueError` instead.

### Axes.hist output

Input that consists of multiple empty lists will now return a list of histogram values for each one of the lists. For example, an input of `[[],[]]` will return 2 lists of histogram values. Previously, a single list was returned.

### backend\_bases.Timer.remove\_callback future signature change

Currently, `backend_bases.Timer.remove_callback(func, *args, **kwargs)` removes a callback previously added by `backend_bases.Timer.add_callback(func, *args, **kwargs)`, but if `*args, **kwargs` is not passed in (ex, `Timer.remove_callback(func)`), then the first callback with a matching `func` is removed, regardless of whether it was added with or without `*args, **kwargs`.

In a future version, `Timer.remove_callback` will always use the latter behavior (not consider `*args, **kwargs`); to specifically consider them, add the callback as a `functools.partial` object

```
cb = timer.add_callback(functools.partial(func, *args, **kwargs))
# ...
# later
timer.remove_callback(cb)
```

`backend_bases.Timer.add_callback` was modified to return *func* to simplify the above usage (previously it returned `None`); this also allows using it as a decorator.

The new API is modelled after `atexit.register / atexit.unregister`.

### StemContainer performance increase

`StemContainer` objects can now store a `LineCollection` object instead of a list of `Line2D` objects for stem lines plotted using `stem`. This gives a very large performance boost to displaying and moving stem plots.

This will become the default behaviour in Matplotlib 3.3. To use it now, the `use_line_collection` keyword argument to `stem` can be set to `True`

```
ax.stem(..., use_line_collection=True)
```

Individual line segments can be extracted from the `LineCollection` using `get_segments()`. See the `LineCollection` documentation for other methods to retrieve the collection properties.

### ColorbarBase inheritance

`matplotlib.colorbar.ColorbarBase` is no longer a subclass of `cm.ScalarMappable`. This inheritance lead to a confusing situation where the `cm.ScalarMappable` passed to `matplotlib.colorbar.Colorbar` (`colorbar`) had a `set_norm` method, as did the `colorbar`. The `colorbar` is now purely a follower to the `ScalarMappable` norm and `colormap`, and the old inherited methods `set_norm`, `set_cmap`, `set_clim` are deprecated, as are the getter versions of those calls. To set the norm associated with a `colorbar` do `colorbar.mappable.set_norm()` etc.

### FreeType and libpng search paths

The `MPLBASEDIRLIST` environment variables and `basedirlist` entry in `setup.cfg` have no effect anymore. Instead, if building in situations where `FreeType` or `libpng` are not in the compiler or linker's default path, set the standard environment variables `CFLAGS/LDFLAGS` on Linux or OSX, or `CL/LINK` on Windows, to indicate the relevant paths.

See details in `Installing`.

### Setting artist properties twice or more in the same call

Setting the same artist property multiple time via aliases is deprecated. Previously, code such as

```
plt.plot([0, 1], c="red", color="blue")
```

would emit a warning indicating that `c` and `color` are aliases of one another, and only keep the `color` kwarg. This behavior has been deprecated; in a future version, this will raise a `TypeError`, similar to Python's behavior when a keyword argument is passed twice

```
plt.plot([0, 1], c="red", c="blue")
```

This warning is raised by `normalize_kwargs`.

### Path code types

Path code types like `Path.MOVETO` are now `np.uint8` instead of `int`. `Path.STOP`, `Path.MOVETO`, `Path.LINEETO`, `Path.CURVE3`, `Path.CURVE4` and `Path.CLOSEPOLY` are now of the type `Path.code_type` (`np.uint8` by default) instead of plain `int`. This makes their type match the array value type of the `Path.codes` array.

### LaTeX code in matplotlibrc file

Previously, the rc file keys `pgf.preamble` and `text.latex.preamble` were parsed using commas as separators. This would break valid LaTeX code, such as:

```
\usepackage[protrusion=true, expansion=false]{microtype}
```

The parsing has been modified to pass the complete line to the LaTeX system, keeping all commas. Passing a list of strings from within a Python script still works as it used to. Passing a list containing non-strings now fails, instead of coercing the results to strings.

### `Axes.spy`

The method `Axes.spy` now raises a `TypeError` for the keyword arguments `interpolation` and `linestyle` instead of silently ignoring them.

Furthermore, `Axes.spy` now does allow for an `extent` argument (was silently ignored so far).

A bug with `Axes.spy(..., origin='lower')` is fixed. Previously this flipped the data but not the y-axis resulting in a mismatch between axes labels and actual data indices. Now, `origin='lower'` flips both the data and the y-axis labels.

### Boxplot tick methods

The `manage_xticks` parameter of `boxplot` and `bxp` has been renamed (with a deprecation period) to `manage_ticks`, to take into account the fact that it manages either x or y ticks depending on the `vert` parameter.

When `manage_ticks=True` (the default), these methods now attempt to take previously drawn boxplots into account when setting the axis limits, ticks, and tick labels.

### MouseEvent

`MouseEvent`s now include the event name in their `str()`. Previously they contained the prefix "MPL MouseEvent".

### RGBA buffer return type

`FigureCanvasAgg.buffer_rgba` and `RendererAgg.buffer_rgba` now return a memoryview. The `buffer_rgba` method now allows direct access to the renderer's underlying buffer (as a  $(m, n, 4)$ -shape memoryview) rather than copying the data to a new bytearray. This is consistent with the behavior on Py2, where a buffer object was returned.

### `matplotlib.font_manager.win32InstalledFonts` return type

`matplotlib.font_manager.win32InstalledFonts` returns an empty list instead of `None` if no fonts are found.

### `Axes.fmt_xdata` and `Axes.fmt_ydata` error handling

Previously, if the user provided a `Axes.fmt_xdata` or `Axes.fmt_ydata` function that raised a `TypeError` (or set them to a non-callable), the exception would be silently ignored and the default formatter be used instead. This is no longer the case; the exception is now propagated out.

### Deprecation of redundant Tick attributes

The `grid0n`, `tick10n`, `tick20n`, `label10n`, and `label20n` *Tick* attributes have been deprecated. Directly get and set the visibility on the underlying artists, available as the `gridline`, `tick1line`, `tick2line`, `label1`, and `label2` attributes.

The `label` attribute, which was an alias for `label1`, has been deprecated.

Subclasses that relied on setting the above visibility attributes needs to be updated; see e.g. `examples/api/skewt.py`.

### Passing a `Line2D`'s `drawstyle` together with the `linestyle` is deprecated

Instead of `plt.plot(..., linestyle="steps--")`, use `plt.plot(..., linestyle="--", drawstyle="steps")`. `ds` is now an alias for `drawstyle`.

## 15.3.2 pgi support dropped

Support for `pgi` in the GTK3 backends has been dropped. `pgi` is an alternative implementation to `PyGObject`. `PyGObject` should be used instead.

## 15.3.3 rcParam changes

### Removed

The following deprecated rcParams have been removed:

- `text.dvipnghack`
- `nbagg.transparent` (use `rcParams["figure.facecolor"]` instead)

- `plugins.directory`
- `axes.hold`
- `backend.qt4` and `backend.qt5` (set the `QT_API` environment variable instead)

### Deprecated

The associated validator functions `rcsetup.validate_qt4` and `validate_qt5` are deprecated.

The `verbose.fileo` and `verbose.level` `rcParams` have been deprecated. These have had no effect since the switch from Matplotlib's old custom Verbose logging to the `stdlib`'s `logging` module. In addition the `rcsetup.validate_verbose` function is deprecated.

The `text.latex.unicode` `rcParam` now defaults to `True` and is deprecated (i.e., in future versions of Matplotlib, unicode input will always be supported). Moreover, the underlying implementation now uses `\usepackage[utf8]{inputenc}` instead of `\usepackage{ucs}\usepackage[utf8x]{inputenc}`.

### 15.3.4 Exception changes

- `mpl_toolkits.axes_grid1.axes_size.GetExtentHelper` now raises `ValueError` for invalid directions instead of `KeyError`.
- Previously, subprocess failures in the animation framework would raise either in a `RuntimeError` or a `ValueError` depending on when the error occurred. They now raise a `subprocess.CalledProcessError` with attributes set as documented by the exception class.
- In certain cases, Axes methods (and pyplot functions) used to raise a `RuntimeError` if they were called with a data kwarg and otherwise mismatched arguments. They now raise a `TypeError` instead.
- `Axes.streamplot` does not support irregularly gridded `x` and `y` values. So far, it used to silently plot an incorrect result. This has been changed to raise a `ValueError` instead.
- The `streamplot.Grid` class, which is internally used by `streamplot` code, also throws a `ValueError` when irregularly gridded values are passed in.

### 15.3.5 Removals

The following deprecated APIs have been removed:

#### Classes and methods

- `Verbose` (replaced by python logging library)
- `artist.Artist.hitlist` (no replacement)
- `artist.Artist.is_figure_set` (use `artist.figure` is not `None` instead)
- `axis.Axis.unit_data` (use `axis.Axis.units` instead)
- `backend_bases.FigureCanvasBase.onRemove` (no replacement) `backend_bases.FigureManagerBase.show_popup` (this never did anything)
- `backend_wx.SubplotToolWx` (no replacement)

- `backend_wx.Toolbar` (use `backend_wx.NavigationToolbar2Wx` instead)
- `cbook.align_iterators` (no replacement)
- `contour.ContourLabeler.get_real_label_width` (no replacement)
- `legend.Legend.draggable` (use `legend.Legend.set_draggable()` instead)
- `texmanager.TexManager.postscriptd`, `texmanager.TexManager.pscnt`, `texmanager.TexManager.make_ps`, `texmanager.TexManager.get_ps_bbox` (no replacements)

## Arguments

- The `fig` kwarg to `GridSpec.get_subplot_params` and `GridSpecFromSubplotSpec.get_subplot_params` (use the argument `figure` instead)
- Passing 'box-forced' to `Axes.set_adjustable` (use 'box' instead)
- Support for the strings 'on'/'true'/'off'/'false' to mean `True` / `False` (directly use `True` / `False` instead). The following functions are affected:
  - `axes.Axes.grid`
  - `Axes3D.grid`
  - `Axis.set_tick_params`
  - `pyplot.box`
- Using `pyplot.axes` with an `axes.Axes` type argument (use `pyplot.sca` instead)

## Other

The following miscellaneous API elements have been removed

- `svgfont` support (in `rcParams["svg.fonttype"]`)
- Logging is now done with the standard python logging library. `matplotlib.verbose` and the command line switches `--verbose-LEVEL` have been removed.

To control the logging output use:

```
import logging
logger = logging.getLogger('matplotlib')
logger.set_level(logging.INFO)
```

- `__version__numpy__`
- `collections.CIRCLE_AREA_FACTOR`
- `font_manager.USE_FONTCONFIG`
- `font_manager.cachedir`

## 15.3.6 matplotlib.mlab removals

Lots of code inside the `matplotlib.mlab` module which was deprecated in Matplotlib 2.2 has been removed. See below for a list:

- `mlab.exp_safe` (use `numpy.exp` instead)

- `mlab.amap`
- `mlab.logspace` (use `numpy.logspace` instead)
- `mlab.rms_flat`
- `mlab.l1norm` (use `numpy.linalg.norm(a, ord=1)` instead)
- `mlab.l2norm` (use `numpy.linalg.norm(a, ord=2)` instead)
- `mlab.norm_flat` (use `numpy.linalg.norm(a.flat, ord=2)` instead)
- `mlab.frange` (use `numpy.arange` instead)
- `mlab.identity` (use `numpy.identity` instead)
- `mlab.base_repr`
- `mlab.binary_repr`
- `mlab.ispower2`
- `mlab.log2` (use `numpy.log2` instead)
- `mlab.isvector`
- `mlab.movavg`
- `mlab.safe_isinf` (use `numpy.isinf` instead)
- `mlab.safe_isnan` (use `numpy.isnan` instead)
- `mlab.cohere_pairs` (use `scipy.signal.coherence` instead)
- `mlab.entropy` (use `scipy.stats.entropy` instead)
- `mlab.normpdf` (use `scipy.stats.norm.pdf` instead)
- `mlab.find` (use `np.nonzero(np.ravel(condition))` instead)
- `mlab.longest_contiguous_ones`
- `mlab.longest_ones`
- `mlab.PCA`
- `mlab.prctile` (use `numpy.percentile` instead)
- `mlab.prctile_rank`
- `mlab.center_matrix`
- `mlab.rk4` (use `scipy.integrate.ode` instead)
- `mlab.bivariate_normal`
- `mlab.get_xyz_where`
- `mlab.get_sparse_matrix`
- `mlab.dist` (use `numpy.hypot` instead)
- `mlab.dist_point_to_segment`
- `mlab.griddata` (use `scipy.interpolate.griddata`)
- `mlab.less_simple_linear_interpolation` (use `numpy.interp`)
- `mlab.slopes`
- `mlab.stineman_interp`

- `mlab.segments_intersect`
- `mlab.fftsurr`
- `mlab.offset_line`
- `mlab.quad2cubic`
- `mlab.vector_lengths`
- `mlab.distances_along_curve`
- `mlab.path_length`
- `mlab.cross_from_above`
- `mlab.cross_from_below`
- `mlab.contiguous_regions` (use `cbook.contiguous_regions` instead)
- `mlab.is_closed_polygon`
- `mlab.poly_between`
- `mlab.poly_below`
- `mlab.inside_poly`
- `mlab.csv2rec`
- `mlab.rec2csv` (use `numpy.recarray.tofile` instead)
- `mlab.rec2text` (use `numpy.recarray.tofile` instead)
- `mlab.rec_summarize`
- `mlab.rec_join`
- `mlab.recs_join`
- `mlab.rec_groupby`
- `mlab.rec_keep_fields`
- `mlab.rec_drop_fields`
- `mlab.rec_append_fields`
- `mlab.csvformat_factory`
- `mlab.get_formatd`
- `mlab.FormatDatetime` (use `datetime.datetime.strftime` instead)
- `mlab.FormatDate` (use `datetime.date.strftime` instead)
- `mlab.FormatMillions`, `mlab.FormatThousands`, `mlab.FormatPercent`, `mlab.FormatBool`, `mlab.FormatInt`, `mlab.FormatFloat`, `mlab.FormatFormatStr`, `mlab.FormatString`, `mlab.FormatObj`
- `mlab.donothing_callback`

### 15.3.7 matplotlib.pylab removals

Lots of code inside the `matplotlib.mlab` module which was deprecated in Matplotlib 2.2 has been removed. This means the following functions are no longer available in the `matplotlib.pylab` module:

- `amap`

- `base_repr`
- `binary_repr`
- `bivariate_normal`
- `center_matrix`
- `csv2rec` (use `numpy.recarray.tofile` instead)
- `dist` (use `numpy.hypot` instead)
- `dist_point_to_segment`
- `distances_along_curve`
- `entropy` (use `scipy.stats.entropy` instead)
- `exp_safe` (use `numpy.exp` instead)
- `fftsurr`
- `find` (use `np.nonzero(np.ravel(condition))` instead)
- `frange` (use `numpy.arange` instead)
- `get_sparse_matrix`
- `get_xyz_where`
- `griddata` (use `scipy.interpolate.griddata` instead)
- `identity` (use `numpy.identity` instead)
- `inside_poly`
- `is_closed_polygon`
- `ispower2`
- `isvector`
- `l1norm` (use `numpy.linalg.norm(a, ord=1)` instead)
- `l2norm` (use `numpy.linalg.norm(a, ord=2)` instead)
- `log2` (use `numpy.log2` instead)
- `longest_contiguous_ones`
- `longest_ones`
- `movavg`
- `norm_flat` (use `numpy.linalg.norm(a.flat, ord=2)` instead)
- `normpdf` (use `scipy.stats.norm.pdf` instead)
- `path_length`
- `poly_below`
- `poly_between`
- `prctile` (use `numpy.percentile` instead)
- `prctile_rank`
- `rec2csv` (use `numpy.recarray.tofile` instead)
- `rec_append_fields`

- `rec_drop_fields`
- `rec_join`
- `rk4` (use `scipy.integrate.ode` instead)
- `rms_flat`
- `segments_intersect`
- `slopes`
- `stineman_interp`
- `vector_lengths`

### 15.3.8 mplot3d changes

#### Voxel shading

`Axes3D.voxels` now shades the resulting voxels; for more details see What's new. The previous behavior can be achieved by passing

```
ax.voxels(.., shade=False)
```

#### Equal aspect axes disabled

Setting the aspect on 3D axes previously returned non-sensical results (e.g. see #1077). Calling `ax.set_aspect('equal')` or `ax.set_aspect(num)` on a 3D axes now raises a `NotImplementedError`.

#### `Poly3DCollection.set_zsort`

`Poly3DCollection.set_zsort` no longer silently ignores invalid inputs, or `False` (which was always broken). Passing `True` to mean "average" is deprecated.

### 15.3.9 Testing

The `--no-network` flag to `tests.py` has been removed (no test requires internet access anymore). If it is desired to disable internet access both for old and new versions of Matplotlib, use `tests.py -m 'not network'` (which is now a no-op).

The image comparison test decorators now skip (rather than xfail) the test for uncomparable formats. The affected decorators are `image_comparison` and `check_figures_equal`. The deprecated `ImageComparisonTest` class is likewise changed.

### 15.3.10 Dependency changes

#### numpy

Matplotlib 3.1 now requires `numpy>=1.11`.

## ghostscript

Support for ghostscript 8.60 (released in 2007) has been removed. The oldest supported version of ghostscript is now 9.0 (released in 2010).

### 15.3.11 Mathtext changes

- In constructs such as "\$1~2\$", `mathtext` now interprets the tilde as a space, consistently with TeX (this was previously a parse error).

#### Deprecations

- The `\stackrel` `mathtext` command has been deprecated (it behaved differently from LaTeX's `\stackrel`). To stack two `mathtext` expressions, use `\genfrac{left-delim}{right-delim}{fraction-bar-thickness}{}{top}{bottom}`.
- The `mathcircled` `mathtext` command (which is not a real TeX command) is deprecated. Directly use unicode characters (e.g. `\N{CIRCLED LATIN CAPITAL LETTER A}` or `\u24b6`) instead.
- Support for setting `rcParams["mathtext.default"]` to `circled` is deprecated.

### 15.3.12 Signature deprecations

The following signature related behaviours are deprecated:

- The `withdash` keyword argument to `Axes.text()`. Consider using `Axes.annotate()` instead.
- Passing (n, 1)-shaped error arrays to `Axes.errorbar()`, which was not documented and did not work for `n = 2`. Pass a 1D array instead.
- The `frameon` kwarg to `savefig` and the `rcParams["savefig.frameon"]` rcParam. To emulate `frameon = False`, set `facecolor` to fully transparent ("none", or (0, 0, 0, 0)).
- Passing a non-1D (typically, (n, 1)-shaped) input to `Axes.pie`. Pass a 1D array instead.
- The `TextPath` constructor used to silently drop ignored arguments; this behavior is deprecated.
- The `usetex` parameter of `TextToPath.get_text_path` is deprecated and folded into the `ismath` parameter, which can now take the values `False`, `True`, and "TeX", consistently with other low-level text processing functions.
- Passing 'normal' to `axes.Axes.axis()` is deprecated, use `ax.axis('auto')` instead.
- Passing the `block` argument of `pyplot.show` positionally is deprecated; it should be passed by keyword.
- When using the `nbagg` backend, `pyplot.show` used to silently accept and ignore all combinations of positional and keyword arguments. This behavior is deprecated.
- The unused `shape` and `imlim` parameters to `Axes.imshow` are deprecated. To avoid triggering the deprecation warning, the `filternorm`, `filterrad`, `resample`, and `url` arguments should be passed by keyword.
- The `interp_at_native` parameter to `BboxImage`, which has had no effect since Matplotlib 2.0, is deprecated.

- All arguments to the `cbook.deprecated` decorator and `cbook.warn_deprecated` function, except the first one (the version where the deprecation occurred), are now keyword-only. The goal is to avoid accidentally setting the “message” argument when the “name” (or “alternative”) argument was intended, as this has repeatedly occurred in the past.
- The arguments of `matplotlib.testing.compare.calculate_rms` have been renamed from `expectedImage`, `actualImage`, to `expected_image`, `actual_image`.
- Passing positional arguments to `Axis.set_ticklabels` beyond `ticklabels` itself has no effect, and support for them is deprecated.
- Passing `shade=None` to `plot_surface` is deprecated. This was an unintended implementation detail with the same semantics as `shade=False`. Please use the latter code instead.
- `matplotlib.ticker.MaxNLocator` and its `set_params` method will issue a warning on unknown keyword arguments instead of silently ignoring them. Future versions will raise an error.

### 15.3.13 Changes in parameter names

- The `arg` parameter to `matplotlib.use` has been renamed to `backend`. This will only affect cases where that parameter has been set as a keyword argument. The common usage pattern as a positional argument `matplotlib.use('Qt5Agg')` is not affected.
- The `normed` parameter to `Axes.hist2d` has been renamed to `density`.
- The `s` parameter to `Annotation` (and indirectly `Axes.annotation`) has been renamed to `text`.
- The `tolerance` parameter to `bezier.find_bezier_t_intersecting_with_closedpath`, `bezier.split_bezier_intersecting_with_closedpath`, `bezier.find_r_to_boundary_of_closedpath`, `bezier.split_path_inout` and `bezier.check_if_parallel` has been renamed to `tolerance`.

In each case, the old parameter name remains supported (it cannot be used simultaneously with the new name), but support for it will be dropped in Matplotlib 3.3.

### 15.3.14 Class/method/attribute deprecations

Support for custom backends that do not provide a `GraphicsContextBase.set_hatch_color` method is deprecated. We suggest that custom backends let their `GraphicsContext` class inherit from `GraphicsContextBase`, to at least provide stubs for all required methods.

- `spine.Spine.is_frame_like`

This has not been used in the codebase since its addition in 2009.

- `axis3d.Axis.get_tick_positions`

This has never been used internally, there is no equivalent method exists on the 2D `Axis` classes, and despite the similar name, it has a completely different behavior from the 2D `Axis`' `axis.Axis.get_ticks_position` method.

- `backend_pgf.LatexManagerFactory`
- `mpl_toolkits.axisartist.axislines.SimpleChainedObjects`
- `mpl_toolkits.Axes.AxisDict`

## Internal Helper Functions

- `checkdep_dvipng`
- `checkdep_ghostscript`
- `checkdep_pdftops`
- `checkdep_inkscape`
- `ticker.decade_up`
- `ticker.decade_down`
- `cbook.dedent`
- `docstring.Appender`
- `docstring.dedent`
- `docstring.copy_dedent`

Use the standard library's docstring manipulation tools instead, such as `inspect.cleandoc` and `inspect.getdoc`.

- `matplotlib.scale.get_scale_docs()`
- `matplotlib.pyplot.get_scale_docs()`

These are considered internal and will be removed from the public API in a future version.

- `projections.process_projection_requirements`
- `backend_ps.PsBackendHelper``
- `backend_ps.ps_backend_helper``,
- `cbook.iterable`
- `cbook.get_label`
- `cbook.safezip` Manually check the lengths of the inputs instead, or rely on numpy to do it.
- `cbook.is_hashable` Use `isinstance(..., collections.abc.Hashable)` instead.
- The `backend_bases.RendererBase.strip_math`. Use `cbook.strip_math` instead.

Multiple internal functions that were exposed as part of the public API of `mpl_toolkits.mplot3d` are deprecated,

### **mpl\_toolkits.mplot3d.art3d**

- `mpl_toolkits.mplot3d.art3d.norm_angle()`
- `mpl_toolkits.mplot3d.art3d.norm_text_angle()`
- `mpl_toolkits.mplot3d.art3d.path_to_3d_segment()`
- `mpl_toolkits.mplot3d.art3d.paths_to_3d_segments()`
- `mpl_toolkits.mplot3d.art3d.path_to_3d_segment_with_codes()`
- `mpl_toolkits.mplot3d.art3d.paths_to_3d_segments_with_codes()`
- `mpl_toolkits.mplot3d.art3d.get_patch_verts()`
- `mpl_toolkits.mplot3d.art3d.get_colors()`
- `mpl_toolkits.mplot3d.art3d.zalpha()`

### **mpl\_toolkits.mplot3d.proj3d**

- `mpl_toolkits.mplot3d.proj3d.line2d()`
- `mpl_toolkits.mplot3d.proj3d.line2d_dist()`
- `mpl_toolkits.mplot3d.proj3d.line2d_seg_dist()`
- `mpl_toolkits.mplot3d.proj3d.mod()`
- `mpl_toolkits.mplot3d.proj3d.proj_transform_vec()`
- `mpl_toolkits.mplot3d.proj3d.proj_transform_vec_clip()`
- `mpl_toolkits.mplot3d.proj3d.vec_pad_ones()`
- `mpl_toolkits.mplot3d.proj3d.proj_trans_clip_points()`

If your project relies on these functions, consider vendoring them.

### **Font Handling**

- `backend_pdf.RendererPdf.afm_font_cache`
- `backend_ps.RendererPS.afmfontd`
- `font_manager.OSXInstalledFonts`
- `TextToPath.glyph_to_path` (Instead call `font.get_path()` and manually transform the path.)

### **Date related functions**

- `dates.seconds()`
- `dates.minutes()`
- `dates.hours()`
- `dates.weeks()`
- `dates.strptime2num`
- `dates.bytespdate2num`

These are brittle in the presence of locale changes. Use standard datetime parsers such as `time.strptime` or `dateutil.parser.parse`, and additionally call `matplotlib.dates.date2num` if you need to convert to Matplotlib's internal datetime representation; or use `dates.datestr2num`.

### **Axes3D**

- `axes3d.Axes3D.w_xaxis`
- `axes3d.Axes3D.w_yaxis`
- `axes3d.Axes3D.w_zaxis`

Use `axes3d.Axes3D.xaxis`, `axes3d.Axes3D.yaxis`, and `axes3d.Axes3D.zaxis` instead.

## Testing

- `matplotlib.testing.decorators.switch_backend` decorator

Test functions should use `pytest.mark.backend(...)`, and the mark will be picked up by the `matplotlib.testing.conf.test.mpl_test_settings` fixture.

## Quiver

- `.color` attribute of Quiver objects

Instead, use (as for any Collection) the `get_facecolor` method. Note that setting to the `.color` attribute did not update the quiver artist, whereas calling `set_facecolor` does.

## GUI / backend details

- `get_py2exe_datafiles``
- `tk_window_focus``
- `backend_gtk3.FileChooserDialog`
- `backend_gtk3.NavigationToolBar2GTK3.get_filechooser`
- `backend_gtk3.SaveFigureGTK3.get_filechooser`
- `NavigationToolBar2QT.adj_window` attribute. This is unused and always None.
- `backend_wx.IDLE_DELAY` global variable This is unused and only relevant to the now removed wx "idling" code (note that as it is a module-level global, no deprecation warning is emitted when accessing it).
- `mlab.demean`
- `backend_gtk3cairo.FigureCanvasGTK3Cairo,`
- `backend_wx.debug_on_error,` `backend_wx.fake_stderr,` `backend_wx.raise_msg_to_str,`  
`backend_wx.MenuButtonWx,` `backend_wx.PrintoutWx,`
- `matplotlib.backends.qt_editor.formlayout` module

This module is a vendored, modified version of the official `formlayout` module available on PyPI. Install that module separately if you need it.

- `GraphicsContextPS.shouldstroke`

## Transforms / scales

- `LogTransformBase`
- `Log10Transform`
- `Log2Transform,`
- `NaturalLogTransformLog`
- `InvertedLogTransformBase`
- `InvertedLog10Transform`
- `InvertedLog2Transform`

- `InvertedNaturalLogTransform`

These classes defined in `matplotlib.scales` are deprecated. As a replacement, use the general `LogTransform` and `InvertedLogTransform` classes, whose constructors take a *base* argument.

### Locators / Formatters

- `OldScalarFormatter.pprint_val`
- `ScalarFormatter.pprint_val`
- `LogFormatter.pprint_val`

These are helper methods that do not have a consistent signature across formatter classes.

### Path tools

- `path.get_paths_extents`

Use `get_path_collection_extents` instead.

- `Path.has_nonfinite` attribute

Use `not np.isfinite(path.vertices).all()` instead.

- `bezier.find_r_to_boundary_of_closedpath` function is deprecated

This has always returned `None` instead of the requested radius.

### Text

- `text.TextWithDash`
- `Text.is_math_text`
- `TextPath.is_math_text`
- `TextPath.text_get_vertices_codes` (As an alternative, construct a new `TextPath` object.)

### Unused attributes

- `NavigationToolbar2QT.buttons`
- `Line2D.verticalOffset`
- `Quiver.keytext`
- `Quiver.keyvec`
- `SpanSelector.buttonDown`

These are unused and never updated.

### Sphinx extensions

- `matplotlib.sphinxext.mathmpl.math_directive`
- `matplotlib.sphinxext.plot_directive.plot_directive`

This is because the `matplotlib.sphinxext.mathmpl` and `matplotlib.sphinxext.plot_directive` interfaces have changed from the (Sphinx-)deprecated function-based interface to a class-based interface; this should not affect end users.

- `mpl_toolkits.axisartist.axis_artist.UnimplementedException`

### Environmental Variables

- The `MATPLOTLIBDATA` environment variable

### Axis

- `Axis.iter_ticks`

This only served as a helper to the private `Axis._update_ticks`

## 15.3.15 Undeprecations

The following API elements have been un-deprecated:

- The `obj_type` kwarg to the `cboc.deprecated` decorator.
- `xmin`, `xmax` kwargs to `Axes.set_xlim` and `ymin`, `ymax` kwargs to `Axes.set_ylim`

## 15.3.16 New features

### Text now has a `c` alias for the `color` property

For consistency with `Line2D`, the `Text` class has gained the `c` alias for the `color` property. For example, one can now write

```
ax.text(.5, .5, "foo", c="red")
```

### `Cn` colors now support `n`>=10

It is now possible to go beyond the tenth color in the property cycle using `Cn` syntax, e.g.

```
plt.plot([1, 2], color="C11")
```

now uses the 12th color in the cycle.

Note that previously, a construct such as:

```
plt.plot([1, 2], "C11")
```

would be interpreted as a request to use color C1 and marker 1 (an "inverted Y"). To obtain such a plot, one should now use

```
plt.plot([1, 2], "1C1")
```

(so that the first "1" gets correctly interpreted as a marker specification), or, more explicitly:

```
plt.plot([1, 2], marker="1", color="C1")
```

#### New `Formatter.format_ticks` method

The `Formatter` class gained a new `format_ticks` method, which takes the list of all tick locations as a single argument and returns the list of all formatted values. It is called by the axis tick handling code and, by default, first calls `set_locs` with all locations, then repeatedly calls `__call__` for each location.

Tick-handling code in the codebase that previously performed this sequence (`set_locs` followed by repeated `__call__`) have been updated to use `format_ticks`.

`format_ticks` is intended to be overridden by `Formatter` subclasses for which the formatting of a tick value depends on other tick values, such as `ConciseDateFormatter`.

#### Added support for RGB(A) images in `pcolorfast`

`pcolorfast` now accepts 3D images (RGB or RGBA) arrays if the X and Y specifications allow image or `pcolorimage` rendering; they remain unsupported by the more general `quadmesh` rendering

### 15.3.17 Invalid inputs

Passing invalid locations to `legend` and `table` used to fallback on a default location. This behavior is deprecated and will throw an exception in a future version.

`offsetbox.AnchoredText` is unable to handle the `horizontalalignment` or `verticalalignment` kwargs, and used to ignore them with a warning. This behavior is deprecated and will throw an exception in a future version.

Passing steps less than 1 or greater than 10 to `MaxNLocator` used to result in undefined behavior. It now throws a `ValueError`.

The signature of the (private) `Axis._update_ticks` has been changed to not take the `renderer` as argument anymore (that argument is unused).

- *Usage patterns*
  - *The pyplot API*
  - *The object-oriented API*
  - *The pylab API (disapproved)*
- *Modules*
- *Toolkits*

See also the *API Changes*.

## USAGE PATTERNS

Below we describe several common approaches to plotting with Matplotlib.

### 16.1 The `pyplot` API

`matplotlib.pyplot` is a collection of command style functions that make Matplotlib work like MATLAB. Each `pyplot` function makes some change to a figure: e.g., creates a figure, creates a plotting area in a figure, plots some lines in a plotting area, decorates the plot with labels, etc.

`pyplot` is mainly intended for interactive plots and simple cases of programmatic plot generation.

Further reading:

- The `matplotlib.pyplot` function reference
- *Pyplot tutorial*
- Pyplot examples

### 16.2 The object-oriented API

At its core, Matplotlib is object-oriented. We recommend directly working with the objects, if you need more control and customization of your plots.

In many cases you will create a *Figure* and one or more *Axes* using `pyplot.subplots` and from then on only work on these objects. However, it's also possible to create *Figures* explicitly (e.g. when including them in GUI applications).

Further reading:

- `matplotlib.axes.Axes` and `matplotlib.figure.Figure` for an overview of plotting functions.
- Most of the examples use the object-oriented approach (except for the `pyplot` section)

## 16.3 The pylab API (disapproved)

**Warning:** Since heavily importing into the global namespace may result in unexpected behavior, the use of `pylab` is strongly discouraged. Use `matplotlib.pyplot` instead.

`pylab` is a module that includes `matplotlib.pyplot`, `numpy` and some additional functions within a single namespace. Its original purpose was to mimic a MATLAB-like way of working by importing all functions into the global namespace. This is considered bad style nowadays.

Matplotlib consists of the following submodules:

## 17.1 matplotlib

`matplotlib.use(backend, warn=False, force=True)`

Select the backend used for rendering and GUI integration.

### Parameters

**backend** [str] The backend to switch to. This can either be one of the standard backend names, which are case-insensitive:

- interactive backends: GTK3Agg, GTK3Cairo, MacOSX, nbAgg, Qt4Agg, Qt4Cairo, Qt5Agg, Qt5Cairo, TkAgg, TkCairo, WebAgg, WX, WXAgi, WXCairo
- non-interactive backends: agg, cairo, pdf, pgf, ps, svg, template

or a string of the form: `module://my.module.name`.

**warn** [bool, optional, default: False] If True and not *force*, warn that the call will have no effect if this is called after pyplot has been imported and a backend is set up.

**force** [bool, optional, default: True] If True, attempt to switch the backend. An `ImportError` is raised if an interactive backend is selected, but another interactive backend has already started.

**See also:**

### Backends

`matplotlib.get_backend`

`matplotlib.get_backend()`

Return the name of the current backend.

**See also:**

`matplotlib.use`

`matplotlib.rcParams`

An instance of `RcParams` for handling default matplotlib values.

`matplotlib.rc_context(rc=None, fname=None)`

Return a context manager for managing rc settings.

This allows one to do:

```
with mpl.rc_context(fname='screen.rc'):
    plt.plot(x, a)
    with mpl.rc_context(fname='print.rc'):
        plt.plot(x, b)
    plt.plot(x, c)
```

The 'a' vs 'x' and 'c' vs 'x' plots would have settings from 'screen.rc', while the 'b' vs 'x' plot would have settings from 'print.rc'.

A dictionary can also be passed to the context manager:

```
with mpl.rc_context(rc={'text.usetex': True}, fname='screen.rc'):
    plt.plot(x, a)
```

The 'rc' dictionary takes precedence over the settings loaded from 'fname'. Passing a dictionary only is also valid. For example a common usage is:

```
with mpl.rc_context(rc={'interactive': False}):
    fig, ax = plt.subplots()
    ax.plot(range(3), range(3))
    fig.savefig('A.png', format='png')
    plt.close(fig)
```

`matplotlib.rc(group, **kwargs)`

Set the current rc params. *group* is the grouping for the rc, e.g., for `lines.linewidth` the group is `lines`, for `axes.facecolor`, the group is `axes`, and so on. Group may also be a list or tuple of group names, e.g., (`xtick`, `ytick`). *kwargs* is a dictionary attribute name/value pairs, e.g.,:

```
rc('lines', linewidth=2, color='r')
```

sets the current rc params and is equivalent to:

```
rcParams['lines.linewidth'] = 2
rcParams['lines.color'] = 'r'
```

The following aliases are available to save typing for interactive users:

Alias	Property
'lw'	'linewidth'
'ls'	'linestyle'
'c'	'color'
'fc'	'facecolor'
'ec'	'edgecolor'
'mew'	'markeredgewidth'
'aa'	'antialiased'

Thus you could abbreviate the above rc command as:

```
rc('lines', lw=2, c='r')
```

Note you can use python's kwargs dictionary facility to store dictionaries of default parameters. e.g., you can customize the font rc as follows:

```
font = {'family' : 'monospace',
        'weight' : 'bold',
        'size'   : 'larger'}

rc('font', **font) # pass in the font dict as kwargs
```

This enables you to easily switch between several configurations. Use `matplotlib.style.use('default')` or `rcdefaults()` to restore the default rc params after changes.

`matplotlib.rc_file(fname, *, use_default_template=True)`  
Update rc params from file.

Style-blacklisted rc params (defined in `matplotlib.style.core.STYLE_BLACKLIST`) are not updated.

### Parameters

**fname** [str] Name of file parsed for matplotlib settings.

**use\_default\_template** [bool] If True, initialize with default parameters before updating with those in the given file. If False, the current configuration persists and only the parameters specified in the file are updated.

`matplotlib.rcdefaults()`  
Restore the rc params from Matplotlib's internal default style.

Style-blacklisted rc params (defined in `matplotlib.style.core.STYLE_BLACKLIST`) are not updated.

### See also:

`rc_file_defaults` Restore the rc params from the rc file originally loaded by Matplotlib.

`matplotlib.style.use` Use a specific style file. Call `style.use('default')` to restore the default style.

`matplotlib.rc_file_defaults()`  
Restore the rc params from the original rc file loaded by Matplotlib.

Style-blacklisted rc params (defined in `matplotlib.style.core.STYLE_BLACKLIST`) are not updated.

`class matplotlib.RcParams(*args, **kwargs)`  
A dictionary object including validation

validating functions are defined and associated with rc parameters in `matplotlib.rcsetup`

`copy(self)`

`find_all(self, pattern)`

Return the subset of this RcParams dictionary whose keys match, using `re.search()`, the given pattern.

---

**Note:** Changes to the returned dictionary are *not* propagated to the parent RcParams dictionary.

---

`msg_backend_obsolete`

`msg_depr`

`msg_depr_ignore`

`msg_depr_set`

`msg_obsolete`

`validate = {'_internal.classic_mode': <function validate_bool>, 'agg.path.chunksize': <function va`

`matplotlib.rc_params(fail_on_error=False)`

Return a `matplotlib.RcParams` instance from the default matplotlib rc file.

`matplotlib.rc_params_from_file(fname, fail_on_error=False, use_default_template=True)`

Return `matplotlib.RcParams` from the contents of the given file.

### Parameters

**fname** [str] Name of file parsed for matplotlib settings.

**fail\_on\_error** [bool] If True, raise an error when the parser fails to convert a parameter.

**use\_default\_template** [bool] If True, initialize with default parameters before updating with those in the given file. If False, the configuration class only contains the parameters specified in the file. (Useful for updating dicts.)

`matplotlib.matplotlib_fname()`

Get the location of the config file.

The file location is determined in the following order

- `$PWD/matplotlibrc`
- `$MATPLOTLIBRC` if it is not a directory
- `$MATPLOTLIBRC/matplotlibrc`
- `$MPLCONFIGDIR/matplotlibrc`
- **On Linux,**
  - `$XDG_CONFIG_HOME/matplotlib/matplotlibrc` (if `$XDG_CONFIG_HOME` is defined)
  - or `$HOME/.config/matplotlib/matplotlibrc` (if `$XDG_CONFIG_HOME` is not defined)
- **On other platforms,**
  - `$HOME/.matplotlib/matplotlibrc` if `$HOME` is defined
- Lastly, it looks in `$MATPLOTLIBDATA/matplotlibrc`, which should always exist.

`matplotlib.interactive(b)`

Set interactive mode to boolean `b`.

If `b` is True, then draw after every plotting command, e.g., after `xlabel`

`matplotlib.is_interactive()`

Return true if plot mode is interactive

`matplotlib.set_loglevel(level)`

Sets the Matplotlib's root logger and root logger handler level, creating the handler if it does not exist yet.

Typically, one should call `set_loglevel("info")` or `set_loglevel("debug")` to get additional debugging information.

### Parameters

**level** [{"notset", "debug", "info", "warning", "error", "critical"}] The log level of the handler.

### Notes

The first time this function is called, an additional handler is attached to Matplotlib's root handler; this handler is reused every time and this function simply manipulates the logger and handler's level.

## 17.2 matplotlib.afm

This is a python interface to Adobe Font Metrics Files. Although a number of other python implementations exist, and may be more complete than this, it was decided not to go with them because they were either:

- 1) copyrighted or used a non-BSD compatible license
- 2) had too many dependencies and a free standing lib was needed
- 3) Did more than needed and it was easier to write afresh rather than figure out how to get just what was needed.

It is pretty easy to use, and requires only built-in python libs:

```
>>> from matplotlib import rcParams
>>> import os.path
>>> afm_fname = os.path.join(rcParams['datapath'],
...                          'fonts', 'afm', 'ptmr8a.afm')
>>>
>>> from matplotlib.afm import AFM
>>> with open(afm_fname, 'rb') as fh:
...     afm = AFM(fh)
>>> afm.string_width_height('What the heck?')
(6220.0, 694)
>>> afm.get_fontname()
'Times-Roman'
>>> afm.get_kern_dist('A', 'f')
0
>>> afm.get_kern_dist('A', 'y')
-92.0
>>> afm.get_bbox_char('!')
[130, -9, 238, 676]
```

As in the Adobe Font Metrics File Format Specification, all dimensions are given in units of 1/1000 of the scale factor (point size) of the font being used.

```
class matplotlib.afm.AFM(fh)
    Bases: object
    Parse the AFM file in file object fh.

    family_name
        The font family name, e.g., 'Times'.

    get_angle(self)
        Return the fontangle as float.

    get_bbox_char(self, c, isord=False)

    get_capheight(self)
        Return the cap height as float.

    get_familyname(self)
        Return the font family name, e.g., 'Times'.

    get_fontname(self)
        Return the font name, e.g., 'Times-Roman'.

    get_fullname(self)
        Return the font full name, e.g., 'Times-Roman'.

    get_height_char(self, c, isord=False)
        Get the bounding box (ink) height of character c (space is 0).

    get_horizontal_stem_width(self)
        Return the standard horizontal stem width as float, or None if not specified in AFM
        file.

    get_kern_dist(self, c1, c2)
        Return the kerning pair distance (possibly 0) for chars c1 and c2.

    get_kern_dist_from_name(self, name1, name2)
        Return the kerning pair distance (possibly 0) for chars name1 and name2.

    get_name_char(self, c, isord=False)
        Get the name of the character, i.e., ';' is 'semicolon'.

    get_str_bbox(self, s)
        Return the string bounding box.

    get_str_bbox_and_descent(self, s)
        Return the string bounding box and the maximal descent.

    get_underline_thickness(self)
        Return the underline thickness as float.

    get_vertical_stem_width(self)
        Return the standard vertical stem width as float, or None if not specified in AFM
        file.

    get_weight(self)
        Return the font weight, e.g., 'Bold' or 'Roman'.

    get_width_char(self, c, isord=False)
        Get the width of the character from the character metric WX field.

    get_width_from_char_name(self, name)
        Get the width of the character from a type1 character name.
```

`get_xheight(self)`  
Return the xheight as float.

`string_width_height(self, s)`  
Return the string width (including kerning) and string height as a  $(w, h)$  tuple.

`class matplotlib.afm.CharMetrics`

Bases: `tuple`

Represents the character metrics of a single character.

### Notes

The fields do currently only describe a subset of character metrics information defined in the AFM standard.

Create new instance of CharMetrics(width, name, bbox)

`bbox`  
The bbox of the character (B) as a tuple  $(llx, lly, urx, ury)$ .

`name`  
The character name (N).

`width`  
The character width (WX).

`class matplotlib.afm.CompositePart`

Bases: `tuple`

Represents the information on a composite element of a composite char.

Create new instance of CompositePart(name, dx, dy)

`dx`  
x-displacement of the part from the origin.

`dy`  
y-displacement of the part from the origin.

`name`  
Name of the part, e.g. 'acute'.

`matplotlib.afm.parse_afm(fh)`  
*[Deprecated]*

### Notes

Deprecated since version 3.0:

## 17.3 matplotlib.animation

### Table of Contents

- *Animation*

- *Writer Classes*
- *Helper Classes*
- *Inheritance Diagrams*

### 17.3.1 Animation

The easiest way to make a live animation in matplotlib is to use one of the *Animation* classes.

<i>Animation</i>	This class wraps the creation of an animation using matplotlib.
<i>FuncAnimation</i>	Makes an animation by repeatedly calling a function <i>func</i> .
<i>ArtistAnimation</i>	Animation using a fixed set of Artist objects.

#### matplotlib.animation.Animation

`class matplotlib.animation.Animation(fig, event_source=None, blit=False)`

This class wraps the creation of an animation using matplotlib.

It is only a base class which should be subclassed to provide needed behavior.

This class is not typically used directly.

#### Parameters

**fig** [matplotlib.figure.Figure] The figure object that is used to get draw, re-size, and any other needed events.

**event\_source** [object, optional] A class that can run a callback when desired events are generated, as well as be stopped and started.

Examples include timers (see *TimedAnimation*) and file system notifications.

**blit** [bool, optional] controls whether blitting is used to optimize drawing. Defaults to False.

#### See also:

*FuncAnimation*, *ArtistAnimation*

`__init__(self, fig, event_source=None, blit=False)`

Initialize self. See `help(type(self))` for accurate signature.

#### Methods

<code>__init__(<i>self</i>, <i>fig</i>[, <i>event_source</i>, <i>blit</i>])</code>	Initialize self.
<code>new_frame_seq(<i>self</i>)</code>	Return a new sequence of frame information.

Continued on next page

Table 2 – continued from previous page

<code>new_saved_frame_seq(self)</code>	Return a new sequence of saved/cached frame information.
<code>save(self, filename[, writer, fps, dpi, ...])</code>	Save the animation as a movie file by drawing every frame.
<code>to_html5_video(self[, embed_limit])</code>	Convert the animation to an HTML5 <video> tag.
<code>to_jshtml(self[, fps, embed_frames, ...])</code>	Generate HTML representation of the animation

`new_frame_seq(self)`

Return a new sequence of frame information.

`new_saved_frame_seq(self)`

Return a new sequence of saved/cached frame information.

`save(self, filename, writer=None, fps=None, dpi=None, codec=None, bitrate=None, extra_args=None, metadata=None, extra_anim=None, savefig_kwargs=None, *, progress_callback=None)`

Save the animation as a movie file by drawing every frame.

### Parameters

**filename** [str] The output filename, e.g., `mymovie.mp4`.

**writer** [*MovieWriter* or str, optional] A *MovieWriter* instance to use or a key that identifies a class to use, such as `'ffmpeg'`. If `None`, defaults to `rcParams["animation.writer"] = 'ffmpeg'`.

**fps** [number, optional] Frames per second in the movie. Defaults to `None`, which will use the animation's specified interval to set the frames per second.

**dpi** [number, optional] Controls the dots per inch for the movie frames. This combined with the figure's size in inches controls the size of the movie. If `None`, defaults to `rcParams["savefig.dpi"]`.

**codec** [str, optional] The video codec to be used. Not all codecs are supported by a given *MovieWriter*. If `None`, default to `rcParams["animation.codec"] = 'h264'`.

**bitrate** [number, optional] Specifies the number of bits used per second in the compressed movie, in kilobits per second. A higher number means a higher quality movie, but at the cost of increased file size. If `None`, defaults to `rcParams["animation.bitrate"] = -1`.

**extra\_args** [list, optional] List of extra string arguments to be passed to the underlying movie utility. If `None`, defaults to `rcParams["animation.extra_args"]`.

**metadata** [Dict[str, str], optional] Dictionary of keys and values for metadata to include in the output file. Some keys that may be of use include: `title`, `artist`, `genre`, `subject`, `copyright`, `srcform`, `comment`.

**extra\_anim** [list, optional] Additional *Animation* objects that should be included in the saved movie file. These need to be from the same `matplotlib.figure.Figure` instance. Also, animation frames will just be simply combined, so there should be a 1:1 correspondence between the frames from the different animations.

**savefig\_kwargs** [dict, optional] Is a dictionary containing keyword arguments to be passed on to the `savefig` command which is called repeatedly to save the individual frames.

**progress\_callback** [function, optional] A callback function that will be called for every frame to notify the saving progress. It must have the signature

```
def func(current_frame: int, total_frames: int) -> Any
```

where *current\_frame* is the current frame number and *total\_frames* is the total number of frames to be saved. *total\_frames* is set to `None`, if the total number of frames can not be determined. Return values may exist but are ignored.

Example code to write the progress to stdout:

```
progress_callback = lambda i, n: print(f'Saving  
->frame {i} of {n}')
```

## Notes

*fps*, *codec*, *bitrate*, *extra\_args* and *metadata* are used to construct a *MovieWriter* instance and can only be passed if *writer* is a string. If they are passed as non-`None` and *writer* is a *MovieWriter*, a `RuntimeError` will be raised.

`to_html5_video(self, embed_limit=None)`

Convert the animation to an HTML5 `<video>` tag.

This saves the animation as an h264 video, encoded in base64 directly into the HTML5 video tag. This respects the rc parameters for the writer as well as the bitrate. This also makes use of the `interval` to control the speed, and uses the `repeat` parameter to decide whether to loop.

### Parameters

**embed\_limit** [float, optional] Limit, in MB, of the returned animation. No animation is created if the limit is exceeded. Defaults to `rcParams["animation.embed_limit"] = 20.0`.

### Returns

**video\_tag** [str] An HTML5 video tag with the animation embedded as base64 encoded h264 video. If the *embed\_limit* is exceeded, this returns the string "Video too large to embed."

`to_jshtml(self, fps=None, embed_frames=True, default_mode=None)`

Generate HTML representation of the animation

## matplotlib.animation.FuncAnimation

```
class matplotlib.animation.FuncAnimation(fig, func, frames=None, init_func=None,
                                         fargs=None, save_count=None, *,
                                         cache_frame_data=True, **kwargs)
```

Makes an animation by repeatedly calling a function *func*.

### Parameters

**fig** [matplotlib.figure.Figure] The figure object that is used to get draw, re-size, and any other needed events.

**func** [callable] The function to call at each frame. The first argument will be the next value in *frames*. Any additional positional arguments can be supplied via the *fargs* parameter.

The required signature is:

```
def func(frame, *fargs) -> iterable_of_artists
```

If `blit == True`, *func* must return an iterable of all artists that were modified or created. This information is used by the blitting algorithm to determine which parts of the figure have to be updated. The return value is unused if `blit == False` and may be omitted in that case.

**frames** [iterable, int, generator function, or None, optional] Source of data to pass *func* and each frame of the animation

- If an iterable, then simply use the values provided. If the iterable has a length, it will override the *save\_count* kwarg.
- If an integer, then equivalent to passing `range(frames)`
- If a generator function, then must have the signature:

```
def gen_function() -> obj
```

- If *None*, then equivalent to passing `itertools.count`.

In all of these cases, the values in *frames* is simply passed through to the user-supplied *func* and thus can be of any type.

**init\_func** [callable, optional] A function used to draw a clear frame. If not given, the results of drawing from the first item in the *frames* sequence will be used. This function will be called once before the first frame.

The required signature is:

```
def init_func() -> iterable_of_artists
```

If `blit == True`, *init\_func* must return an iterable of artists to be re-drawn. This information is used by the blitting algorithm to determine which parts of the figure have to be updated. The return value is unused if `blit == False` and may be omitted in that case.

**fargs** [tuple or None, optional] Additional arguments to pass to each call to *func*.

**save\_count** [int, optional] The number of values from *frames* to cache.

**interval** [number, optional] Delay between frames in milliseconds. Defaults to 200.

**repeat\_delay** [number, optional] If the animation is repeated, adds a delay in milliseconds before repeating the animation. Defaults to *None*.

**repeat** [bool, optional] Controls whether the animation should repeat when the sequence of frames is completed. Defaults to *True*.

**blit** [bool, optional] Controls whether blitting is used to optimize drawing. Note: when using blitting any animated artists will be drawn according to their zorder. However, they will be drawn on top of any previous artists, regardless of their zorder. Defaults to *False*.

**cache\_frame\_data** [bool, optional] Controls whether frame data is cached. Defaults to *True*. Disabling cache might be helpful when frames contain large objects.

```
__init__(self, fig, func, frames=None, init_func=None, fargs=None,
          save_count=None, *, cache_frame_data=True, **kwargs)
```

Initialize self. See help(type(self)) for accurate signature.

## Methods

<code>__init__(self, fig, func[, frames, ...])</code>	Initialize self.
<code>new_frame_seq(self)</code>	Return a new sequence of frame information.
<code>new_saved_frame_seq(self)</code>	Return a new sequence of saved/cached frame information.
<code>save(self, filename[, writer, fps, dpi, ...])</code>	Save the animation as a movie file by drawing every frame.
<code>to_html5_video(self[, embed_limit])</code>	Convert the animation to an HTML5 <video> tag.
<code>to_jshtml(self[, fps, embed_frames, ...])</code>	Generate HTML representation of the animation

```
new_frame_seq(self)
```

Return a new sequence of frame information.

```
new_saved_frame_seq(self)
```

Return a new sequence of saved/cached frame information.

## matplotlib.animation.ArtistAnimation

```
class matplotlib.animation.ArtistAnimation(fig, artists, *args, **kwargs)
```

Animation using a fixed set of Artist objects.

Before creating an instance, all plotting should have taken place and the relevant artists saved.

### Parameters

**fig** [matplotlib.figure.Figure] The figure object that is used to get draw, resize, and any other needed events.

**artists** [list] Each list entry a collection of artists that represent what needs to be enabled on each frame. These will be disabled for other frames.

**interval** [number, optional] Delay between frames in milliseconds. Defaults to 200.

**repeat\_delay** [number, optional] If the animation is repeated, adds a delay in milliseconds before repeating the animation. Defaults to *None*.

**repeat** [bool, optional] Controls whether the animation should repeat when the sequence of frames is completed. Defaults to True.

**blit** [bool, optional] Controls whether blitting is used to optimize drawing. Defaults to False.

`__init__(self, fig, artists, *args, **kwargs)`  
Initialize self. See `help(type(self))` for accurate signature.

### Methods

<code>__init__(self, fig, artists, *args, **kwargs)</code>	Initialize self.
<code>new_frame_seq(self)</code>	Return a new sequence of frame information.
<code>new_saved_frame_seq(self)</code>	Return a new sequence of saved/cached frame information.
<code>save(self, filename[, writer, fps, dpi, ...])</code>	Save the animation as a movie file by drawing every frame.
<code>to_html5_video(self[, embed_limit])</code>	Convert the animation to an HTML5 <code>&lt;video&gt;</code> tag.
<code>to_jshtml(self[, fps, embed_frames, ...])</code>	Generate HTML representation of the animation

In both cases it is critical to keep a reference to the instance object. The animation is advanced by a timer (typically from the host GUI framework) which the *Animation* object holds the only reference to. If you do not hold a reference to the *Animation* object, it (and hence the timers), will be garbage collected which will stop the animation.

To save an animation to disk use *Animation.save* OR *Animation.to\_html5\_video*

See *Helper Classes* below for details about what movie formats are supported.

### FuncAnimation

The inner workings of *FuncAnimation* is more-or-less:

```
for d in frames:
    artists = func(d, *fargs)
    fig.canvas.draw_idle()
    fig.canvas.start_event_loop(interval)
```

with details to handle 'blitting' (to dramatically improve the live performance), to be non-blocking, not repeatedly start/stop the GUI event loop, handle repeats, multiple animated axes, and easily save the animation to a movie file.

'Blitting' is a [old technique](#) in computer graphics. The general gist is to take an existing bit map (in our case a mostly rasterized figure) and then 'blit' one more artist on top. Thus, by managing a saved 'clean' bitmap, we can only re-draw the few artists that are changing at each frame and possibly save significant amounts of time. When we use blitting (by passing `blit=True`), the core loop of *FuncAnimation* gets a bit more complicated:

```
ax = fig.gca()
```

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```

def update_blit(artists):
    fig.canvas.restore_region(bg_cache)
    for a in artists:
        a.axes.draw_artist(a)

    ax.figure.canvas.blit(ax.bbox)

artists = init_func()

for a in artists:
    a.set_animated(True)

fig.canvas.draw()
bg_cache = fig.canvas.copy_from_bbox(ax.bbox)

for f in frames:
    artists = func(f, *fargs)
    update_blit(artists)
    fig.canvas.start_event_loop(interval)

```

This is of course leaving out many details (such as updating the background when the figure is resized or fully re-drawn). However, this hopefully minimalist example gives a sense of how `init_func` and `func` are used inside of *FuncAnimation* and the theory of how 'blitting' works.

The expected signature on `func` and `init_func` is very simple to keep *FuncAnimation* out of your book keeping and plotting logic, but this means that the callable objects you pass in must know what artists they should be working on. There are several approaches to handling this, of varying complexity and encapsulation. The simplest approach, which works quite well in the case of a script, is to define the artist at a global scope and let Python sort things out. For example

```

import numpy as np
import matplotlib.pyplot as plt
from matplotlib.animation import FuncAnimation

fig, ax = plt.subplots()
xdata, ydata = [], []
ln, = plt.plot([], [], 'ro')

def init():
    ax.set_xlim(0, 2*np.pi)
    ax.set_ylim(-1, 1)
    return ln,

def update(frame):
    xdata.append(frame)
    ydata.append(np.sin(frame))
    ln.set_data(xdata, ydata)
    return ln,

ani = FuncAnimation(fig, update, frames=np.linspace(0, 2*np.pi, 128),
                    init_func=init, blit=True)
plt.show()

```

The second method is to use `functools.partial` to 'bind' artists to function. A third method is to use closures to build up the required artists and functions. A fourth method is to create a class.

## Examples

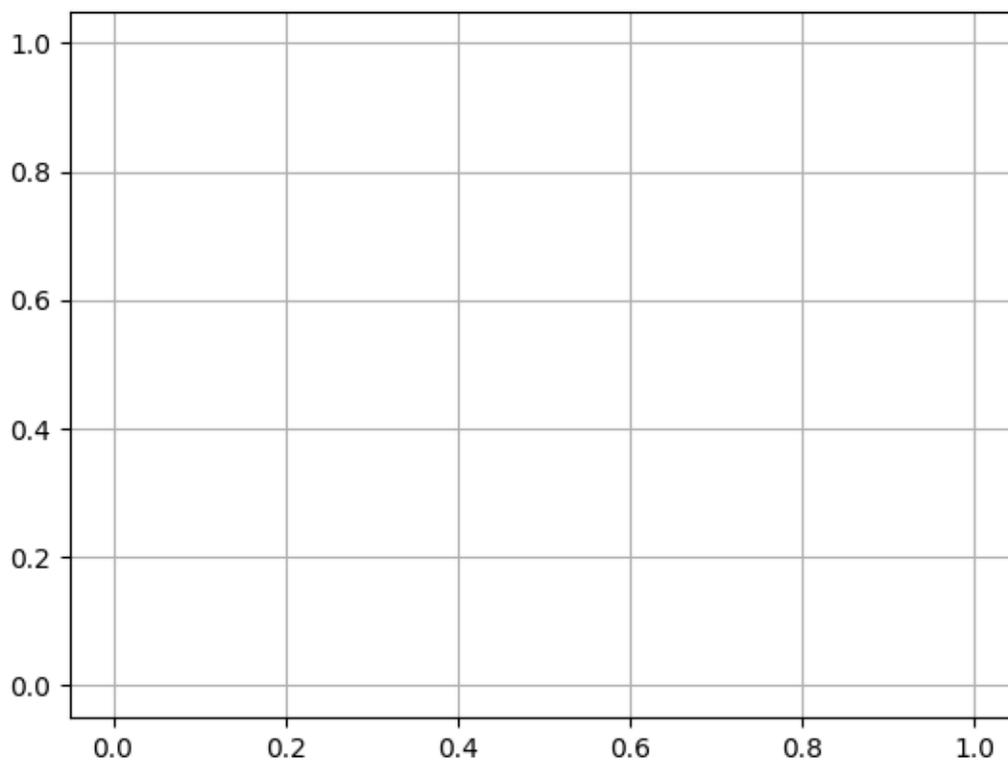
---

**Note:** Click [here](#) to download the full example code

---

### Decay

This example showcases: - using a generator to drive an animation, - changing axes limits during an animation.



```
import numpy as np
import matplotlib.pyplot as plt
import matplotlib.animation as animation
```

```
def data_gen(t=0):
```

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```
cnt = 0
while cnt < 1000:
    cnt += 1
    t += 0.1
    yield t, np.sin(2*np.pi*t) * np.exp(-t/10.)

def init():
    ax.set_ylim(-1.1, 1.1)
    ax.set_xlim(0, 10)
    del xdata[:]
    del ydata[:]
    line.set_data(xdata, ydata)
    return line,

fig, ax = plt.subplots()
line, = ax.plot([], [], lw=2)
ax.grid()
xdata, ydata = [], []

def run(data):
    # update the data
    t, y = data
    xdata.append(t)
    ydata.append(y)
    xmin, xmax = ax.get_xlim()

    if t >= xmax:
        ax.set_xlim(xmin, 2*xmax)
        ax.figure.canvas.draw()
    line.set_data(xdata, ydata)

    return line,

ani = animation.FuncAnimation(fig, run, data_gen, blit=False, interval=10,
                             repeat=False, init_func=init)
plt.show()
```

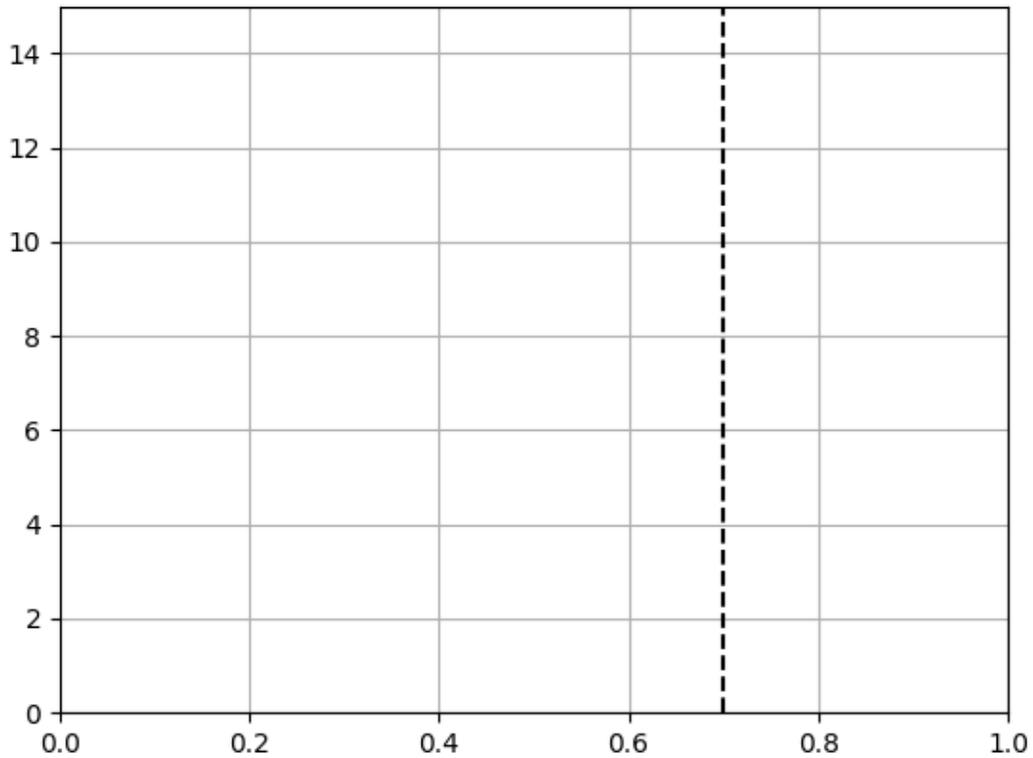
---

**Note:** Click [here](#) to download the full example code

---

## The Bayes update

This animation displays the posterior estimate updates as it is refitted when new data arrives. The vertical line represents the theoretical value to which the plotted distribution should converge.



```
import math

import numpy as np
import matplotlib.pyplot as plt
from matplotlib.animation import FuncAnimation

def beta_pdf(x, a, b):
    return (x**(a-1) * (1-x)**(b-1) * math.gamma(a + b)
           / (math.gamma(a) * math.gamma(b)))

class UpdateDist(object):
    def __init__(self, ax, prob=0.5):
        self.success = 0
        self.prob = prob
        self.line, = ax.plot([], [], 'k-')
        self.x = np.linspace(0, 1, 200)
        self.ax = ax

        # Set up plot parameters
        self.ax.set_xlim(0, 1)
        self.ax.set_ylim(0, 15)
```

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```

self.ax.grid(True)

# This vertical line represents the theoretical value, to
# which the plotted distribution should converge.
self.ax.axvline(prob, linestyle='--', color='black')

def init(self):
    self.success = 0
    self.line.set_data([], [])
    return self.line,

def __call__(self, i):
    # This way the plot can continuously run and we just keep
    # watching new realizations of the process
    if i == 0:
        return self.init()

    # Choose success based on exceed a threshold with a uniform pick
    if np.random.rand(1,) < self.prob:
        self.success += 1
    y = beta_pdf(self.x, self.success + 1, (i - self.success) + 1)
    self.line.set_data(self.x, y)
    return self.line,

# Fixing random state for reproducibility
np.random.seed(19680801)

fig, ax = plt.subplots()
ud = UpdateDist(ax, prob=0.7)
anim = FuncAnimation(fig, ud, frames=np.arange(100), init_func=ud.init,
                    interval=100, blit=True)
plt.show()

```

---

**Note:** Click [here](#) to download the full example code

---

### The double pendulum problem

This animation illustrates the double pendulum problem.

Double pendulum formula translated from the C code at [http://www.physics.usyd.edu.au/~wheat/dpend\\_html/solve\\_dpend.c](http://www.physics.usyd.edu.au/~wheat/dpend_html/solve_dpend.c)

```

from numpy import sin, cos
import numpy as np
import matplotlib.pyplot as plt
import scipy.integrate as integrate
import matplotlib.animation as animation

```

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```

G = 9.8 # acceleration due to gravity, in m/s2
L1 = 1.0 # length of pendulum 1 in m
L2 = 1.0 # length of pendulum 2 in m
M1 = 1.0 # mass of pendulum 1 in kg
M2 = 1.0 # mass of pendulum 2 in kg

def derivs(state, t):

    dydx = np.zeros_like(state)
    dydx[0] = state[1]

    delta = state[2] - state[0]
    den1 = (M1+M2) * L1 - M2 * L1 * cos(delta) * cos(delta)
    dydx[1] = ((M2 * L1 * state[1] * state[1] * sin(delta) * cos(delta)
                + M2 * G * sin(state[2]) * cos(delta)
                + M2 * L2 * state[3] * state[3] * sin(delta)
                - (M1+M2) * G * sin(state[0]))
               / den1)

    dydx[2] = state[3]

    den2 = (L2/L1) * den1
    dydx[3] = ((- M2 * L2 * state[3] * state[3] * sin(delta) * cos(delta)
                + (M1+M2) * G * sin(state[0]) * cos(delta)
                - (M1+M2) * L1 * state[1] * state[1] * sin(delta)
                - (M1+M2) * G * sin(state[2]))
               / den2)

    return dydx

# create a time array from 0..100 sampled at 0.05 second steps
dt = 0.05
t = np.arange(0, 20, dt)

# th1 and th2 are the initial angles (degrees)
# w10 and w20 are the initial angular velocities (degrees per second)
th1 = 120.0
w1 = 0.0
th2 = -10.0
w2 = 0.0

# initial state
state = np.radians([th1, w1, th2, w2])

# integrate your ODE using scipy.integrate.
y = integrate.odeint(derivs, state, t)

x1 = L1*sin(y[:, 0])
y1 = -L1*cos(y[:, 0])

x2 = L2*sin(y[:, 2]) + x1

```

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```
y2 = -L2*cos(y[:, 2]) + y1

fig = plt.figure()
ax = fig.add_subplot(111, autoscale_on=False, xlim=(-2, 2), ylim=(-2, 2))
ax.set_aspect('equal')
ax.grid()

line, = ax.plot([], [], 'o-', lw=2)
time_template = 'time = %.1fs'
time_text = ax.text(0.05, 0.9, '', transform=ax.transAxes)

def init():
    line.set_data([], [])
    time_text.set_text('')
    return line, time_text

def animate(i):
    thisx = [0, x1[i], x2[i]]
    thisy = [0, y1[i], y2[i]]

    line.set_data(thisx, thisy)
    time_text.set_text(time_template % (i*dt))
    return line, time_text

ani = animation.FuncAnimation(fig, animate, range(1, len(y)),
                              interval=dt*1000, blit=True, init_func=init)
plt.show()
```

---

**Note:** Click [here](#) to download the full example code

---

### Animated histogram

Use a path patch to draw a bunch of rectangles for an animated histogram.

```
import numpy as np

import matplotlib.pyplot as plt
import matplotlib.patches as patches
import matplotlib.path as path
import matplotlib.animation as animation

# Fixing random state for reproducibility
np.random.seed(19680801)

# histogram our data with numpy
data = np.random.randn(1000)
```

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```
n, bins = np.histogram(data, 100)

# get the corners of the rectangles for the histogram
left = np.array(bins[:-1])
right = np.array(bins[1:])
bottom = np.zeros(len(left))
top = bottom + n
nrects = len(left)
```

Here comes the tricky part - we have to set up the vertex and path codes arrays using `plt.Path.MOVETO`, `plt.Path.LINETO` and `plt.Path.CLOSEPOLY` for each rect.

- We need 1 `MOVETO` per rectangle, which sets the initial point.
- We need 3 `LINETO`'s, which tell Matplotlib to draw lines from vertex 1 to vertex 2, v2 to v3, and v3 to v4.
- We then need one `CLOSEPOLY` which tells Matplotlib to draw a line from the v4 to our initial vertex (the `MOVETO` vertex), in order to close the polygon.

**Note:** The vertex for `CLOSEPOLY` is ignored, but we still need a placeholder in the `verts` array to keep the codes aligned with the vertices.

```
nverts = nrects * (1 + 3 + 1)
verts = np.zeros((nverts, 2))
codes = np.ones(nverts, int) * path.Path.LINETO
codes[0::5] = path.Path.MOVETO
codes[4::5] = path.Path.CLOSEPOLY
verts[0::5, 0] = left
verts[0::5, 1] = bottom
verts[1::5, 0] = left
verts[1::5, 1] = top
verts[2::5, 0] = right
verts[2::5, 1] = top
verts[3::5, 0] = right
verts[3::5, 1] = bottom
```

To animate the histogram, we need an `animate` function, which generates a random set of numbers and updates the locations of the vertices for the histogram (in this case, only the heights of each rectangle). `patch` will eventually be a `Patch` object.

```
patch = None

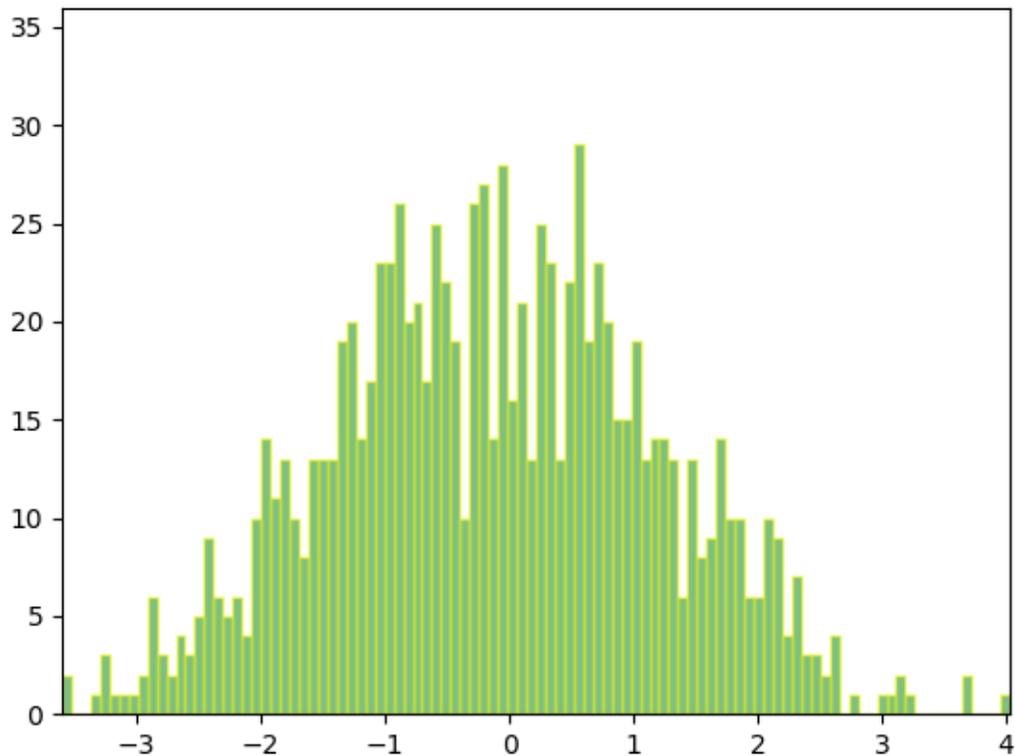
def animate(i):
    # simulate new data coming in
    data = np.random.randn(1000)
    n, bins = np.histogram(data, 100)
    top = bottom + n
    verts[1::5, 1] = top
    verts[2::5, 1] = top
    return [patch, ]
```

And now we build the Path and Patch instances for the histogram using our vertices and codes. We add the patch to the Axes instance, and setup the FuncAnimation with our animate function.

```
fig, ax = plt.subplots()
barpath = path.Path(verts, codes)
patch = patches.PathPatch(
    barpath, facecolor='green', edgecolor='yellow', alpha=0.5)
ax.add_patch(patch)

ax.set_xlim(left[0], right[-1])
ax.set_ylim(bottom.min(), top.max())

ani = animation.FuncAnimation(fig, animate, 100, repeat=False, blit=True)
plt.show()
```



---

**Note:** Click [here](#) to download the full example code

---

### Rain simulation

Simulates rain drops on a surface by animating the scale and opacity of 50 scatter points.

Author: Nicolas P. Rougier

```
import numpy as np
import matplotlib.pyplot as plt
from matplotlib.animation import FuncAnimation

# Fixing random state for reproducibility
np.random.seed(19680801)

# Create new Figure and an Axes which fills it.
fig = plt.figure(figsize=(7, 7))
ax = fig.add_axes([0, 0, 1, 1], frameon=False)
ax.set_xlim(0, 1), ax.set_xticks([])
ax.set_ylim(0, 1), ax.set_yticks([])
```

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```

# Create rain data
n_drops = 50
rain_drops = np.zeros(n_drops, dtype=[('position', float, 2),
                                       ('size', float, 1),
                                       ('growth', float, 1),
                                       ('color', float, 4)])

# Initialize the raindrops in random positions and with
# random growth rates.
rain_drops['position'] = np.random.uniform(0, 1, (n_drops, 2))
rain_drops['growth'] = np.random.uniform(50, 200, n_drops)

# Construct the scatter which we will update during animation
# as the raindrops develop.
scat = ax.scatter(rain_drops['position'][:, 0], rain_drops['position'][:, 1],
                  s=rain_drops['size'], lw=0.5, edgecolors=rain_drops['color'],
                  facecolors='none')

def update(frame_number):
    # Get an index which we can use to re-spawn the oldest raindrop.
    current_index = frame_number % n_drops

    # Make all colors more transparent as time progresses.
    rain_drops['color'][:, 3] -= 1.0/len(rain_drops)
    rain_drops['color'][:, 3] = np.clip(rain_drops['color'][:, 3], 0, 1)

    # Make all circles bigger.
    rain_drops['size'] += rain_drops['growth']

    # Pick a new position for oldest rain drop, resetting its size,
    # color and growth factor.
    rain_drops['position'][current_index] = np.random.uniform(0, 1, 2)
    rain_drops['size'][current_index] = 5
    rain_drops['color'][current_index] = (0, 0, 0, 1)
    rain_drops['growth'][current_index] = np.random.uniform(50, 200)

    # Update the scatter collection, with the new colors, sizes and positions.
    scat.set_edgecolors(rain_drops['color'])
    scat.set_sizes(rain_drops['size'])
    scat.set_offsets(rain_drops['position'])

# Construct the animation, using the update function as the animation director.
animation = FuncAnimation(fig, update, interval=10)
plt.show()

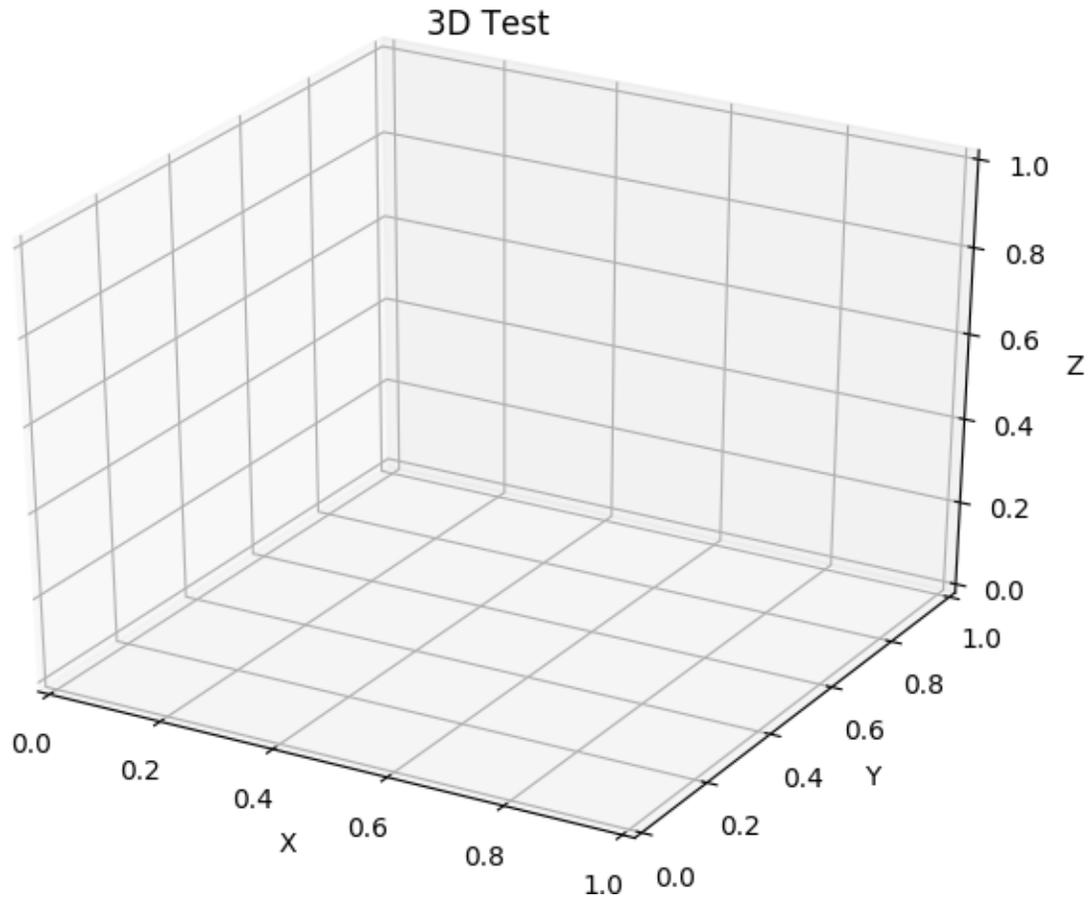
```

---

**Note:** Click [here](#) to download the full example code

---

## Animated 3D random walk



```
import numpy as np
import matplotlib.pyplot as plt
import mpl_toolkits.mplot3d.axes3d as p3
import matplotlib.animation as animation

# Fixing random state for reproducibility
np.random.seed(19680801)

def Gen_RandLine(length, dims=2):
    """
    Create a line using a random walk algorithm

    length is the number of points for the line.
    dims is the number of dimensions the line has.
    """
    lineData = np.empty((dims, length))
    lineData[:, 0] = np.random.rand(dims)
    for index in range(1, length):
        # scaling the random numbers by 0.1 so
        # movement is small compared to position.
```

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```
    # subtraction by 0.5 is to change the range to [-0.5, 0.5]
    # to allow a line to move backwards.
    step = ((np.random.rand(dims) - 0.5) * 0.1)
    lineData[:, index] = lineData[:, index - 1] + step

    return lineData

def update_lines(num, dataLines, lines):
    for line, data in zip(lines, dataLines):
        # NOTE: there is no .set_data() for 3 dim data...
        line.set_data(data[0:2, :num])
        line.set_3d_properties(data[2, :num])
    return lines

# Attaching 3D axis to the figure
fig = plt.figure()
ax = p3.Axes3D(fig)

# Fifty lines of random 3-D lines
data = [Gen_RandLine(25, 3) for index in range(50)]

# Creating fifty line objects.
# NOTE: Can't pass empty arrays into 3d version of plot()
lines = [ax.plot(dat[0, 0:1], dat[1, 0:1], dat[2, 0:1])[0] for dat in data]

# Setting the axes properties
ax.set_xlim3d([0.0, 1.0])
ax.set_xlabel('X')

ax.set_ylim3d([0.0, 1.0])
ax.set_ylabel('Y')

ax.set_zlim3d([0.0, 1.0])
ax.set_zlabel('Z')

ax.set_title('3D Test')

# Creating the Animation object
line_ani = animation.FuncAnimation(fig, update_lines, 25, fargs=(data, lines),
                                   interval=50, blit=False)

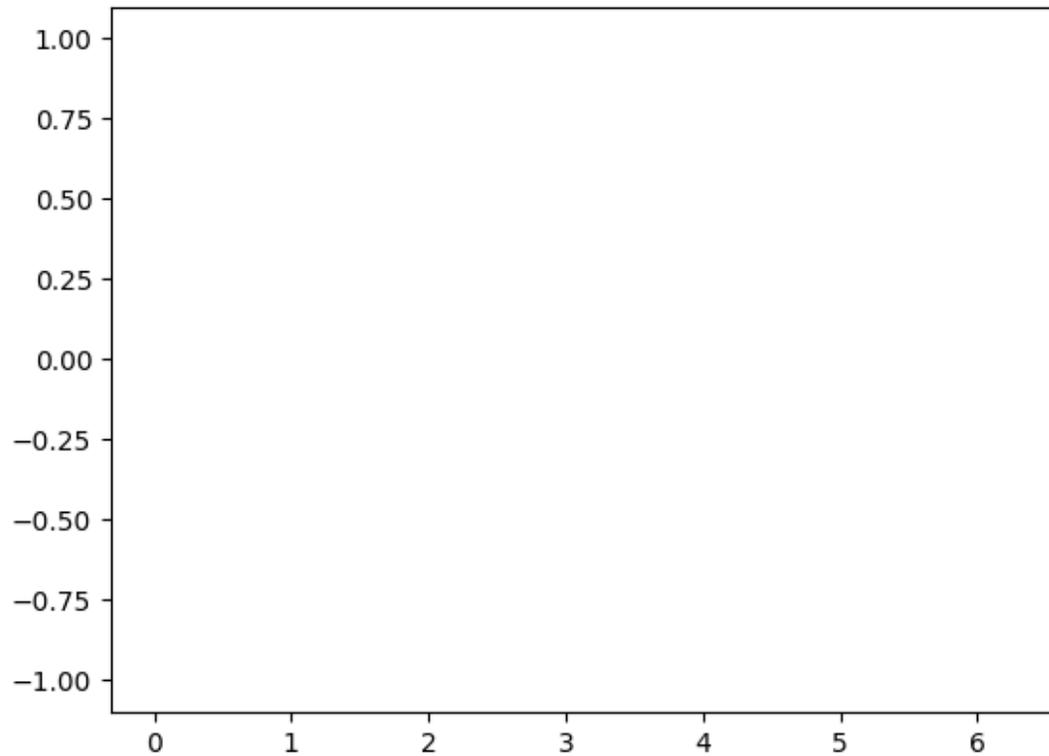
plt.show()
```

---

**Note:** Click [here](#) to download the full example code

---

## Animated line plot



```
import numpy as np
import matplotlib.pyplot as plt
import matplotlib.animation as animation

fig, ax = plt.subplots()

x = np.arange(0, 2*np.pi, 0.01)
line, = ax.plot(x, np.sin(x))

def init(): # only required for blitting to give a clean slate.
    line.set_ydata([np.nan] * len(x))
    return line,

def animate(i):
    line.set_ydata(np.sin(x + i / 100)) # update the data.
    return line,

ani = animation.FuncAnimation(
```

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```
fig, animate, init_func=init, interval=2, blit=True, save_count=50)

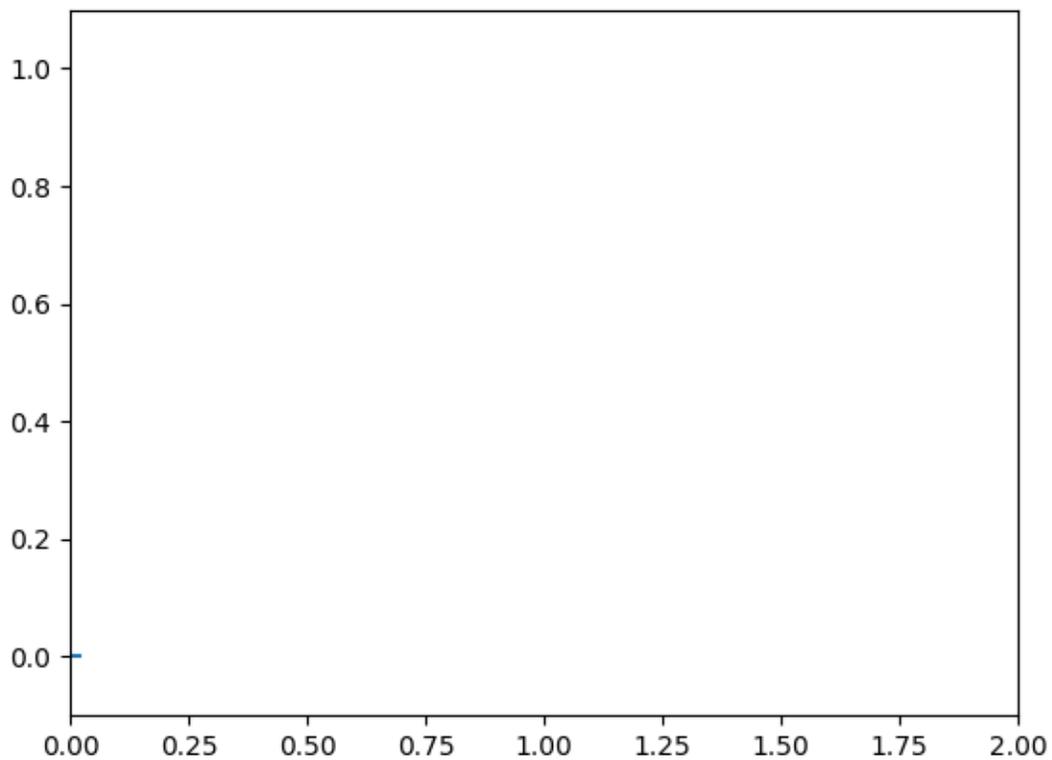
# To save the animation, use e.g.
#
# ani.save("movie.mp4")
#
# or
#
# from matplotlib.animation import FFMpegWriter
# writer = FFMpegWriter(fps=15, metadata=dict(artist='Me'), bitrate=1800)
# ani.save("movie.mp4", writer=writer)

plt.show()
```

**Note:** Click [here](#) to download the full example code

## Oscilloscope

Emulates an oscilloscope.



```

import numpy as np
from matplotlib.lines import Line2D
import matplotlib.pyplot as plt
import matplotlib.animation as animation

class Scope(object):
    def __init__(self, ax, maxt=2, dt=0.02):
        self.ax = ax
        self.dt = dt
        self.maxt = maxt
        self.tdata = [0]
        self.ydata = [0]
        self.line = Line2D(self.tdata, self.ydata)
        self.ax.add_line(self.line)
        self.ax.set_ylim(-.1, 1.1)
        self.ax.set_xlim(0, self.maxt)

    def update(self, y):
        lastt = self.tdata[-1]
        if lastt > self.tdata[0] + self.maxt: # reset the arrays
            self.tdata = [self.tdata[-1]]
            self.ydata = [self.ydata[-1]]
            self.ax.set_xlim(self.tdata[0], self.tdata[0] + self.maxt)
            self.ax.figure.canvas.draw()

        t = self.tdata[-1] + self.dt
        self.tdata.append(t)
        self.ydata.append(y)
        self.line.set_data(self.tdata, self.ydata)
        return self.line,

def emitter(p=0.03):
    'return a random value with probability p, else 0'
    while True:
        v = np.random.rand(1)
        if v > p:
            yield 0.
        else:
            yield np.random.rand(1)

# Fixing random state for reproducibility
np.random.seed(19680801)

fig, ax = plt.subplots()
scope = Scope(ax)

# pass a generator in "emitter" to produce data for the update func
ani = animation.FuncAnimation(fig, scope.update, emitter, interval=10,
                              blit=True)

```

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```
plt.show()
```

---

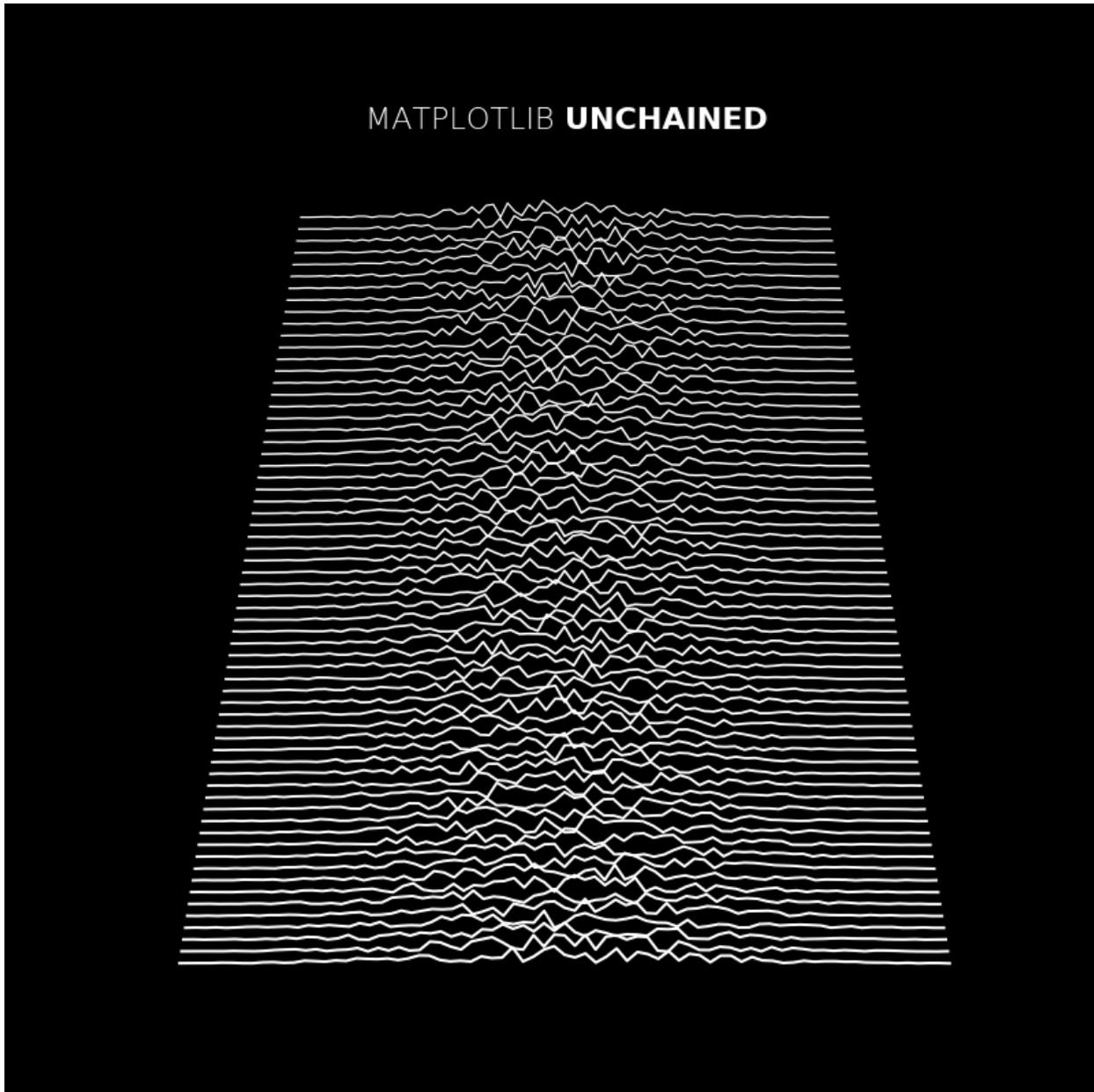
**Note:** Click *here* to download the full example code

---

## MATPLOTLIB UNCHAINED

Comparative path demonstration of frequency from a fake signal of a pulsar (mostly known because of the cover for Joy Division's Unknown Pleasures).

Author: Nicolas P. Rougier



```
import numpy as np
import matplotlib.pyplot as plt
import matplotlib.animation as animation

# Fixing random state for reproducibility
np.random.seed(19680801)

# Create new Figure with black background
fig = plt.figure(figsize=(8, 8), facecolor='black')

# Add a subplot with no frame
ax = plt.subplot(111, frameon=False)
```

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```
# Generate random data
data = np.random.uniform(0, 1, (64, 75))
X = np.linspace(-1, 1, data.shape[-1])
G = 1.5 * np.exp(-4 * X ** 2)

# Generate line plots
lines = []
for i in range(len(data)):
    # Small reduction of the X extents to get a cheap perspective effect
    xscale = 1 - i / 200.
    # Same for linewidth (thicker strokes on bottom)
    lw = 1.5 - i / 100.0
    line, = ax.plot(xscale * X, i + G * data[i], color="w", lw=lw)
    lines.append(line)

# Set y limit (or first line is cropped because of thickness)
ax.set_ylim(-1, 70)

# No ticks
ax.set_xticks([])
ax.set_yticks([])

# 2 part titles to get different font weights
ax.text(0.5, 1.0, "MATPLOTLIB ", transform=ax.transAxes,
        ha="right", va="bottom", color="w",
        family="sans-serif", fontweight="light", fontsize=16)
ax.text(0.5, 1.0, "UNCHAINED", transform=ax.transAxes,
        ha="left", va="bottom", color="w",
        family="sans-serif", fontweight="bold", fontsize=16)

def update(*args):
    # Shift all data to the right
    data[:, 1:] = data[:, :-1]

    # Fill-in new values
    data[:, 0] = np.random.uniform(0, 1, len(data))

    # Update data
    for i in range(len(data)):
        lines[i].set_ydata(i + G * data[i])

    # Return modified artists
    return lines

# Construct the animation, using the update function as the animation director.
anim = animation.FuncAnimation(fig, update, interval=10)
plt.show()
```

ArtistAnimation

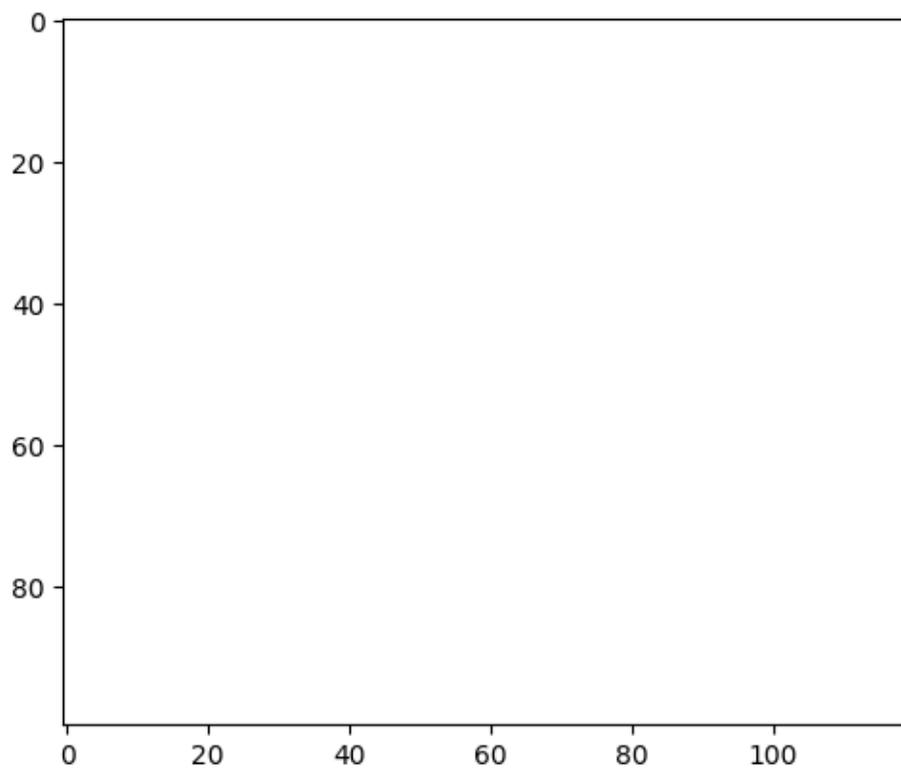
## Examples

---

**Note:** Click [here](#) to download the full example code

---

### Animated image using a precomputed list of images



```
import numpy as np
import matplotlib.pyplot as plt
import matplotlib.animation as animation

fig = plt.figure()

def f(x, y):
    return np.sin(x) + np.cos(y)

x = np.linspace(0, 2 * np.pi, 120)
```

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```

y = np.linspace(0, 2 * np.pi, 100).reshape(-1, 1)
# ims is a list of lists, each row is a list of artists to draw in the
# current frame; here we are just animating one artist, the image, in
# each frame
ims = []
for i in range(60):
    x += np.pi / 15.
    y += np.pi / 20.
    im = plt.imshow(f(x, y), animated=True)
    ims.append([im])

ani = animation.ArtistAnimation(fig, ims, interval=50, blit=True,
                                repeat_delay=1000)

# To save the animation, use e.g.
#
# ani.save("movie.mp4")
#
# or
#
# from matplotlib.animation import FFMpegWriter
# writer = FFMpegWriter(fps=15, metadata=dict(artist='Me'), bitrate=1800)
# ani.save("movie.mp4", writer=writer)

plt.show()

```

### 17.3.2 Writer Classes

The provided writers fall into a few broad categories.

The Pillow writer relies on the Pillow library to write the animation, keeping all data in memory.

*PillowWriter*

#### matplotlib.animation.PillowWriter

```
class matplotlib.animation.PillowWriter(*args, **kwargs)
```

```
    __init__(self, *args, **kwargs)
        MovieWriter
```

#### Parameters

**fps** [int] Framerate for movie.

**codec** [string or None, optional] The codec to use. If None (the default) the `animation.codec rcParam` is used.

**bitrate** [int or None, optional] The bitrate for the saved movie file, which is one way to control the output file size and quality. The default value

is `None`, which uses the `animation.bitrate` rcParam. A value of `-1` implies that the bitrate should be determined automatically by the underlying utility.

**extra\_args** [list of strings or `None`, optional] A list of extra string arguments to be passed to the underlying movie utility. The default is `None`, which passes the additional arguments in the `animation.extra_args` rcParam.

**metadata** [Dict[str, str] or `None`] A dictionary of keys and values for metadata to include in the output file. Some keys that may be of use include: `title`, `artist`, `genre`, `subject`, `copyright`, `srcform`, `comment`.

### Methods

<code>__init__(self, *args, **kwargs)</code>	MovieWriter
<code>bin_path()</code>	Return the binary path to the command-line tool used by a specific subclass.
<code>cleanup(self)</code>	Clean-up and collect the process used to write the movie file.
<code>finish(self)</code>	Finish any processing for writing the movie.
<code>grab_frame(self, **savefig_kwargs)</code>	Grab the image information from the figure and save as a movie frame.
<code>isAvailable()</code>	Check to see if a MovieWriter subclass is actually available.
<code>saving(self, fig, outfile, dpi, *args, ...)</code>	Context manager to facilitate writing the movie file.
<code>setup(self, fig, outfile[, dpi])</code>	Perform setup for writing the movie file.

### Attributes

<code>frame_size</code>	A tuple (width, height) in pixels of a movie frame.
-------------------------	---

`finish(self)`

Finish any processing for writing the movie.

`grab_frame(self, **savefig_kwargs)`

Grab the image information from the figure and save as a movie frame.

All keyword arguments in `savefig_kwargs` are passed on to the `savefig` command that saves the figure.

classmethod `isAvailable()`

Check to see if a MovieWriter subclass is actually available.

`setup(self, fig, outfile, dpi=None)`

Perform setup for writing the movie file.

### Parameters

**fig** [matplotlib.figure.Figure] The figure object that contains the information for frames

**outfile** [string] The filename of the resulting movie file

**dpi** [int, optional] The DPI (or resolution) for the file. This controls the size in pixels of the resulting movie file. Default is fig.dpi.

The pipe-based writers stream the captured frames over a pipe to an external process. The pipe-based variants tend to be more performant, but may not work on all systems.

<i>FFmpegWriter</i>	Pipe-based ffmpeg writer.
<i>ImageMagickWriter</i>	Pipe-based animated gif.
<i>AVConvWriter</i>	Pipe-based avconv writer.

### matplotlib.animation.FFMpegWriter

```
class matplotlib.animation.FFMpegWriter(fps=5, codec=None, bitrate=None, extra_args=None, metadata=None)
```

Pipe-based ffmpeg writer.

Frames are streamed directly to ffmpeg via a pipe and written in a single pass.

#### Parameters

**fps** [int] Framerate for movie.

**codec** [string or None, optional] The codec to use. If None (the default) the `animation.codec` rcParam is used.

**bitrate** [int or None, optional] The bitrate for the saved movie file, which is one way to control the output file size and quality. The default value is None, which uses the `animation.bitrate` rcParam. A value of -1 implies that the bitrate should be determined automatically by the underlying utility.

**extra\_args** [list of strings or None, optional] A list of extra string arguments to be passed to the underlying movie utility. The default is None, which passes the additional arguments in the `animation.extra_args` rcParam.

**metadata** [Dict[str, str] or None] A dictionary of keys and values for metadata to include in the output file. Some keys that may be of use include: title, artist, genre, subject, copyright, srcform, comment.

```
__init__(self, fps=5, codec=None, bitrate=None, extra_args=None, metadata=None)
MovieWriter
```

#### Parameters

**fps** [int] Framerate for movie.

**codec** [string or None, optional] The codec to use. If None (the default) the `animation.codec` rcParam is used.

**bitrate** [int or None, optional] The bitrate for the saved movie file, which is one way to control the output file size and quality. The default value is None, which uses the `animation.bitrate` rcParam. A value of -1 implies that the bitrate should be determined automatically by the underlying utility.

**extra\_args** [list of strings or None, optional] A list of extra string arguments to be passed to the underlying movie utility. The default is None,

which passes the additional arguments in the `animation.extra_args` rc-Param.

**metadata** [Dict[str, str] or None] A dictionary of keys and values for metadata to include in the output file. Some keys that may be of use include: title, artist, genre, subject, copyright, srcform, comment.

### Methods

<code>__init__(self[, fps, codec, bitrate, ...])</code>	MovieWriter
<code>bin_path()</code>	Return the binary path to the command-line tool used by a specific subclass.
<code>cleanup(self)</code>	Clean-up and collect the process used to write the movie file.
<code>finish(self)</code>	Finish any processing for writing the movie.
<code>grab_frame(self, <i>kwargs</i>)</code>	Grab the image information from the figure and save as a movie frame.
<code>isAvailable()</code>	Check to see if a MovieWriter subclass is actually available.
<code>saving(self, fig, outfile, dpi, <i>args</i>, ...)</code>	Context manager to facilitate writing the movie file.
<code>setup(self, fig, outfile[, dpi])</code>	Perform setup for writing the movie file.

### Attributes

<code>args_key</code>	
<code>exec_key</code>	
<code>frame_size</code>	A tuple (width, height) in pixels of a movie frame.
<code>output_args</code>	

### matplotlib.animation.ImageMagickWriter

```
class matplotlib.animation.ImageMagickWriter(fps=5, codec=None, bitrate=None, extra_args=None, metadata=None)
```

Pipe-based animated gif.

Frames are streamed directly to ImageMagick via a pipe and written in a single pass.

#### Parameters

**fps** [int] Framerate for movie.

**codec** [string or None, optional] The codec to use. If None (the default) the `animation.codec` rcParam is used.

**bitrate** [int or None, optional] The bitrate for the saved movie file, which is one way to control the output file size and quality. The default value is None, which uses the `animation.bitrate` rcParam. A value of -1 implies that the bitrate should be determined automatically by the underlying utility.

**extra\_args** [list of strings or None, optional] A list of extra string arguments to be passed to the underlying movie utility. The default is `None`, which passes the additional arguments in the `animation.extra_args` rcParam.

**metadata** [Dict[str, str] or None] A dictionary of keys and values for metadata to include in the output file. Some keys that may be of use include: title, artist, genre, subject, copyright, srcform, comment.

```
__init__(self, fps=5, codec=None, bitrate=None, extra_args=None, metadata=None)
MovieWriter
```

### Parameters

**fps** [int] Framerate for movie.

**codec** [string or None, optional] The codec to use. If `None` (the default) the `animation.codec` rcParam is used.

**bitrate** [int or None, optional] The bitrate for the saved movie file, which is one way to control the output file size and quality. The default value is `None`, which uses the `animation.bitrate` rcParam. A value of -1 implies that the bitrate should be determined automatically by the underlying utility.

**extra\_args** [list of strings or None, optional] A list of extra string arguments to be passed to the underlying movie utility. The default is `None`, which passes the additional arguments in the `animation.extra_args` rcParam.

**metadata** [Dict[str, str] or None] A dictionary of keys and values for metadata to include in the output file. Some keys that may be of use include: title, artist, genre, subject, copyright, srcform, comment.

### Methods

<code>__init__(self[, fps, codec, bitrate, ...])</code>	MovieWriter
<code>bin_path()</code>	Return the binary path to the command-line tool used by a specific subclass.
<code>cleanup(self)</code>	Clean-up and collect the process used to write the movie file.
<code>finish(self)</code>	Finish any processing for writing the movie.
<code>grab_frame(self, **savefig_kwargs)</code>	Grab the image information from the figure and save as a movie frame.
<code>isAvailable()</code>	Check to see if a MovieWriter subclass is actually available.
<code>saving(self, fig, outfile, dpi, *args, ...)</code>	Context manager to facilitate writing the movie file.
<code>setup(self, fig, outfile[, dpi])</code>	Perform setup for writing the movie file.

### Attributes

`args_key`

Continued on next page

Table 12 – continued from previous page

delay	
exec_key	
frame_size	A tuple (width, height) in pixels of a movie frame.
output_args	

**matplotlib.animation.AVConvWriter**

```
class matplotlib.animation.AVConvWriter(fps=5, codec=None, bitrate=None, extra_args=None, metadata=None)
```

Pipe-based avconv writer.

Frames are streamed directly to avconv via a pipe and written in a single pass.

**Parameters**

**fps** [int] Framerate for movie.

**codec** [string or None, optional] The codec to use. If None (the default) the `animation.codec` rcParam is used.

**bitrate** [int or None, optional] The bitrate for the saved movie file, which is one way to control the output file size and quality. The default value is None, which uses the `animation.bitrate` rcParam. A value of -1 implies that the bitrate should be determined automatically by the underlying utility.

**extra\_args** [list of strings or None, optional] A list of extra string arguments to be passed to the underlying movie utility. The default is None, which passes the additional arguments in the `animation.extra_args` rcParam.

**metadata** [Dict[str, str] or None] A dictionary of keys and values for metadata to include in the output file. Some keys that may be of use include: title, artist, genre, subject, copyright, srcform, comment.

```
__init__(self, fps=5, codec=None, bitrate=None, extra_args=None, metadata=None)
MovieWriter
```

**Parameters**

**fps** [int] Framerate for movie.

**codec** [string or None, optional] The codec to use. If None (the default) the `animation.codec` rcParam is used.

**bitrate** [int or None, optional] The bitrate for the saved movie file, which is one way to control the output file size and quality. The default value is None, which uses the `animation.bitrate` rcParam. A value of -1 implies that the bitrate should be determined automatically by the underlying utility.

**extra\_args** [list of strings or None, optional] A list of extra string arguments to be passed to the underlying movie utility. The default is None, which passes the additional arguments in the `animation.extra_args` rcParam.

**metadata** [Dict[str, str] or None] A dictionary of keys and values for metadata to include in the output file. Some keys that may be of use include: title, artist, genre, subject, copyright, srcform, comment.

### Methods

<code>__init__(self[, fps, codec, bitrate, ...])</code>	MovieWriter
<code>bin_path()</code>	Return the binary path to the command-line tool used by a specific subclass.
<code>cleanup(self)</code>	Clean-up and collect the process used to write the movie file.
<code>finish(self)</code>	Finish any processing for writing the movie.
<code>grab_frame(self, <i>\**savefig_kwargs</i>)</code>	Grab the image information from the figure and save as a movie frame.
<code>isAvailable()</code>	Check to see if a MovieWriter subclass is actually available.
<code>saving(self, fig, outfile, dpi, <i>\*args, ...</i>)</code>	Context manager to facilitate writing the movie file.
<code>setup(self, fig, outfile[, dpi])</code>	Perform setup for writing the movie file.

### Attributes

<code>args_key</code>	
<code>exec_key</code>	
<code>frame_size</code>	A tuple (width, height) in pixels of a movie frame.
<code>output_args</code>	

The file-based writers save temporary files for each frame which are stitched into a single file at the end. Although slower, these writers can be easier to debug.

<i>FFmpegFileWriter</i>	File-based ffmpeg writer.
<i>ImageMagickFileWriter</i>	File-based animated gif writer.
<i>AVConvFileWriter</i>	File-based avconv writer.

### matplotlib.animation.FFMpegFileWriter

```
class matplotlib.animation.FFMpegFileWriter(*args, **kwargs)
```

File-based ffmpeg writer.

Frames are written to temporary files on disk and then stitched together at the end.

```
__init__(self, *args, **kwargs)
    MovieWriter
```

#### Parameters

**fps** [int] Framerate for movie.

**codec** [string or None, optional] The codec to use. If None (the default) the `animation.codec` rcParam is used.

**bitrate** [int or None, optional] The bitrate for the saved movie file, which is one way to control the output file size and quality. The default value is None, which uses the `animation.bitrate` rcParam. A value of -1 implies

that the bitrate should be determined automatically by the underlying utility.

**extra\_args** [list of strings or None, optional] A list of extra string arguments to be passed to the underlying movie utility. The default is `None`, which passes the additional arguments in the `animation.extra_args` rc-Param.

**metadata** [Dict[str, str] or None] A dictionary of keys and values for metadata to include in the output file. Some keys that may be of use include: title, artist, genre, subject, copyright, srcform, comment.

### Methods

<code>__init__(self, *args, **kwargs)</code>	MovieWriter
<code>bin_path()</code>	Return the binary path to the command-line tool used by a specific subclass.
<code>cleanup(self)</code>	Clean-up and collect the process used to write the movie file.
<code>finish(self)</code>	Finish any processing for writing the movie.
<code>grab_frame(self, **savefig_kwargs)</code>	Grab the image information from the figure and save as a movie frame.
<code>isAvailable()</code>	Check to see if a MovieWriter subclass is actually available.
<code>saving(self, fig, outfile, dpi, *args, ...)</code>	Context manager to facilitate writing the movie file.
<code>setup(self, fig, outfile[, dpi, ...])</code>	Perform setup for writing the movie file.

### Attributes

<code>args_key</code>	
<code>exec_key</code>	
<code>frame_format</code>	Format (png, jpeg, etc.) to use for saving the frames, which can be decided by the individual subclasses.
<code>frame_size</code>	A tuple (width, height) in pixels of a movie frame.
<code>output_args</code>	
<code>supported_formats</code>	

```
supported_formats = ['png', 'jpeg', 'ppm', 'tiff', 'sgi', 'bmp', 'pbm', 'raw', 'rgba']
```

### matplotlib.animation.ImageMagickFileWriter

```
class matplotlib.animation.ImageMagickFileWriter(*args, **kwargs)
```

File-based animated gif writer.

Frames are written to temporary files on disk and then stitched together at the end.

`__init__(self, *args, **kwargs)`  
 MovieWriter

### Parameters

- fps** [int] Framerate for movie.
- codec** [string or None, optional] The codec to use. If None (the default) the `animation.codec` rcParam is used.
- bitrate** [int or None, optional] The bitrate for the saved movie file, which is one way to control the output file size and quality. The default value is None, which uses the `animation.bitrate` rcParam. A value of -1 implies that the bitrate should be determined automatically by the underlying utility.
- extra\_args** [list of strings or None, optional] A list of extra string arguments to be passed to the underlying movie utility. The default is None, which passes the additional arguments in the `animation.extra_args` rcParam.
- metadata** [Dict[str, str] or None] A dictionary of keys and values for metadata to include in the output file. Some keys that may be of use include: title, artist, genre, subject, copyright, srcform, comment.

### Methods

<code>__init__(self, *args, **kwargs)</code>	MovieWriter
<code>bin_path()</code>	Return the binary path to the command-line tool used by a specific subclass.
<code>cleanup(self)</code>	Clean-up and collect the process used to write the movie file.
<code>finish(self)</code>	Finish any processing for writing the movie.
<code>grab_frame(self, **savefig_kwargs)</code>	Grab the image information from the figure and save as a movie frame.
<code>isAvailable()</code>	Check to see if a MovieWriter subclass is actually available.
<code>saving(self, fig, outfile, dpi, *args, ...)</code>	Context manager to facilitate writing the movie file.
<code>setup(self, fig, outfile[, dpi, ...])</code>	Perform setup for writing the movie file.

### Attributes

<code>args_key</code>	
<code>delay</code>	
<code>exec_key</code>	
<code>frame_format</code>	Format (png, jpeg, etc.) to use for saving the frames, which can be decided by the individual subclasses.
<code>frame_size</code>	A tuple (width, height) in pixels of a movie frame.
<code>output_args</code>	

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---

*supported\_formats*


---

```
supported_formats = ['png', 'jpeg', 'ppm', 'tiff', 'sgi', 'bmp', 'pbm', 'raw', 'rgba']
```

### matplotlib.animation.AVConvFileWriter

```
class matplotlib.animation.AVConvFileWriter(*args, **kwargs)
```

File-based avconv writer.

Frames are written to temporary files on disk and then stitched together at the end.

```
__init__(self, *args, **kwargs)
```

MovieWriter

#### Parameters

**fps** [int] Framerate for movie.

**codec** [string or None, optional] The codec to use. If None (the default) the `animation.codec` rcParam is used.

**bitrate** [int or None, optional] The bitrate for the saved movie file, which is one way to control the output file size and quality. The default value is None, which uses the `animation.bitrate` rcParam. A value of -1 implies that the bitrate should be determined automatically by the underlying utility.

**extra\_args** [list of strings or None, optional] A list of extra string arguments to be passed to the underlying movie utility. The default is None, which passes the additional arguments in the `animation.extra_args` rcParam.

**metadata** [Dict[str, str] or None] A dictionary of keys and values for metadata to include in the output file. Some keys that may be of use include: title, artist, genre, subject, copyright, srcform, comment.

#### Methods

<code>__init__(self, *args, **kwargs)</code>	MovieWriter
<code>bin_path()</code>	Return the binary path to the command-line tool used by a specific subclass.
<code>cleanup(self)</code>	Clean-up and collect the process used to write the movie file.
<code>finish(self)</code>	Finish any processing for writing the movie.
<code>grab_frame(self, **savefig_kwargs)</code>	Grab the image information from the figure and save as a movie frame.
<code>isAvailable()</code>	Check to see if a MovieWriter subclass is actually available.
<code>saving(self, fig, outfile, dpi, *args, ...)</code>	Context manager to facilitate writing the movie file.
<code>setup(self, fig, outfile[, dpi, ...])</code>	Perform setup for writing the movie file.

### Attributes

<code>args_key</code>	
<code>exec_key</code>	
<code>frame_format</code>	Format (png, jpeg, etc.) to use for saving the frames, which can be decided by the individual subclasses.
<code>frame_size</code>	A tuple (width, height) in pixels of a movie frame.
<code>output_args</code>	
<code>supported_formats</code>	

Fundamentally, a *MovieWriter* provides a way to grab sequential frames from the same underlying *Figure* object. The base class *MovieWriter* implements 3 methods and a context manager. The only difference between the pipe-based and file-based writers is in the arguments to their respective setup methods.

The `setup()` method is used to prepare the writer (possibly opening a pipe), successive calls to `grab_frame()` capture a single frame at a time and `finish()` finalizes the movie and writes the output file to disk. For example

```
moviewriter = MovieWriter(...)
moviewriter.setup(fig=fig, 'my_movie.ext', dpi=100)
for j in range(n):
    update_figure(n)
    moviewriter.grab_frame()
moviewriter.finish()
```

If using the writer classes directly (not through *Animation.save*), it is strongly encouraged to use the saving context manager

```
with moviewriter.saving(fig, 'myfile.mp4', dpi=100):
    for j in range(n):
        update_figure(n)
        moviewriter.grab_frame()
```

to ensures that setup and cleanup are performed as necessary.

### Examples

---

**Note:** Click [here](#) to download the full example code

---

### Frame grabbing

Use a *MovieWriter* directly to grab individual frames and write them to a file. This avoids any event loop integration, and thus works even with the Agg backend. This is not recommended for use in an interactive setting.

```

import numpy as np
import matplotlib
matplotlib.use("Agg")
import matplotlib.pyplot as plt
from matplotlib.animation import FFMpegWriter

# Fixing random state for reproducibility
np.random.seed(19680801)

metadata = dict(title='Movie Test', artist='Matplotlib',
                comment='Movie support!')
writer = FFMpegWriter(fps=15, metadata=metadata)

fig = plt.figure()
l, = plt.plot([], [], 'k-o')

plt.xlim(-5, 5)
plt.ylim(-5, 5)

x0, y0 = 0, 0

with writer.saving(fig, "writer_test.mp4", 100):
    for i in range(100):
        x0 += 0.1 * np.random.randn()
        y0 += 0.1 * np.random.randn()
        l.set_data(x0, y0)
        writer.grab_frame()

```

### 17.3.3 Helper Classes

#### Animation Base Classes

<i>Animation</i>	This class wraps the creation of an animation using matplotlib.
<i>TimedAnimation</i>	<i>Animation</i> subclass for time-based animation.

#### matplotlib.animation.TimedAnimation

```
class matplotlib.animation.TimedAnimation(fig, interval=200, repeat_delay=None,
                                         repeat=True, event_source=None, *args,
                                         **kwargs)
```

*Animation* subclass for time-based animation.

A new frame is drawn every *interval* milliseconds.

#### Parameters

**fig** [matplotlib.figure.Figure] The figure object that is used to get draw, resize, and any other needed events.

**interval** [number, optional] Delay between frames in milliseconds. Defaults to 200.

**repeat\_delay** [number, optional] If the animation is repeated, adds a delay in milliseconds before repeating the animation. Defaults to `None`.

**repeat** [bool, optional] Controls whether the animation should repeat when the sequence of frames is completed. Defaults to `True`.

**blit** [bool, optional] Controls whether blitting is used to optimize drawing. Defaults to `False`.

```
__init__(self, fig, interval=200, repeat_delay=None, repeat=True,
          event_source=None, *args, **kwargs)
```

Initialize self. See `help(type(self))` for accurate signature.

### Methods

<code>__init__(self, fig[, interval, ...])</code>	Initialize self.
<code>new_frame_seq(self)</code>	Return a new sequence of frame information.
<code>new_saved_frame_seq(self)</code>	Return a new sequence of saved/cached frame information.
<code>save(self, filename[, writer, fps, dpi, ...])</code>	Save the animation as a movie file by drawing every frame.
<code>to_html5_video(self[, embed_limit])</code>	Convert the animation to an HTML5 <code>&lt;video&gt;</code> tag.
<code>to_jshtml(self[, fps, embed_frames, ...])</code>	Generate HTML representation of the animation

### Writer Registry

A module-level registry is provided to map between the name of the writer and the class to allow a string to be passed to `Animation.save` instead of a writer instance.

<code>MovieWriterRegistry</code>	Registry of available writer classes by human readable name.
----------------------------------	--

### matplotlib.animation.MovieWriterRegistry

```
class matplotlib.animation.MovieWriterRegistry
    Registry of available writer classes by human readable name.
    __init__(self)
        Initialize self. See help(type(self)) for accurate signature.
```

### Methods

<code>__init__(self)</code>	Initialize self.
-----------------------------	------------------

Continued on next page

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<code>ensure_not_dirty(self)</code>	If dirty, reasks the writers if they are available
<code>is_available(self, name)</code>	Check if given writer is available by name.
<code>list(self)</code>	Get a list of available MovieWriters.
<code>register(self, name)</code>	Decorator for registering a class under a name.
<code>reset_available_writers(self)</code>	Reset the available state of all registered writers
<code>set_dirty(self)</code>	Sets a flag to re-setup the writers.

`ensure_not_dirty(self)`

If dirty, reasks the writers if they are available

`is_available(self, name)`

Check if given writer is available by name.

#### Parameters

**name** [str]

#### Returns

**available** [bool]

`list(self)`

Get a list of available MovieWriters.

`register(self, name)`

Decorator for registering a class under a name.

Example use:

```
@registry.register(name)
class Foo:
    pass
```

`reset_available_writers(self)`

Reset the available state of all registered writers

`set_dirty(self)`

Sets a flag to re-setup the writers.

## Writer Base Classes

To reduce code duplication base classes

<code>AbstractMovieWriter</code>	Abstract base class for writing movies.
<code>MovieWriter</code>	Base class for writing movies.
<code>FileMovieWriter</code>	<code>MovieWriter</code> for writing to individual files and stitching at the end.

**matplotlib.animation.AbstractMovieWriter**

```
class matplotlib.animation.AbstractMovieWriter
```

Abstract base class for writing movies. Fundamentally, what a MovieWriter does is provide a way to grab frames by calling `grab_frame()`.

`setup()` is called to start the process and `finish()` is called afterwards.

This class is set up to provide for writing movie frame data to a pipe. `saving()` is provided as a context manager to facilitate this process as:

```
with moviewriter.saving(fig, outfile='myfile.mp4', dpi=100):
    # Iterate over frames
    moviewriter.grab_frame(**savefig_kwargs)
```

The use of the context manager ensures that `setup()` and `finish()` are performed as necessary.

An instance of a concrete subclass of this class can be given as the `writer` argument of `Animation.save()`.

```
__init__(self, /, *args, **kwargs)
```

Initialize self. See `help(type(self))` for accurate signature.

**Methods**

<code>finish(self)</code>	Finish any processing for writing the movie.
<code>grab_frame(self, \**savefig_kwargs)</code>	Grab the image information from the figure and save as a movie frame.
<code>saving(self, fig, outfile, dpi, \*args, ...)</code>	Context manager to facilitate writing the movie file.
<code>setup(self, fig, outfile[, dpi])</code>	Perform setup for writing the movie file.

```
finish(self)
```

Finish any processing for writing the movie.

```
grab_frame(self, \**savefig_kwargs)
```

Grab the image information from the figure and save as a movie frame.

All keyword arguments in `savefig_kwargs` are passed on to the `savefig` command that saves the figure.

```
saving(self, fig, outfile, dpi, *args, **kwargs)
```

Context manager to facilitate writing the movie file.

`*args`, `**kw` are any parameters that should be passed to `setup`.

```
setup(self, fig, outfile, dpi=None)
```

Perform setup for writing the movie file.

**Parameters**

**fig** [`matplotlib.figure.Figure` instance] The figure object that contains the information for frames

**outfile** [string] The filename of the resulting movie file

**dpi** [int, optional] The DPI (or resolution) for the file. This controls the size in pixels of the resulting movie file. Default is `fig.dpi`.

### matplotlib.animation.MovieWriter

```
class matplotlib.animation.MovieWriter(fps=5, codec=None, bitrate=None, extra_args=None, metadata=None)
```

Base class for writing movies.

This is a base class for `MovieWriter` subclasses that write a movie frame data to a pipe. You cannot instantiate this class directly. See examples for how to use its subclasses.

#### Attributes

**frame\_format** [str] The format used in writing frame data, defaults to 'rgba'

**fig** [*Figure*] The figure to capture data from. This must be provided by the sub-classes.

#### Parameters

**fps** [int] Framerate for movie.

**codec** [string or None, optional] The codec to use. If `None` (the default) the `animation.codec` rcParam is used.

**bitrate** [int or None, optional] The bitrate for the saved movie file, which is one way to control the output file size and quality. The default value is `None`, which uses the `animation.bitrate` rcParam. A value of -1 implies that the bitrate should be determined automatically by the underlying utility.

**extra\_args** [list of strings or None, optional] A list of extra string arguments to be passed to the underlying movie utility. The default is `None`, which passes the additional arguments in the `animation.extra_args` rcParam.

**metadata** [Dict[str, str] or None] A dictionary of keys and values for metadata to include in the output file. Some keys that may be of use include: title, artist, genre, subject, copyright, srcform, comment.

```
__init__(self, fps=5, codec=None, bitrate=None, extra_args=None, metadata=None)  
MovieWriter
```

#### Parameters

**fps** [int] Framerate for movie.

**codec** [string or None, optional] The codec to use. If `None` (the default) the `animation.codec` rcParam is used.

**bitrate** [int or None, optional] The bitrate for the saved movie file, which is one way to control the output file size and quality. The default value is `None`, which uses the `animation.bitrate` rcParam. A value of -1 implies that the bitrate should be determined automatically by the underlying utility.

**extra\_args** [list of strings or None, optional] A list of extra string arguments to be passed to the underlying movie utility. The default is `None`,

which passes the additional arguments in the `animation.extra_args` `RCParam`.

**metadata** [Dict[str, str] or None] A dictionary of keys and values for metadata to include in the output file. Some keys that may be of use include: title, artist, genre, subject, copyright, srcform, comment.

### Methods

<code>__init__(self[, fps, codec, bitrate, ...])</code>	MovieWriter
<code>bin_path()</code>	Return the binary path to the command-line tool used by a specific subclass.
<code>cleanup(self)</code>	Clean-up and collect the process used to write the movie file.
<code>finish(self)</code>	Finish any processing for writing the movie.
<code>grab_frame(self, **savefig_kwargs)</code>	Grab the image information from the figure and save as a movie frame.
<code>isAvailable()</code>	Check to see if a MovieWriter subclass is actually available.
<code>saving(self, fig, outfile, dpi, *args, ...)</code>	Context manager to facilitate writing the movie file.
<code>setup(self, fig, outfile[, dpi])</code>	Perform setup for writing the movie file.

### Attributes

<code>frame_size</code>	A tuple (width, height) in pixels of a movie frame.
-------------------------	---

`classmethod bin_path()`

Return the binary path to the commandline tool used by a specific subclass. This is a class method so that the tool can be looked for before making a particular MovieWriter subclass available.

`cleanup(self)`

Clean-up and collect the process used to write the movie file.

`finish(self)`

Finish any processing for writing the movie.

`frame_size`

A tuple (width, height) in pixels of a movie frame.

`grab_frame(self, **savefig_kwargs)`

Grab the image information from the figure and save as a movie frame.

All keyword arguments in `savefig_kwargs` are passed on to the `savefig` command that saves the figure.

`classmethod isAvailable()`

Check to see if a MovieWriter subclass is actually available.

`setup(self, fig, outfile, dpi=None)`

Perform setup for writing the movie file.

**Parameters**

- fig** [matplotlib.figure.Figure] The figure object that contains the information for frames
- outfile** [string] The filename of the resulting movie file
- dpi** [int, optional] The DPI (or resolution) for the file. This controls the size in pixels of the resulting movie file. Default is fig.dpi.

**matplotlib.animation.FileMovieWriter**

```
class matplotlib.animation.FileMovieWriter(*args, **kwargs)
    MovieWriter for writing to individual files and stitching at the end.
```

This must be sub-classed to be useful.

```
__init__(self, *args, **kwargs)
    MovieWriter
```

**Parameters**

- fps** [int] Framerate for movie.
- codec** [string or None, optional] The codec to use. If None (the default) the `animation.codec rcParam` is used.
- bitrate** [int or None, optional] The bitrate for the saved movie file, which is one way to control the output file size and quality. The default value is None, which uses the `animation.bitrate rcParam`. A value of -1 implies that the bitrate should be determined automatically by the underlying utility.
- extra\_args** [list of strings or None, optional] A list of extra string arguments to be passed to the underlying movie utility. The default is None, which passes the additional arguments in the `animation.extra_args rcParam`.
- metadata** [Dict[str, str] or None] A dictionary of keys and values for metadata to include in the output file. Some keys that may be of use include: title, artist, genre, subject, copyright, srcform, comment.

**Methods**

<code>__init__(self, *args, **kwargs)</code>	MovieWriter
<code>bin_path()</code>	Return the binary path to the command-line tool used by a specific subclass.
<code>cleanup(self)</code>	Clean-up and collect the process used to write the movie file.
<code>finish(self)</code>	Finish any processing for writing the movie.
<code>grab_frame(self, **savefig_kwargs)</code>	Grab the image information from the figure and save as a movie frame.
<code>isAvailable()</code>	Check to see if a MovieWriter subclass is actually available.

Continued on next page

Table 30 – continued from previous page

<code>saving(self, fig, outfile, dpi, \*args, ...)</code>	Context manager to facilitate writing the movie file.
<code>setup(self, fig, outfile[, dpi, ...])</code>	Perform setup for writing the movie file.

**Attributes**

<code>frame_format</code>	Format (png, jpeg, etc.) to use for saving the frames, which can be decided by the individual subclasses.
<code>frame_size</code>	A tuple (width, height) in pixels of a movie frame.

`cleanup(self)`

Clean-up and collect the process used to write the movie file.

`finish(self)`

Finish any processing for writing the movie.

`frame_format`

Format (png, jpeg, etc.) to use for saving the frames, which can be decided by the individual subclasses.

`grab_frame(self, **savefig_kwargs)`

Grab the image information from the figure and save as a movie frame. All keyword arguments in `savefig_kwargs` are passed on to the `savefig` command that saves the figure.

`setup(self, fig, outfile, dpi=None, frame_prefix='_tmp', clear_temp=True)`

Perform setup for writing the movie file.

**Parameters**

**fig** [matplotlib.figure.Figure] The figure to grab the rendered frames from.

**outfile** [str] The filename of the resulting movie file.

**dpi** [number, optional] The dpi of the output file. This, with the figure size, controls the size in pixels of the resulting movie file. Default is `fig.dpi`.

**frame\_prefix** [str, optional] The filename prefix to use for temporary files. Defaults to `'_tmp'`.

**clear\_temp** [bool, optional] If the temporary files should be deleted after stitching the final result. Setting this to `False` can be useful for debugging. Defaults to `True`.

and mixins

<code>AVConvBase</code>	Mixin class for avconv output.
<code>FFMpegBase</code>	Mixin class for FFMpeg output.
<code>ImageMagickBase</code>	Mixin class for ImageMagick output.

**matplotlib.animation.AVConvBase**

```
class matplotlib.animation.AVConvBase
```

Mixin class for avconv output.

To be useful this must be multiply-inherited from with a `MovieWriterBase` sub-class.

```
__init__(self, /, *args, **kwargs)
```

Initialize self. See `help(type(self))` for accurate signature.

**Methods**

<i>isAvailable()</i>	Check to see if a <code>MovieWriter</code> subclass is actually available.
----------------------	--

**Attributes**

<i>args_key</i>
-----------------

<i>exec_key</i>
-----------------

<i>output_args</i>
--------------------

```
args_key = 'animation.avconv_args'
```

```
exec_key = 'animation.avconv_path'
```

```
classmethod isAvailable()
```

Check to see if a `MovieWriter` subclass is actually available.

**matplotlib.animation.FFMpegBase**

```
class matplotlib.animation.FFMpegBase
```

Mixin class for FFMpeg output.

To be useful this must be multiply-inherited from with a `MovieWriterBase` sub-class.

```
__init__(self, /, *args, **kwargs)
```

Initialize self. See `help(type(self))` for accurate signature.

**Methods**

<i>isAvailable()</i>
----------------------

**Attributes**

<i>args_key</i>
-----------------

<i>exec_key</i>
-----------------

<i>output_args</i>
--------------------

```
args_key = 'animation.ffmpeg_args'  
exec_key = 'animation.ffmpeg_path'  
classmethod isAvailable()  
output_args
```

### matplotlib.animation.ImageMagickBase

class matplotlib.animation.ImageMagickBase

Mixin class for ImageMagick output.

To be useful this must be multiply-inherited from with a *MovieWriterBase* sub-class.

`__init__(self, /, *args, **kwargs)`

Initialize self. See help(type(self)) for accurate signature.

#### Methods

`bin_path()`

---

`isAvailable()`

---

#### Attributes

`args_key`

---

`delay`

---

`exec_key`

---

`output_args`

---

```
args_key = 'animation.convert_args'
```

```
classmethod bin_path()
```

```
delay
```

```
exec_key = 'animation.convert_path'
```

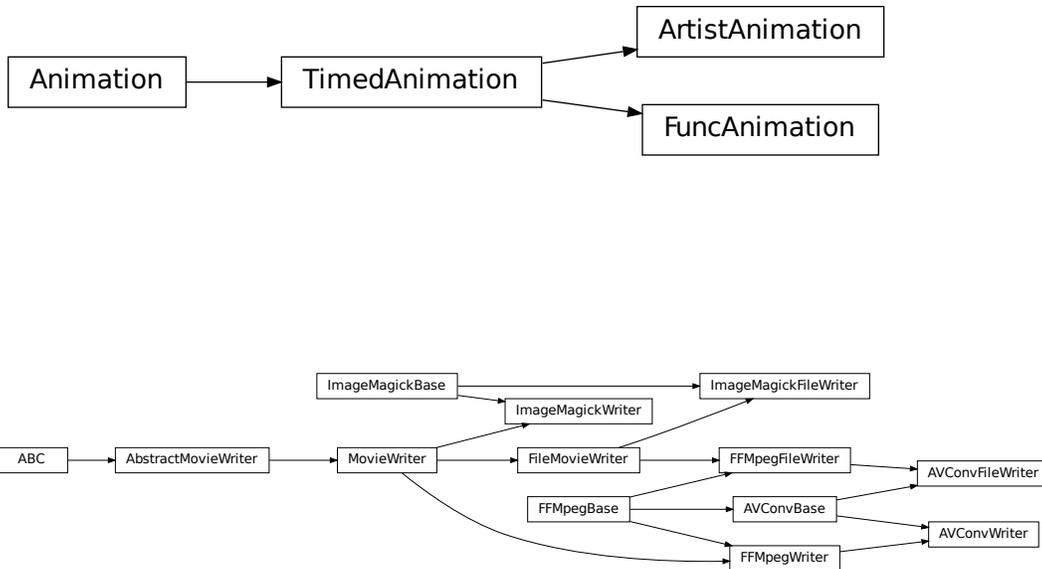
```
classmethod isAvailable()
```

```
output_args
```

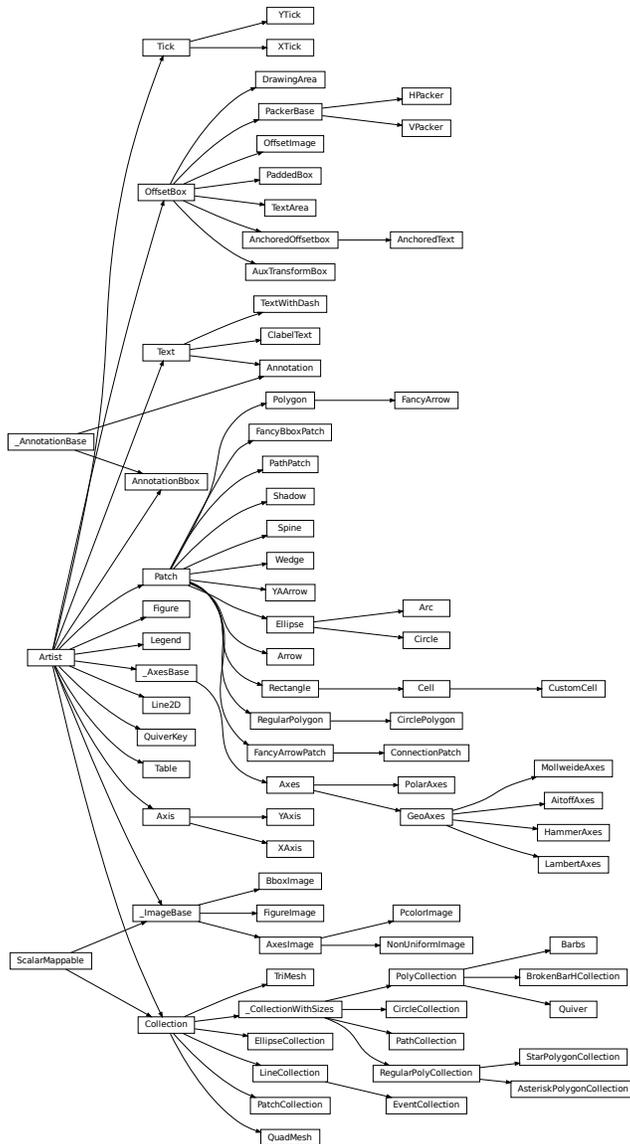
are provided.

See the source code for how to easily implement new *MovieWriter* classes.

### 17.3.4 Inheritance Diagrams



## 17.4 matplotlib.artist



### 17.4.1 Artist class

```
class matplotlib.artist.Artist
```

Abstract base class for objects that render into a FigureCanvas.

Typically, all visible elements in a figure are subclasses of Artist.

**Interactive**

<code>Artist.add_callback</code>	Add a callback function that will be called whenever one of the <i>Artist's</i> properties changes.
<code>Artist.remove_callback</code>	Remove a callback based on its observer id.
<code>Artist.pchanged</code>	Call all of the registered callbacks.
<code>Artist.get_cursor_data</code>	Return the cursor data for a given event.
<code>Artist.format_cursor_data</code>	Return a string representation of <i>data</i> .
<code>Artist.mouseover</code>	
<code>Artist.contains</code>	Test whether the artist contains the mouse event.
<code>Artist.set_contains</code>	Define a custom contains test for the artist.
<code>Artist.get_contains</code>	Return the custom contains function of the artist if set, or <i>None</i> .
<code>Artist.pick</code>	Process a pick event.
<code>Artist.pickable</code>	Return whether the artist is pickable.
<code>Artist.set_picker</code>	Define the picking behavior of the artist.
<code>Artist.get_picker</code>	Return the picking behavior of the artist.

**matplotlib.artist.Artist.add\_callback**

`Artist.add_callback(self, func)`

Add a callback function that will be called whenever one of the *Artist's* properties changes.

**Parameters**

**func** [callable] The callback function. It must have the signature:

```
def func(artist: Artist) -> Any
```

where *artist* is the calling *Artist*. Return values may exist but are ignored.

**Returns**

**oid** [int] The observer id associated with the callback. This id can be used for removing the callback with `remove_callback` later.

**See also:**

`remove_callback`

**matplotlib.artist.Artist.remove\_callback**

`Artist.remove_callback(self, oid)`

Remove a callback based on its observer id.

**See also:**

`add_callback`

### matplotlib.artist.Artist.pchanged

`Artist.pchanged(self)`

Call all of the registered callbacks.

This function is triggered internally when a property is changed.

**See also:**

`add_callback`

`remove_callback`

### matplotlib.artist.Artist.get\_cursor\_data

`Artist.get_cursor_data(self, event)`

Return the cursor data for a given event.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

Cursor data can be used by Artists to provide additional context information for a given event. The default implementation just returns *None*.

Subclasses can override the method and return arbitrary data. However, when doing so, they must ensure that *format\_cursor\_data* can convert the data to a string representation.

The only current use case is displaying the z-value of an *AxesImage* in the status bar of a plot window, while moving the mouse.

**Parameters**

**event** [*matplotlib.backend\_bases.MouseEvent*]

**See also:**

`format_cursor_data`

### matplotlib.artist.Artist.format\_cursor\_data

`Artist.format_cursor_data(self, data)`

Return a string representation of *data*.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

The default implementation converts ints and floats and arrays of ints and floats into a comma-separated string enclosed in square brackets.

**See also:**

`get_cursor_data`

**matplotlib.artist.Artist.mouseover**`Artist.mouseover`**matplotlib.artist.Artist.contains**`Artist.contains(self, mouseevent)`

Test whether the artist contains the mouse event.

**Parameters****mouseevent** [`matplotlib.backend_bases.MouseEvent`]**Returns****contains** [bool] Whether any values are within the radius.**details** [dict] An artist-specific dictionary of details of the event context, such as which points are contained in the pick radius. See the individual Artist subclasses for details.**See also:**`set_contains, get_contains`**matplotlib.artist.Artist.set\_contains**`Artist.set_contains(self, picker)`

Define a custom contains test for the artist.

The provided callable replaces the default `contains` method of the artist.**Parameters****picker** [callable] A custom picker function to evaluate if an event is within the artist. The function must have the signature:

```
def contains(artist: Artist, event: MouseEvent) -> bool, dict
```

that returns:

- a bool indicating if the event is within the artist
- a dict of additional information. The dict should at least return the same information as the default `contains()` implementation of the respective artist, but may provide additional information.

**matplotlib.artist.Artist.get\_contains**`Artist.get_contains(self)`Return the custom contains function of the artist if set, or `None`.**See also:**`set_contains`

### matplotlib.artist.Artist.pick

`Artist.pick(self, mouseevent)`

Process a pick event.

Each child artist will fire a pick event if *mouseevent* is over the artist and the artist has picker set.

**See also:**

`set_picker`, `get_picker`, `pickable`

### matplotlib.artist.Artist.pickable

`Artist.pickable(self)`

Return whether the artist is pickable.

**See also:**

`set_picker`, `get_picker`, `pick`

### matplotlib.artist.Artist.set\_picker

`Artist.set_picker(self, picker)`

Define the picking behavior of the artist.

**Parameters**

**picker** [None or bool or float or callable] This can be one of the following:

- *None*: Picking is disabled for this artist (default).
- A boolean: If *True* then picking will be enabled and the artist will fire a pick event if the mouse event is over the artist.
- A float: If *picker* is a number it is interpreted as an epsilon tolerance in points and the artist will fire off an event if it's data is within epsilon of the mouse event. For some artists like lines and patch collections, the artist may provide additional data to the pick event that is generated, e.g., the indices of the data within epsilon of the pick event
- A function: If *picker* is callable, it is a user supplied function which determines whether the artist is hit by the mouse event:

```
hit, props = picker(artist, mouseevent)
```

to determine the hit test. if the mouse event is over the artist, return *hit=True* and *props* is a dictionary of properties you want added to the `PickEvent` attributes.

### matplotlib.artist.Artist.get\_picker

`Artist.get_picker(self)`

Return the picking behavior of the artist.

The possible values are described in *set\_picker*.

**See also:**

*set\_picker*, *pickable*, *pick*

## Clipping

<i>Artist.set_clip_on</i>	Set whether the artist uses clipping.
<i>Artist.get_clip_on</i>	Return whether the artist uses clipping.
<i>Artist.set_clip_box</i>	Set the artist's clip <i>Bbox</i> .
<i>Artist.get_clip_box</i>	Return the clipbox.
<i>Artist.set_clip_path</i>	Set the artist's clip path, which may be:
<i>Artist.get_clip_path</i>	Return the clip path.

### matplotlib.artist.Artist.set\_clip\_on

*Artist.set\_clip\_on(self, b)*

Set whether the artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

**Parameters**

**b** [bool]

### matplotlib.artist.Artist.get\_clip\_on

*Artist.get\_clip\_on(self)*

Return whether the artist uses clipping.

### matplotlib.artist.Artist.set\_clip\_box

*Artist.set\_clip\_box(self, clipbox)*

Set the artist's clip *Bbox*.

**Parameters**

**clipbox** [*Bbox*]

### matplotlib.artist.Artist.get\_clip\_box

*Artist.get\_clip\_box(self)*

Return the clipbox.

### matplotlib.artist.Artist.set\_clip\_path

*Artist.set\_clip\_path(self, path, transform=None)*

Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- *None*, to remove a previously set clipping path.

For efficiency, if the path happens to be an axis-aligned rectangle, this method will set the clipping box to the corresponding rectangle and set the clipping path to *None*.

ACCEPTS: [(*Path*, *Transform*) | *Patch* | *None*]

### matplotlib.artist.Artist.get\_clip\_path

`Artist.get_clip_path(self)`  
Return the clip path.

### Bulk Properties

<i>Artist.update</i>	Update this artist's properties from the dictionary <i>props</i> .
<i>Artist.update_from</i>	Copy properties from <i>other</i> to <i>self</i> .
<i>Artist.properties</i>	Return a dictionary of all the properties of the artist.
<i>Artist.set</i>	A property batch setter.

### matplotlib.artist.Artist.update

`Artist.update(self, props)`  
Update this artist's properties from the dictionary *props*.

### matplotlib.artist.Artist.update\_from

`Artist.update_from(self, other)`  
Copy properties from *other* to *self*.

### matplotlib.artist.Artist.properties

`Artist.properties(self)`  
Return a dictionary of all the properties of the artist.

### matplotlib.artist.Artist.set

`Artist.set(self, **kwargs)`  
A property batch setter. Pass *kwargs* to set properties.

## Drawing

<code>Artist.draw</code>	Draw the Artist using the given renderer.
<code>Artist.set_animated</code>	Set the artist's animation state.
<code>Artist.get_animated</code>	Return the animated state.
<code>Artist.set_alpha</code>	Set the alpha value used for blending - not supported on all backends.
<code>Artist.get_alpha</code>	Return the alpha value used for blending - not supported on all backends
<code>Artist.set_snap</code>	Set the snapping behavior.
<code>Artist.get_snap</code>	Returns the snap setting.
<code>Artist.set_visible</code>	Set the artist's visibility.
<code>Artist.get_visible</code>	Return the visibility.
<code>Artist.zorder</code>	
<code>Artist.set_zorder</code>	Set the zorder for the artist.
<code>Artist.get_zorder</code>	Return the artist's zorder.
<code>Artist.set_agg_filter</code>	Set the agg filter.
<code>Artist.set_sketch_params</code>	Sets the sketch parameters.
<code>Artist.get_sketch_params</code>	Returns the sketch parameters for the artist.
<code>Artist.set_rasterized</code>	Force rasterized (bitmap) drawing in vector backend output.
<code>Artist.get_rasterized</code>	Return whether the artist is to be rasterized.
<code>Artist.set_path_effects</code>	Set the path effects.
<code>Artist.get_path_effects</code>	
<code>Artist.get_agg_filter</code>	Return filter function to be used for agg filter.
<code>Artist.get_window_extent</code>	Get the axes bounding box in display space.
<code>Artist.get_transformed_clip_path_and_affine</code>	Return the clip path with the non-affine part of its transformation applied, and the remaining affine part of its transformation.

### matplotlib.artist.Artist.draw

`Artist.draw(self, renderer, *args, **kwargs)`  
 Draw the Artist using the given renderer.

This method will be overridden in the Artist subclasses. Typically, it is implemented to not have any effect if the Artist is not visible (`Artist.get_visible` is `False`).

#### Parameters

**renderer** [`RendererBase` subclass.]

### matplotlib.artist.Artist.set\_animated

`Artist.set_animated(self, b)`  
 Set the artist's animation state.

#### Parameters

**b** [bool]

### matplotlib.artist.Artist.get\_animated

`Artist.get_animated(self)`  
Return the animated state.

### matplotlib.artist.Artist.set\_alpha

`Artist.set_alpha(self, alpha)`  
Set the alpha value used for blending - not supported on all backends.

#### Parameters

**alpha** [float]

### matplotlib.artist.Artist.get\_alpha

`Artist.get_alpha(self)`  
Return the alpha value used for blending - not supported on all backends

### matplotlib.artist.Artist.set\_snap

`Artist.set_snap(self, snap)`  
Set the snapping behavior.

Snapping aligns positions with the pixel grid, which results in clearer images. For example, if a black line of 1px width was defined at a position in between two pixels, the resulting image would contain the interpolated value of that line in the pixel grid, which would be a grey value on both adjacent pixel positions. In contrast, snapping will move the line to the nearest integer pixel value, so that the resulting image will really contain a 1px wide black line.

Snapping is currently only supported by the Agg and MacOSX backends.

#### Parameters

**snap** [bool or None] Possible values:

- *True*: Snap vertices to the nearest pixel center.
- *False*: Do not modify vertex positions.
- *None*: (auto) If the path contains only rectilinear line segments, round to the nearest pixel center.

### matplotlib.artist.Artist.get\_snap

`Artist.get_snap(self)`  
Returns the snap setting.

See `set_snap` for details.

**matplotlib.artist.Artist.set\_visible**

`Artist.set_visible(self, b)`  
Set the artist's visibility.

**Parameters**

**b** [bool]

**matplotlib.artist.Artist.get\_visible**

`Artist.get_visible(self)`  
Return the visibility.

**matplotlib.artist.Artist.zorder**

`Artist.zorder = 0`

**matplotlib.artist.Artist.set\_zorder**

`Artist.set_zorder(self, level)`  
Set the zorder for the artist. Artists with lower zorder values are drawn first.

**Parameters**

**level** [float]

**matplotlib.artist.Artist.get\_zorder**

`Artist.get_zorder(self)`  
Return the artist's zorder.

**matplotlib.artist.Artist.set\_agg\_filter**

`Artist.set_agg_filter(self, filter_func)`  
Set the agg filter.

**Parameters**

**filter\_func** [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

**matplotlib.artist.Artist.set\_sketch\_params**

`Artist.set_sketch_params(self, scale=None, length=None, randomness=None)`  
Sets the sketch parameters.

**Parameters**

**scale** [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

**length** [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

**randomness** [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

#### `matplotlib.artist.Artist.get_sketch_params`

`Artist.get_sketch_params(self)`

Returns the sketch parameters for the artist.

##### **Returns**

**sketch\_params** [tuple or None] A 3-tuple with the following elements:

- *scale*: The amplitude of the wiggle perpendicular to the source line.
- *length*: The length of the wiggle along the line.
- *randomness*: The scale factor by which the length is shrunken or expanded.

Returns `None` if no sketch parameters were set.

#### `matplotlib.artist.Artist.set_rasterized`

`Artist.set_rasterized(self, rasterized)`

Force rasterized (bitmap) drawing in vector backend output.

Defaults to `None`, which implies the backend's default behavior.

##### **Parameters**

**rasterized** [bool or None]

#### `matplotlib.artist.Artist.get_rasterized`

`Artist.get_rasterized(self)`

Return whether the artist is to be rasterized.

#### `matplotlib.artist.Artist.set_path_effects`

`Artist.set_path_effects(self, path_effects)`

Set the path effects.

##### **Parameters**

**path\_effects** [`AbstractPathEffect`]

**matplotlib.artist.Artist.get\_path\_effects**`Artist.get_path_effects(self)`**matplotlib.artist.Artist.get\_agg\_filter**`Artist.get_agg_filter(self)`

Return filter function to be used for agg filter.

**matplotlib.artist.Artist.get\_window\_extent**`Artist.get_window_extent(self, renderer)`

Get the axes bounding box in display space.

The bounding box' width and height are nonnegative.

Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

**matplotlib.artist.Artist.get\_transformed\_clip\_path\_and\_affine**`Artist.get_transformed_clip_path_and_affine(self)`

Return the clip path with the non-affine part of its transformation applied, and the remaining affine part of its transformation.

**Figure and Axes**

<code>Artist.remove</code>	Remove the artist from the figure if possible.
<code>Artist.axes</code>	The <i>Axes</i> instance the artist resides in, or <i>None</i> .
<code>Artist.set_figure</code>	Set the <i>Figure</i> instance the artist belongs to.
<code>Artist.get_figure</code>	Return the <i>Figure</i> instance the artist belongs to.

**matplotlib.artist.Artist.remove**`Artist.remove(self)`

Remove the artist from the figure if possible.

The effect will not be visible until the figure is redrawn, e.g., with *FigureCanvasBase.draw\_idle*. Call *relim* to update the axes limits if desired.Note: *relim* will not see collections even if the collection was added to the axes with *autolim* = True.

Note: there is no support for removing the artist's legend entry.

#### matplotlib.artist.Artist.axes

`Artist.axes`

The *Axes* instance the artist resides in, or *None*.

#### matplotlib.artist.Artist.set\_figure

`Artist.set_figure(self, fig)`

Set the *Figure* instance the artist belongs to.

##### Parameters

**fig** [*Figure*]

#### matplotlib.artist.Artist.get\_figure

`Artist.get_figure(self)`

Return the *Figure* instance the artist belongs to.

#### Children

`Artist.get_children`

Return a list of the child *Artists* of this *Artist*.

---

`Artist.findobj`

Find artist objects.

---

#### matplotlib.artist.Artist.get\_children

`Artist.get_children(self)`

Return a list of the child *Artists* of this *Artist*.

#### matplotlib.artist.Artist.findobj

`Artist.findobj(self, match=None, include_self=True)`

Find artist objects.

Recursively find all *Artist* instances contained in the artist.

##### Parameters

**match** A filter criterion for the matches. This can be

- *None*: Return all objects contained in artist.
- A function with signature `def match(artist: Artist) -> bool`. The result will only contain artists for which the function returns *True*.
- A class instance: e.g., *Line2D*. The result will only contain artists of this class or its subclasses (isinstance check).

**include\_self** [bool] Include *self* in the list to be checked for a match.

### Returns

**artists** [list of *Artist*]

### Transform

<i>Artist.set_transform</i>	Set the artist transform.
<i>Artist.get_transform</i>	Return the <i>Transform</i> instance used by this artist.
<i>Artist.is_transform_set</i>	Return whether the Artist has an explicitly set transform.

### matplotlib.artist.Artist.set\_transform

`Artist.set_transform(self, t)`  
Set the artist transform.

#### Parameters

**t** [*Transform*]

### matplotlib.artist.Artist.get\_transform

`Artist.get_transform(self)`  
Return the *Transform* instance used by this artist.

### matplotlib.artist.Artist.is\_transform\_set

`Artist.is_transform_set(self)`  
Return whether the Artist has an explicitly set transform.  
This is *True* after *set\_transform* has been called.

### Units

<i>Artist.convert_xunits</i>	Convert <i>x</i> using the unit type of the xaxis.
<i>Artist.convert_yunits</i>	Convert <i>y</i> using the unit type of the yaxis.
<i>Artist.have_units</i>	Return <i>True</i> if units are set on the <i>x</i> or <i>y</i> axes.

### matplotlib.artist.Artist.convert\_xunits

`Artist.convert_xunits(self, x)`  
Convert *x* using the unit type of the xaxis.  
If the artist is not contained in an Axes or if the xaxis does not have units, *x* itself is returned.

### matplotlib.artist.Artist.convert\_yunits

`Artist.convert_yunits(self, y)`

Convert *y* using the unit type of the yaxis.

If the artist is not contained in an Axes or if the yaxis does not have units, *y* itself is returned.

### matplotlib.artist.Artist.have\_units

`Artist.have_units(self)`

Return *True* if units are set on the x or y axes.

### Metadata

<code>Artist.set_gid</code>	Set the (group) id for the artist.
<code>Artist.get_gid</code>	Return the group id.
<code>Artist.set_label</code>	Set a label that will be displayed in the legend.
<code>Artist.get_label</code>	Return the label used for this artist in the legend.
<code>Artist.set_url</code>	Set the url for the artist.
<code>Artist.get_url</code>	Return the url.

### matplotlib.artist.Artist.set\_gid

`Artist.set_gid(self, gid)`

Set the (group) id for the artist.

#### Parameters

**gid** [str]

### matplotlib.artist.Artist.get\_gid

`Artist.get_gid(self)`

Return the group id.

### matplotlib.artist.Artist.set\_label

`Artist.set_label(self, s)`

Set a label that will be displayed in the legend.

#### Parameters

**s** [object] *s* will be converted to a string by calling `str`.

**matplotlib.artist.Artist.get\_label**

`Artist.get_label(self)`  
Return the label used for this artist in the legend.

**matplotlib.artist.Artist.set\_url**

`Artist.set_url(self, url)`  
Set the url for the artist.

**Parameters**

**url** [str]

**matplotlib.artist.Artist.get\_url**

`Artist.get_url(self)`  
Return the url.

**Miscellaneous**

<code>Artist.sticky_edges</code>	x and y sticky edge lists for autoscaling.
<code>Artist.set_in_layout</code>	Set if artist is to be included in layout calculations, E.g.
<code>Artist.get_in_layout</code>	Return boolean flag, True if artist is included in layout calculations.
<code>Artist.stale</code>	Whether the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

**matplotlib.artist.Artist.sticky\_edges**

`Artist.sticky_edges`  
x and y sticky edge lists for autoscaling.

When performing autoscaling, if a data limit coincides with a value in the corresponding `sticky_edges` list, then no margin will be added—the view limit “sticks” to the edge. A typical use case is histograms, where one usually expects no margin on the bottom edge (0) of the histogram.

This attribute cannot be assigned to; however, the x and y lists can be modified in place as needed.

**Examples**

```
>>> artist.sticky_edges.x[:] = (xmin, xmax)
>>> artist.sticky_edges.y[:] = (ymin, ymax)
```

**matplotlib.artist.Artist.set\_in\_layout**`Artist.set_in_layout(self, in_layout)`

Set if artist is to be included in layout calculations, E.g. *Constrained Layout Guide*, `Figure.tight_layout()`, and `fig.savefig(fname, bbox_inches='tight')`.

**Parameters****in\_layout** [bool]**matplotlib.artist.Artist.get\_in\_layout**`Artist.get_in_layout(self)`

Return boolean flag, True if artist is included in layout calculations.

E.g. *Constrained Layout Guide*, `Figure.tight_layout()`, and `fig.savefig(fname, bbox_inches='tight')`.

**matplotlib.artist.Artist.stale**`Artist.stale`

Whether the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

## 17.4.2 Functions

<code>allow_rasterization</code>	Decorator for <code>Artist.draw</code> method.
<code>get</code>	Return the value of object's property.
<code>getp</code>	Return the value of object's property.
<code>setp</code>	Set a property on an artist object.
<code>kwdoc</code>	Inspect an <code>Artist</code> class (using <code>ArtistInspector</code> ) and return information about its settable properties and their current values.
<code>ArtistInspector</code>	A helper class to inspect an <code>Artist</code> and return information about its settable properties and their current values.

**matplotlib.artist.allow\_rasterization**`matplotlib.artist.allow_rasterization(draw)`

Decorator for `Artist.draw` method. Provides routines that run before and after the draw call. The before and after functions are useful for changing artist-dependent renderer attributes or making other setup function calls, such as starting and flushing a mixed-mode renderer.

**matplotlib.artist.get**

`matplotlib.artist.get(obj, property=None)`

Return the value of object's property. *property* is an optional string for the property you want to return

Example usage:

```
getp(obj) # get all the object properties
getp(obj, 'linestyle') # get the linestyle property
```

*obj* is a *Artist* instance, e.g., *Line2D* or an instance of a *Axes* or *matplotlib.text.Text*. If the *property* is 'somename', this function returns

```
obj.get_somename()
```

*getp()* can be used to query all the gettable properties with *getp(obj)*. Many properties have aliases for shorter typing, e.g. 'lw' is an alias for 'linewidth'. In the output, aliases and full property names will be listed as:

```
property or alias = value
```

e.g.:

```
linewidth or lw = 2
```

**matplotlib.artist.getp**

`matplotlib.artist.getp(obj, property=None)`

Return the value of object's property. *property* is an optional string for the property you want to return

Example usage:

```
getp(obj) # get all the object properties
getp(obj, 'linestyle') # get the linestyle property
```

*obj* is a *Artist* instance, e.g., *Line2D* or an instance of a *Axes* or *matplotlib.text.Text*. If the *property* is 'somename', this function returns

```
obj.get_somename()
```

*getp()* can be used to query all the gettable properties with *getp(obj)*. Many properties have aliases for shorter typing, e.g. 'lw' is an alias for 'linewidth'. In the output, aliases and full property names will be listed as:

```
property or alias = value
```

e.g.:

```
linewidth or lw = 2
```

**matplotlib.artist.setp**

`matplotlib.artist.setp(obj, *args, **kwargs)`

Set a property on an artist object.

matplotlib supports the use of `setp()` (“set property”) and `getp()` to set and get object properties, as well as to do introspection on the object. For example, to set the linestyle of a line to be dashed, you can do:

```
>>> line, = plot([1,2,3])
>>> setp(line, linestyle='--')
```

If you want to know the valid types of arguments, you can provide the name of the property you want to set without a value:

```
>>> setp(line, 'linestyle')
linestyle: [ '-' | '--' | '-.' | ':' | 'steps' | 'None' ]
```

If you want to see all the properties that can be set, and their possible values, you can do:

```
>>> setp(line)
... long output listing omitted
```

You may specify another output file to `setp` if `sys.stdout` is not acceptable for some reason using the `file` keyword-only argument:

```
>>> with fopen('output.log') as f:
>>>     setp(line, file=f)
```

`setp()` operates on a single instance or a iterable of instances. If you are in query mode introspecting the possible values, only the first instance in the sequence is used. When actually setting values, all the instances will be set. e.g., suppose you have a list of two lines, the following will make both lines thicker and red:

```
>>> x = arange(0,1.0,0.01)
>>> y1 = sin(2*pi*x)
>>> y2 = sin(4*pi*x)
>>> lines = plot(x, y1, x, y2)
>>> setp(lines, linewidth=2, color='r')
```

`setp()` works with the MATLAB style string/value pairs or with python kwargs. For example, the following are equivalent:

```
>>> setp(lines, 'linewidth', 2, 'color', 'r') # MATLAB style
>>> setp(lines, linewidth=2, color='r')     # python style
```

## matplotlib.artist.kwdoc

matplotlib.artist.kwdoc(*artist*)

Inspect an *Artist* class (using *ArtistInspector*) and return information about its settable properties and their current values.

### Parameters

**artist** [*Artist* or an iterable of *Artists*]

### Returns

**string** The settable properties of *artist*, as plain text if `rcParams["docstring.hardcopy"]` is False and as a rst table (intended for use in Sphinx) if it is True.

### matplotlib.artist.ArtistInspector

`class matplotlib.artist.ArtistInspector(o)`

A helper class to inspect an *Artist* and return information about its settable properties and their current values.

Initialize the artist inspector with an *Artist* or an iterable of *Artists*. If an iterable is used, we assume it is a homogeneous sequence (all *Artists* are of the same type) and it is your responsibility to make sure this is so.

`__init__(self, o)`

Initialize the artist inspector with an *Artist* or an iterable of *Artists*. If an iterable is used, we assume it is a homogeneous sequence (all *Artists* are of the same type) and it is your responsibility to make sure this is so.

#### Methods

<code>__init__(self, o)</code>	Initialize the artist inspector with an <i>Artist</i> or an iterable of <i>Artists</i> .
<code>aliased_name(self, s)</code>	Return 'PROPNAME or alias' if <i>s</i> has an alias, else return 'PROPNAME'.
<code>aliased_name_rest(self, s, target)</code>	Return 'PROPNAME or alias' if <i>s</i> has an alias, else return 'PROPNAME', formatted for ReST.
<code>get_aliases(self)</code>	Get a dict mapping property fullnames to sets of aliases for each alias in the <i>ArtistInspector</i> .
<code>get_setters(self)</code>	Get the attribute strings with setters for object.
<code>get_valid_values(self, attr)</code>	Get the legal arguments for the setter associated with <i>attr</i> .
<code>is_alias(self, o)</code>	Return whether method object <i>o</i> is an alias for another method.
<code>pprint_getters(self)</code>	Return the getters and actual values as list of strings.
<code>pprint_setters(self[, prop, leadingspace])</code>	If <i>prop</i> is <i>None</i> , return a list of strings of all settable properties and their valid values.
<code>pprint_setters_rest(self[, prop, leadingspace])</code>	If <i>prop</i> is <i>None</i> , return a list of strings of all settable properties and their valid values.
<code>properties(self)</code>	Return a dictionary mapping property name -> value.

`aliased_name(self, s)`

Return 'PROPNAME or alias' if *s* has an alias, else return 'PROPNAME'.

e.g., for the line markerfacecolor property, which has an alias, return 'markerface-

color or mfc' and for the transform property, which does not, return 'transform'.

`aliased_name_rest(self, s, target)`

Return 'PROPNAME or alias' if *s* has an alias, else return 'PROPNAME', formatted for ReST.

e.g., for the line `markerfacecolor` property, which has an alias, return 'markerfacecolor or mfc' and for the transform property, which does not, return 'transform'.

`get_aliases(self)`

Get a dict mapping property fullnames to sets of aliases for each alias in the *ArtistInspector*.

e.g., for lines:

```
{'markerfacecolor': {'mfc'},
 'linewidth'       : {'lw'},
 }
```

`get_setters(self)`

Get the attribute strings with setters for object. e.g., for a line, return ['markerfacecolor', 'linewidth', ...].

`get_valid_values(self, attr)`

Get the legal arguments for the setter associated with *attr*.

This is done by querying the docstring of the setter for a line that begins with "ACCEPTS:" or ".. ACCEPTS:", and then by looking for a numpydoc-style documentation for the setter's first argument.

`is_alias(self, o)`

Return whether method object *o* is an alias for another method.

`pprint_getters(self)`

Return the getters and actual values as list of strings.

`pprint_setters(self, prop=None, leadingspace=2)`

If *prop* is *None*, return a list of strings of all settable properties and their valid values.

If *prop* is not *None*, it is a valid property name and that property will be returned as a string of property : valid values.

`pprint_setters_rest(self, prop=None, leadingspace=4)`

If *prop* is *None*, return a list of strings of all settable properties and their valid values. Format the output for ReST

If *prop* is not *None*, it is a valid property name and that property will be returned as a string of property : valid values.

`properties(self)`

Return a dictionary mapping property name -> value.

## 17.5 matplotlib.axes

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• *Inheritance*

### 17.5.1 The Axes class

```
class matplotlib.axes.Axes(fig, rect, facecolor=None, frameon=True, sharex=None,
                           sharey=None, label="", xscale=None, yscale=None,
                           **kwargs)
```

Bases: matplotlib.axes.\_base.\_AxesBase

The *Axes* contains most of the figure elements: *Axis, Tick, Line2D, Text, Polygon*, etc., and sets the coordinate system.

The *Axes* instance supports callbacks through a *callbacks* attribute which is a *CallbackRegistry* instance. The events you can connect to are 'xlim\_changed' and 'ylim\_changed' and the callback will be called with *func(ax)* where *ax* is the *Axes* instance.

#### Attributes

**dataLim** [BBox] The bounding box enclosing all data displayed in the Axes.

**viewLim** [BBox] The view limits in data coordinates.

Build an axes in a figure.

#### Parameters

**fig** [*Figure*] The axes is build in the *Figure fig*.

**rect** [[left, bottom, width, height]] The axes is build in the rectangle *rect*. *rect* is in *Figure* coordinates.

**sharex, sharey** [*Axes*, optional] The x or y *axis* is shared with the x or y axis in the input *Axes*.

**frameon** [bool, optional] True means that the axes frame is visible.

**\*\*kwargs** Other optional keyword arguments:

	Property	Description
<i>adjustable</i>	{'box', 'datalim'}	
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3)
<i>alpha</i>	float	
<i>anchor</i>	2-tuple of floats or {'C', 'SW', 'S', 'SE', ...}	
<i>animated</i>	bool	
<i>aspect</i>	{'auto', 'equal'} or num	
<i>autoscale_on</i>	bool	
<i>autoscalex_on</i>	bool	
<i>autoscaley_on</i>	bool	
<i>axes_locator</i>	Callable[[Axes, Renderer], Bbox]	
<i>axisbelow</i>	bool or 'line'	
<i>clip_box</i>	Bbox	
<i>clip_on</i>	bool	
<i>clip_path</i>	[(Path, Transform)   Patch   None]	
<i>contains</i>	callable	
<i>facecolor</i>	color	
<i>fc</i>	color	

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	Property	Description
<i>figure</i>		<i>Figure</i>
<i>frame_on</i>	bool	
<i>gid</i>	str	
<i>in_layout</i>	bool	
<i>label</i>	object	
<i>navigate</i>	bool	
<i>navigate_mode</i>	unknown	
<i>path_effects</i>	<i>AbstractPathEffect</i>	
<i>picker</i>	None or bool or float or callable	
<i>position</i>	[left, bottom, width, height] or <i>Bbox</i>	
<i>rasterization_zorder</i>	float or None	
<i>rasterized</i>	bool or None	
<i>sketch_params</i>	(scale: float, length: float, randomness: float)	
<i>snap</i>	bool or None	
<i>title</i>	str	
<i>transform</i>	<i>Transform</i>	
<i>url</i>	str	
<i>visible</i>	bool	
<i>xbound</i>	unknown	
<i>xlabel</i>	str	
<i>xlim</i>	(left: float, right: float)	
<i>xmargin</i>	float greater than -0.5	
<i>xscale</i>	{"linear", "log", "symlog", "logit", ...}	
<i>xticklabels</i>	List[str]	
<i>xticks</i>	list	
<i>ybound</i>	unknown	
<i>ylabel</i>	str	
<i>ylim</i>	(bottom: float, top: float)	
<i>ymargin</i>	float greater than -0.5	
<i>yscale</i>	{"linear", "log", "symlog", "logit", ...}	
<i>yticklabels</i>	List[str]	
<i>yticks</i>	list	
<i>zorder</i>	float	

**Returns**

**axes** [*Axes*] The new *Axes* object.

**17.5.2 Subplots***SubplotBase*

Base class for subplots, which are *Axes* instances with additional methods to facilitate generating and manipulating a set of *Axes* within a figure.

*subplot\_class\_factory*

This makes a new class that inherits from *SubplotBase* and the given *axes\_class* (which is assumed to be a subclass of *axes.Axes*).

**matplotlib.axes.SubplotBase**

```
class matplotlib.axes.SubplotBase(fig, *args, **kwargs)
```

Bases: `object`

Base class for subplots, which are *Axes* instances with additional methods to facilitate generating and manipulating a set of *Axes* within a figure.

*fig* is a `matplotlib.figure.Figure` instance.

*args* is the tuple (*numRows*, *numCols*, *plotNum*), where the array of subplots in the figure has dimensions *numRows*, *numCols*, and where *plotNum* is the number of the subplot being created. *plotNum* starts at 1 in the upper left corner and increases to the right.

If *numRows*  $\leq$  *numCols*  $\leq$  *plotNum*  $<$  10, *args* can be the decimal integer *numRows* \* 100 + *numCols* \* 10 + *plotNum*.

```
change_geometry(self, numrows, numcols, num)  
    change subplot geometry, e.g., from 1,1,1 to 2,2,3
```

```
get_geometry(self)  
    get the subplot geometry, e.g., 2,2,3
```

```
get_gridspec(self)  
    get the GridSpec instance associated with the subplot
```

```
get_subplotspec(self)  
    get the SubplotSpec instance associated with the subplot
```

```
is_first_col(self)
```

```
is_first_row(self)
```

```
is_last_col(self)
```

```
is_last_row(self)
```

```
label_outer(self)  
    Only show "outer" labels and tick labels.
```

x-labels are only kept for subplots on the last row; y-labels only for subplots on the first column.

```
set_subplotspec(self, subplotspec)  
    set the SubplotSpec instance associated with the subplot
```

```
update_params(self)  
    update the subplot position from fig.subplotspars
```

**matplotlib.axes.subplot\_class\_factory**

```
axes.subplot_class_factory(axes_class=None)
```

This makes a new class that inherits from *SubplotBase* and the given *axes\_class* (which is assumed to be a subclass of *axes.Axes*). This is perhaps a little bit roundabout to make a new class on the fly like this, but it means that a new Subplot class does not have to be created for every type of Axes.

## 17.5.3 Plotting

### Basic

<code>Axes.plot</code>	Plot y versus x as lines and/or markers.
<code>Axes.errorbar</code>	Plot y versus x as lines and/or markers with attached errorbars.
<code>Axes.scatter</code>	A scatter plot of y vs x with varying marker size and/or color.
<code>Axes.plot_date</code>	Plot data that contains dates.
<code>Axes.step</code>	Make a step plot.
<code>Axes.loglog</code>	Make a plot with log scaling on both the x and y axis.
<code>Axes.semilogx</code>	Make a plot with log scaling on the x axis.
<code>Axes.semilogy</code>	Make a plot with log scaling on the y axis.
<code>Axes.fill_between</code>	Fill the area between two horizontal curves.
<code>Axes.fill_betweenx</code>	Fill the area between two vertical curves.
<code>Axes.bar</code>	Make a bar plot.
<code>Axes.barh</code>	Make a horizontal bar plot.
<code>Axes.stem</code>	Create a stem plot.
<code>Axes.eventplot</code>	Plot identical parallel lines at the given positions.
<code>Axes.pie</code>	Plot a pie chart.
<code>Axes.stackplot</code>	Draw a stacked area plot.
<code>Axes.broken_barh</code>	Plot a horizontal sequence of rectangles.
<code>Axes.vlines</code>	Plot vertical lines.
<code>Axes.hlines</code>	Plot horizontal lines at each y from <i>xmin</i> to <i>xmax</i> .
<code>Axes.fill</code>	Plot filled polygons.

### matplotlib.axes.Axes.plot

`Axes.plot(self, *args, scalex=True, scaley=True, data=None, **kwargs)`  
 Plot y versus x as lines and/or markers.

Call signatures:

```
plot([x], y, [fmt], *, data=None, **kwargs)
plot([x], y, [fmt], [x2], y2, [fmt2], ..., **kwargs)
```

The coordinates of the points or line nodes are given by *x*, *y*.

The optional parameter *fmt* is a convenient way for defining basic formatting like color, marker and linestyle. It's a shortcut string notation described in the *Notes* section below.

```
>>> plot(x, y)           # plot x and y using default line style and color
>>> plot(x, y, 'bo')    # plot x and y using blue circle markers
>>> plot(y)             # plot y using x as index array 0..N-1
>>> plot(y, 'r+')       # ditto, but with red plusses
```

You can use *Line2D* properties as keyword arguments for more control on the appearance. Line properties and *fmt* can be mixed. The following two calls yield identical results:

```
>>> plot(x, y, 'go--', linewidth=2, markersize=12)
>>> plot(x, y, color='green', marker='o', linestyle='dashed',
...      linewidth=2, markersize=12)
```

When conflicting with *fmt*, keyword arguments take precedence.

### Plotting labelled data

There's a convenient way for plotting objects with labelled data (i.e. data that can be accessed by index `obj['y']`). Instead of giving the data in *x* and *y*, you can provide the object in the *data* parameter and just give the labels for *x* and *y*:

```
>>> plot('xlabel', 'ylabel', data=obj)
```

All indexable objects are supported. This could e.g. be a `dict`, a `pandas.DataFrame` or a structured numpy array.

### Plotting multiple sets of data

There are various ways to plot multiple sets of data.

- The most straight forward way is just to call `plot` multiple times. Example:

```
>>> plot(x1, y1, 'bo')
>>> plot(x2, y2, 'go')
```

- Alternatively, if your data is already a 2d array, you can pass it directly to *x*, *y*. A separate data set will be drawn for every column.

Example: an array *a* where the first column represents the *x* values and the other columns are the *y* columns:

```
>>> plot(a[0], a[1:])
```

- The third way is to specify multiple sets of [*x*], *y*, [*fmt*] groups:

```
>>> plot(x1, y1, 'g^', x2, y2, 'g-')
```

In this case, any additional keyword argument applies to all datasets. Also this syntax cannot be combined with the *data* parameter.

By default, each line is assigned a different style specified by a 'style cycle'. The *fmt* and line property parameters are only necessary if you want explicit deviations from these defaults. Alternatively, you can also change the style cycle using the 'axes.prop\_cycle' `rcParam`.

### Parameters

**x, y** [array-like or scalar] The horizontal / vertical coordinates of the data points. *x* values are optional and default to `range(len(y))`.

Commonly, these parameters are 1D arrays.

They can also be scalars, or two-dimensional (in that case, the columns represent separate data sets).

These arguments cannot be passed as keywords.

**fmt** [str, optional] A format string, e.g. 'ro' for red circles. See the *Notes* section for a full description of the format strings.

Format strings are just an abbreviation for quickly setting basic line properties. All of these and more can also be controlled by keyword arguments.

This argument cannot be passed as keyword.

**data** [indexable object, optional] An object with labelled data. If given, provide the label names to plot in x and y.

---

**Note:** Technically there's a slight ambiguity in calls where the second label is a valid *fmt*. `plot('n', 'o', data=obj)` could be `plt(x, y)` or `plt(y, fmt)`. In such cases, the former interpretation is chosen, but a warning is issued. You may suppress the warning by adding an empty format string `plot('n', 'o', '', data=obj)`.

---

## Returns

**lines** A list of *Line2D* objects representing the plotted data.

## Other Parameters

**scalex, scaley** [bool, optional, default: True] These parameters determined if the view limits are adapted to the data limits. The values are passed on to *autoscale\_view*.

**\*\*kwargs** [*Line2D* properties, optional] *kwargs* are used to specify properties like a line label (for auto legends), linewidth, antialiasing, marker face color. Example:

```
>>> plot([1,2,3], [1,2,3], 'go-', label='line 1', linewidth=2)
>>> plot([1,2,3], [1,4,9], 'rs', label='line 2')
```

If you make multiple lines with one plot command, the *kwargs* apply to all those lines.

Here is a list of available *Line2D* properties:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<i>alpha</i>		float
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i>		bool
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>color</i> or <i>c</i>		color
<i>contains</i>		callable
<i>dash_capstyle</i>		{'butt', 'round', 'projecting'}
<i>dash_joinstyle</i>		{'miter', 'round', 'bevel'}
<i>dashes</i>		sequence of floats (on/off ink in points) or (None, None)
<i>drawstyle</i> or <i>ds</i>		{'default', 'steps', 'steps-pre', 'steps-mid', 'steps-post'}, default: 'default'
<i>figure</i>		<i>Figure</i>
<i>fillstyle</i>		{'full', 'left', 'right', 'bottom', 'top', 'none'}
<i>gid</i>		str
<i>in_layout</i>		bool

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	Property	Description
<i>label</i>	object	
<i>linestyle</i> or <i>ls</i>	{'-' , '-' , '-.' , ':' , '' , (offset, on-off-seq), ...}	
<i>linewidth</i> or <i>lw</i>	float	
<i>marker</i>		marker style
<i>markeredgecolor</i> or <i>mec</i>		color
<i>markeredgewidth</i> or <i>mew</i>		float
<i>markerfacecolor</i> or <i>mfc</i>		color
<i>markerfacecoloralt</i> or <i>mfcalt</i>		color
<i>markersize</i> or <i>ms</i>		float
<i>markevery</i>		None or int or (int, int) or slice or List[int] or float or (float, float)
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		float or callable[[Artist, Event], Tuple[bool, dict]]
<i>pickradius</i>		float
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>solid_capstyle</i>		{'butt', 'round', 'projecting'}
<i>solid_joinstyle</i>		{'miter', 'round', 'bevel'}
<i>transform</i>		<i>matplotlib.transforms.Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>xdata</i>		1D array
<i>ydata</i>		1D array
<i>zorder</i>		float

**See also:**

*scatter* XY scatter plot with markers of varying size and/or color ( sometimes also called bubble chart).

**Notes****Format Strings**

A format string consists of a part for color, marker and line:

```
fmt = '[marker][line][color]'
```

Each of them is optional. If not provided, the value from the style cycle is used. Exception: If line is given, but no marker, the data will be a line without markers.

Other combinations such as [color][marker][line] are also supported, but note that their parsing may be ambiguous.

**Markers**

character	description
'.'	point marker
','	pixel marker
'o'	circle marker
'v'	triangle_down marker
'^'	triangle_up marker
'<'	triangle_left marker
'>'	triangle_right marker
'1'	tri_down marker
'2'	tri_up marker
'3'	tri_left marker
'4'	tri_right marker
's'	square marker
'p'	pentagon marker
'*'	star marker
'h'	hexagon1 marker
'H'	hexagon2 marker
'+'	plus marker
'x'	x marker
'D'	diamond marker
'd'	thin_diamond marker
' '	vline marker
'_'	hline marker

## Line Styles

character	description
'-'	solid line style
'--'	dashed line style
'-.'	dash-dot line style
':'	dotted line style

Example format strings:

```
'b'      # blue markers with default shape
'or'     # red circles
'-g'     # green solid line
'--'     # dashed line with default color
'^k:'    # black triangle_up markers connected by a dotted line
```

## Colors

The supported color abbreviations are the single letter codes

character	color
'b'	blue
'g'	green
'r'	red
'c'	cyan
'm'	magenta
'y'	yellow
'k'	black
'w'	white

and the 'CN' colors that index into the default property cycle.

If the color is the only part of the format string, you can additionally use any *matplotlib.colors* spec, e.g. full names ('green') or hex strings ('#008000').

#### Examples using `matplotlib.axes.Axes.plot`

- `sphinx_gallery_gallery_lines_bars_and_markers_joinstyle.py`
- `sphinx_gallery_gallery_lines_bars_and_markers_simple_plot.py`
- `sphinx_gallery_gallery_images_contours_and_fields_triinterp_demo.py`
- `sphinx_gallery_gallery_pie_and_polar_charts_polar_demo.py`
- `sphinx_gallery_gallery_pie_and_polar_charts_polar_legend.py`
- `sphinx_gallery_gallery_text_labels_and_annotations_legend.py`
- `sphinx_gallery_gallery_pyplots_align_ylabel.py`
- `sphinx_gallery_gallery_pyplots_fig_axes_labels_simple.py`
- `sphinx_gallery_gallery_pyplots_pyplot_formatstr.py`
- `sphinx_gallery_gallery_pyplots_pyplot_three.py`
- `sphinx_gallery_gallery_color_color_demo.py`
- `sphinx_gallery_gallery_color_color_by_yvalue.py`
- `sphinx_gallery_gallery_color_color_cycler.py`
- `sphinx_gallery_gallery_shapes_and_collections_marker_path.py`
- `sphinx_gallery_gallery_user_interfaces_canvasagg.py`
- *Usage Guide*

#### `matplotlib.axes.Axes.errorbar`

`Axes.errorbar`(*self*, *x*, *y*, *yerr=None*, *xerr=None*, *fmt=""*, *ecolor=None*, *elinewidth=None*, *capsize=None*, *barsabove=False*, *lolims=False*, *uplims=False*, *xlolims=False*, *xuplims=False*, *errorevery=1*, *capthick=None*, *\**, *data=None*, *\*\*kwargs*)

Plot *y* versus *x* as lines and/or markers with attached errorbars.

$x$ ,  $y$  define the data locations,  $xerr$ ,  $yerr$  define the errorbar sizes. By default, this draws the data markers/lines as well the errorbars. Use `fmt='none'` to draw errorbars without any data markers.

### Parameters

**x, y** [scalar or array-like] The data positions.

**xerr, yerr** [scalar or array-like, shape(N,) or shape(2,N), optional] The errorbar sizes:

- scalar: Symmetric +/- values for all data points.
- shape(N,): Symmetric +/-values for each data point.
- **shape(2,N): Separate - and + values for each bar. First row** contains the lower errors, the second row contains the upper errors.
- *None*: No errorbar.

Note that all error arrays should have *positive* values.

See `/gallery/statistics/errorbar_features` for an example on the usage of `xerr` and `yerr`.

**fmt** [plot format string, optional, default: ""] The format for the data points / data lines. See `plot` for details.

Use 'none' (case insensitive) to plot errorbars without any data markers.

**ecolor** [mpl color, optional, default: None] A matplotlib color arg which gives the color the errorbar lines. If None, use the color of the line connecting the markers.

**elinewidth** [scalar, optional, default: None] The linewidth of the errorbar lines. If None, the linewidth of the current style is used.

**capsize** [scalar, optional, default: None] The length of the error bar caps in points. If None, it will take the value from `rcParams["errorbar.capsize"]`.

**capthick** [scalar, optional, default: None] An alias to the keyword argument `markeredgewidth` (a.k.a. `mew`). This setting is a more sensible name for the property that controls the thickness of the error bar cap in points. For backwards compatibility, if `mew` or `markeredgewidth` are given, then they will over-ride `capthick`. This may change in future releases.

**barsabove** [bool, optional, default: False] If True, will plot the errorbars above the plot symbols. Default is below.

**lolims, uplims, xlolims, xuplims** [bool, optional, default: False] These arguments can be used to indicate that a value gives only upper/lower limits. In that case a caret symbol is used to indicate this. `lims`-arguments may be of the same type as `xerr` and `yerr`. To use limits with inverted axes, `set_xlim()` or `set_ylim()` must be called before `errorbar()`.

**errorevery** [positive integer, optional, default: 1] Subsamples the errorbars. e.g., if `errorevery=5`, errorbars for every 5-th datapoint will be plotted. The data plot itself still shows all data points.

### Returns

**container** [`ErrorbarContainer`] The container contains:

- plotline: `Line2D` instance of  $x$ ,  $y$  plot markers and/or line.

- `caplines`: A tuple of *Line2D* instances of the error bar caps.
- `barlinecols`: A tuple of *LineCollection* with the horizontal and vertical error ranges.

### Other Parameters

**\*\*kwargs** All other keyword arguments are passed on to the plot command for the markers. For example, this code makes big red squares with thick green edges:

```
x,y,yerr = rand(3,10)
errorbar(x, y, yerr, marker='s', mfc='red',
         mec='green', ms=20, mew=4)
```

where *mfc*, *mec*, *ms* and *mew* are aliases for the longer property names, *markerfacecolor*, *markeredgecolor*, *markersize* and *markeredgewidth*.

Valid kwargs for the marker properties are *Lines2D* properties:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<i>alpha</i>	float	
<i>animated</i>	bool	
<i>antialiased</i> or <i>aa</i>	bool	
<i>clip_box</i>	<i>Bbox</i>	
<i>clip_on</i>	bool	
<i>clip_path</i>	<i>[(Path, Transform)   Patch   None]</i>	
<i>color</i> or <i>c</i>	color	
<i>contains</i>	callable	
<i>dash_capstyle</i>	{'butt', 'round', 'projecting'}	
<i>dash_joinstyle</i>	{'miter', 'round', 'bevel'}	
<i>dashes</i>	sequence of floats (on/off ink in points) or (None, None)	
<i>drawstyle</i> or <i>ds</i>	{'default', 'steps', 'steps-pre', 'steps-mid', 'steps-post'}, default: 'default'	
<i>figure</i>	<i>Figure</i>	
<i>fillstyle</i>	{'full', 'left', 'right', 'bottom', 'top', 'none'}	
<i>gid</i>	str	
<i>in_layout</i>	bool	
<i>label</i>	object	
<i>linestyle</i> or <i>ls</i>	{'-', '--', '-.', ':', '', (offset, on-off-seq), ...}	
<i>linewidth</i> or <i>lw</i>	float	
<i>marker</i>		marker style
<i>markeredgecolor</i> or <i>mec</i>	color	
<i>markeredgewidth</i> or <i>mew</i>	float	
<i>markerfacecolor</i> or <i>mfc</i>	color	
<i>markerfacecoloralt</i> or <i>mfcalt</i>	color	
<i>markersize</i> or <i>ms</i>	float	
<i>markevery</i>	None or int or (int, int) or slice or List[int] or float or (float, float)	
<i>path_effects</i>	<i>AbstractPathEffect</i>	
<i>picker</i>	float or callable[[ <i>Artist</i> , <i>Event</i> ], Tuple[bool, dict]]	
<i>pickradius</i>	float	
<i>rasterized</i>	bool or None	
<i>sketch_params</i>	(scale: float, length: float, randomness: float)	
<i>snap</i>	bool or None	

Continued on next page

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	Property	Description
<i>solid_capstyle</i>		{'butt', 'round', 'projecting'}
<i>solid_joinstyle</i>		{'miter', 'round', 'bevel'}
<i>transform</i>		<i>matplotlib.transforms.Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>xdata</i>		1D array
<i>ydata</i>		1D array
<i>zorder</i>		float

## Notes

**Note:** In addition to the above described arguments, this function can take a **data** key-word argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x', 'xerr', 'y', 'yerr'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

## Examples using `matplotlib.axes.Axes.errorbar`

- `sphx_glr_gallery_lines_bars_and_markers_errorbar_limits_simple.py`

## `matplotlib.axes.Axes.scatter`

```
Axes.scatter(self, x, y, s=None, c=None, marker=None, cmap=None, norm=None,
              vmin=None, vmax=None, alpha=None, linewidths=None, verts=None,
              edgecolors=None, *, plotnonfinite=False, data=None, **kwargs)
```

A scatter plot of `y` vs `x` with varying marker size and/or color.

### Parameters

- x, y** [array\_like, shape (n, )] The data positions.
- s** [scalar or array\_like, shape (n, ), optional] The marker size in points\*\*2. Default is `rcParams['lines.markersize'] ** 2`.
- c** [color, sequence, or sequence of color, optional] The marker color. Possible values:
  - A single color format string.
  - A sequence of color specifications of length `n`.
  - A sequence of `n` numbers to be mapped to colors using `cmap` and `norm`.
  - A 2-D array in which the rows are RGB or RGBA.

Note that `c` should not be a single numeric RGB or RGBA sequence because that is indistinguishable from an array of values to be colormapped. If you want to specify the same RGB or RGBA value for all

points, use a 2-D array with a single row. Otherwise, value- matching will have precedence in case of a size matching with `x` and `y`.

Defaults to `None`. In that case the marker color is determined by the value of `color`, `facecolor` or `facecolors`. In case those are not specified or `None`, the marker color is determined by the next color of the Axes' current "shape and fill" color cycle. This cycle defaults to `rcParams["axes.prop_cycle"]`.

**marker** [*MarkerStyle*, optional] The marker style. *marker* can be either an instance of the class or the text shorthand for a particular marker. Defaults to `None`, in which case it takes the value of `rcParams["scatter.marker"] = 'o'`. See *markers* for more information about marker styles.

**cmap** [*Colormap*, optional, default: `None`] A *Colormap* instance or registered colormap name. *cmap* is only used if *c* is an array of floats. If `None`, defaults to `rc.image.cmap`.

**norm** [*Normalize*, optional, default: `None`] A *Normalize* instance is used to scale luminance data to 0, 1. *norm* is only used if *c* is an array of floats. If `None`, use the default `colors.Normalize`.

**vmin, vmax** [scalar, optional, default: `None`] *vmin* and *vmax* are used in conjunction with *norm* to normalize luminance data. If `None`, the respective min and max of the color array is used. *vmin* and *vmax* are ignored if you pass a *norm* instance.

**alpha** [scalar, optional, default: `None`] The alpha blending value, between 0 (transparent) and 1 (opaque).

**linewidths** [scalar or array\_like, optional, default: `None`] The linewidth of the marker edges. Note: The default *edgecolors* is 'face'. You may want to change this as well. If `None`, defaults to `rcParams.lines.linewidth`.

**edgecolors** [{'face', 'none', `None`} or color or sequence of color, optional.] The edge color of the marker. Possible values:

- 'face': The edge color will always be the same as the face color.
- 'none': No patch boundary will be drawn.
- A Matplotlib color or sequence of color.

Defaults to `None`, in which case it takes the value of `rcParams["scatter.edgecolors"] = 'face'`.

For non-filled markers, the *edgecolors* kwarg is ignored and forced to 'face' internally.

**plotnonfinite** [boolean, optional, default: `False`] Set to plot points with non-finite *c*, in conjunction with *set\_bad*.

## Returns

**paths** [*PathCollection*]

## Other Parameters

**\*\*kwargs** [*Collection* properties]

## See also:

*plot* To plot scatter plots when markers are identical in size and color.

---

## Notes

- The `plot` function will be faster for scatterplots where markers don't vary in size or color.
- Any or all of `x`, `y`, `s`, and `c` may be masked arrays, in which case all masks will be combined and only unmasked points will be plotted.
- Fundamentally, scatter works with 1-D arrays; `x`, `y`, `s`, and `c` may be input as 2-D arrays, but within scatter they will be flattened. The exception is `c`, which will be flattened only if its size matches the size of `x` and `y`.

---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: `'c'`, `'color'`, `'edgecolors'`, `'facecolor'`, `'facecolors'`, `'linewidths'`, `'s'`, `'x'`, `'y'`.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

## Examples using `matplotlib.axes.Axes.scatter`

- `sphx_glr_gallery_lines_bars_and_markers_scatter_piecharts.py`
- `sphx_glr_gallery_lines_bars_and_markers_scatter_with_legend.py`
- `sphx_glr_gallery_pie_and_polar_charts_polar_scatter.py`
- `sphx_glr_gallery_shapes_and_collections_scatter.py`

## `matplotlib.axes.Axes.plot_date`

`Axes.plot_date(self, x, y, fmt='o', tz=None, xdate=True, ydate=False, *, data=None, **kwargs)`

Plot data that contains dates.

Similar to `plot`, this plots `y` vs. `x` as lines or markers. However, the axis labels are formatted as dates depending on `xdate` and `ydate`.

### Parameters

- x, y** [array-like] The coordinates of the data points. If `xdate` or `ydate` is `True`, the respective values `x` or `y` are interpreted as *Matplotlib dates*.
- fmt** [str, optional] The plot format string. For details, see the corresponding parameter in `plot`.
- tz** [`None` | timezone string | `tzinfo` instance] The time zone to use in labeling dates. If `None`, defaults to `rcParam.timezone`.
- xdate** [bool, optional, default: `True`] If `True`, the x-axis will be interpreted as *Matplotlib dates*.

**ydate** [bool, optional, default: False] If *True*, the y-axis will be interpreted as Matplotlib dates.

**Returns**

**lines** A list of *Line2D* objects representing the plotted data.

**Other Parameters**

**\*\*kwargs** Keyword arguments control the *Line2D* properties:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<i>alpha</i>		float
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i>		bool
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>color</i> or <i>c</i>		color
<i>contains</i>		callable
<i>dash_capstyle</i>		{'butt', 'round', 'projecting'}
<i>dash_joinstyle</i>		{'miter', 'round', 'bevel'}
<i>dashes</i>		sequence of floats (on/off ink in points) or (None, None)
<i>drawstyle</i> or <i>ds</i>		{'default', 'steps', 'steps-pre', 'steps-mid', 'steps-post'}, default: 'default'
<i>figure</i>		<i>Figure</i>
<i>fillstyle</i>		{'full', 'left', 'right', 'bottom', 'top', 'none'}
<i>gid</i>		str
<i>in_layout</i>		bool
<i>label</i>		object
<i>linestyle</i> or <i>ls</i>		{'-', '--', '-.', ':', ' ', (offset, on-off-seq), ...}
<i>linewidth</i> or <i>lw</i>		float
<i>marker</i>		marker style
<i>markeredgewidth</i> or <i>mec</i>		color
<i>markeredgewidth</i> or <i>mew</i>		float
<i>markerfacecolor</i> or <i>mfc</i>		color
<i>markerfacecoloralt</i> or <i>mfcalt</i>		color
<i>markersize</i> or <i>ms</i>		float
<i>markevery</i>		None or int or (int, int) or slice or List[int] or float or (float, float)
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		float or callable[[ <i>Artist</i> , <i>Event</i> ], Tuple[bool, dict]]
<i>pickradius</i>		float
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>solid_capstyle</i>		{'butt', 'round', 'projecting'}
<i>solid_joinstyle</i>		{'miter', 'round', 'bevel'}
<i>transform</i>		<i>matplotlib.transforms.Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>xdata</i>		1D array
<i>ydata</i>		1D array
<i>zorder</i>		float

**See also:**

`matplotlib.dates` Helper functions on dates.

`matplotlib.dates.date2num` Convert dates to num.

`matplotlib.dates.num2date` Convert num to dates.

`matplotlib.dates.drange` Create an equally spaced sequence of dates.

**Notes**

If you are using custom date tickers and formatters, it may be necessary to set the formatters/locators after the call to `plot_date`. `plot_date` will set the default tick locator to `AutoDateLocator` (if the tick locator is not already set to a `DateLocator` instance) and the default tick formatter to `AutoDateFormatter` (if the tick formatter is not already set to a `DateFormatter` instance).

---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x', 'y'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

**matplotlib.axes.Axes.step**

`Axes.step(self, x, y, *args, where='pre', data=None, **kwargs)`

Make a step plot.

Call signatures:

```
step(x, y, [fmt], *, data=None, where='pre', **kwargs)
step(x, y, [fmt], x2, y2, [fmt2], ..., *, where='pre', **kwargs)
```

This is just a thin wrapper around `plot` which changes some formatting options. Most of the concepts and parameters of `plot` can be used here as well.

**Parameters**

**x** [array\_like] 1-D sequence of x positions. It is assumed, but not checked, that it is uniformly increasing.

**y** [array\_like] 1-D sequence of y levels.

**fmt** [str, optional] A format string, e.g. 'g' for a green line. See `plot` for a more detailed description.

Note: While full format strings are accepted, it is recommended to only specify the color. Line styles are currently ignored (use the keyword argument `linestyle` instead). Markers are accepted and plotted on the given positions, however, this is a rarely needed feature for step plots.

**data** [indexable object, optional] An object with labelled data. If given, provide the label names to plot in *x* and *y*.

**where** [{'pre', 'post', 'mid'}], optional, default 'pre'] Define where the steps should be placed:

- 'pre': The *y* value is continued constantly to the left from every *x* position, i.e. the interval (*x*[*i*-1], *x*[*i*]) has the value *y*[*i*].
- 'post': The *y* value is continued constantly to the right from every *x* position, i.e. the interval [*x*[*i*], *x*[*i*+1]) has the value *y*[*i*].
- 'mid': Steps occur half-way between the *x* positions.

### Returns

**lines** A list of *Line2D* objects representing the plotted data.

### Other Parameters

**\*\*kwargs** Additional parameters are the same as those for *plot*.

### Notes

#### Examples using `matplotlib.axes.Axes.step`

- `sphx_glr_gallery_lines_bars_and_markers_step_demo.py`

#### `matplotlib.axes.Axes.loglog`

`Axes.loglog(self, *args, **kwargs)`

Make a plot with log scaling on both the *x* and *y* axis.

Call signatures:

```
loglog([x], y, [fmt], data=None, **kwargs)
loglog([x], y, [fmt], [x2], y2, [fmt2], ..., **kwargs)
```

This is just a thin wrapper around *plot* which additionally changes both the *x*-axis and the *y*-axis to log scaling. All of the concepts and parameters of *plot* can be used here as well.

The additional parameters *basex/y*, *subsx/y* and *nonposx/y* control the *x/y*-axis properties. They are just forwarded to *Axes.set\_xscale* and *Axes.set\_yscale*.

### Parameters

**basex, basey** [scalar, optional, default 10] Base of the *x/y* logarithm.

**subsx, subsy** [sequence, optional] The location of the minor *x/y* ticks. If *None*, reasonable locations are automatically chosen depending on the number of decades in the plot. See *Axes.set\_xscale* / *Axes.set\_yscale* for details.

**nonposx, nonposy** [{'mask', 'clip'}], optional, default 'mask'] Non-positive values in *x* or *y* can be masked as invalid, or clipped to a very small positive number.

### Returns

**lines** A list of *Line2D* objects representing the plotted data.

### Other Parameters

**\*\*kwargs** All parameters supported by *plot*.

#### matplotlib.axes.Axes.semilogx

`Axes.semilogx(self, *args, **kwargs)`

Make a plot with log scaling on the x axis.

Call signatures:

```
semilogx([x], y, [fmt], data=None, **kwargs)
semilogx([x], y, [fmt], [x2], y2, [fmt2], ..., **kwargs)
```

This is just a thin wrapper around *plot* which additionally changes the x-axis to log scaling. All of the concepts and parameters of *plot* can be used here as well.

The additional parameters *basex*, *subsx* and *nonposx* control the x-axis properties. They are just forwarded to *Axes.set\_xscale*.

### Parameters

**basex** [scalar, optional, default 10] Base of the x logarithm.

**subsx** [array\_like, optional] The location of the minor xticks. If *None*, reasonable locations are automatically chosen depending on the number of decades in the plot. See *Axes.set\_xscale* for details.

**nonposx** [{'mask', 'clip'}, optional, default 'mask'] Non-positive values in x can be masked as invalid, or clipped to a very small positive number.

### Returns

**lines** A list of *Line2D* objects representing the plotted data.

### Other Parameters

**\*\*kwargs** All parameters supported by *plot*.

#### matplotlib.axes.Axes.semilogy

`Axes.semilogy(self, *args, **kwargs)`

Make a plot with log scaling on the y axis.

Call signatures:

```
semilogy([x], y, [fmt], data=None, **kwargs)
semilogy([x], y, [fmt], [x2], y2, [fmt2], ..., **kwargs)
```

This is just a thin wrapper around *plot* which additionally changes the y-axis to log scaling. All of the concepts and parameters of *plot* can be used here as well.

The additional parameters *basey*, *subsy* and *nonposy* control the y-axis properties. They are just forwarded to *Axes.set\_yscale*.

### Parameters

**basey** [scalar, optional, default 10] Base of the y logarithm.

**subsy** [array\_like, optional] The location of the minor yticks. If *None*, reasonable locations are automatically chosen depending on the number of decades in the plot. See *Axes.set\_yscale* for details.

**nonposy** [{'mask', 'clip'}, optional, default 'mask'] Non-positive values in y can be masked as invalid, or clipped to a very small positive number.

### Returns

**lines** A list of *Line2D* objects representing the plotted data.

### Other Parameters

**\*\*kwargs** All parameters supported by *plot*.

### matplotlib.axes.Axes.fill\_between

*Axes.fill\_between*(*self*, *x*, *y1*, *y2=0*, *where=None*, *interpolate=False*, *step=None*, \*, *data=None*, \*\**kwargs*)

Fill the area between two horizontal curves.

The curves are defined by the points (*x*, *y1*) and (*x*, *y2*). This creates one or multiple polygons describing the filled area.

You may exclude some horizontal sections from filling using *where*.

By default, the edges connect the given points directly. Use *step* if the filling should be a step function, i.e. constant in between *x*.

### Parameters

**x** [array (length N)] The x coordinates of the nodes defining the curves.

**y1** [array (length N) or scalar] The y coordinates of the nodes defining the first curve.

**y2** [array (length N) or scalar, optional, default: 0] The y coordinates of the nodes defining the second curve.

**where** [array of bool (length N), optional, default: None] Define *where* to exclude some horizontal regions from being filled. The filled regions are defined by the coordinates *x[where]*. More precisely, fill between *x[i]* and *x[i+1]* if *where[i]* and *where[i+1]*. Note that this definition implies that an isolated *True* value between two *False* values in *where* will not result in filling. Both sides of the *True* position remain unfilled due to the adjacent *False* values.

**interpolate** [bool, optional] This option is only relevant if *where* is used and the two curves are crossing each other.

Semantically, *where* is often used for *y1 > y2* or similar. By default, the nodes of the polygon defining the filled region will only be placed at the positions in the *x* array. Such a polygon cannot describe the above semantics close to the intersection. The x-sections containing the intersection are simply clipped.

Setting *interpolate* to *True* will calculate the actual intersection point and extend the filled region up to this point.

**step** [{‘pre’, ‘post’, ‘mid’}, optional] Define *step* if the filling should be a step function, i.e. constant in between  $x$ . The value determines where the step will occur:

- ‘pre’: The  $y$  value is continued constantly to the left from every  $x$  position, i.e. the interval  $(x[i-1], x[i])$  has the value  $y[i]$ .
- ‘post’: The  $y$  value is continued constantly to the right from every  $x$  position, i.e. the interval  $[x[i], x[i+1])$  has the value  $y[i]$ .
- ‘mid’: Steps occur half-way between the  $x$  positions.

## Returns

*PolyCollection* A *PolyCollection* containing the plotted polygons.

## Other Parameters

**\*\*kwargs** All other keyword arguments are passed on to *PolyCollection*. They control the *Polygon* properties:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and
<i>alpha</i>		float or None
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i> or <i>antialiaseds</i>		bool or sequence of bools
<i>array</i>		ndarray
<i>capstyle</i>		{‘butt’, ‘round’, ‘projecting’}
<i>clip</i>		a length 2 sequence of floats; may be overridden in methods that have
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>cmap</i>		colormap or registered colormap name
<i>color</i>		color or sequence of rgba tuples
<i>contains</i>		callable
<i>edgecolor</i> or <i>ec</i> or <i>edgecolors</i>		color or sequence of colors or ‘face’
<i>facecolor</i> or <i>facecolors</i> or <i>fc</i>		color or sequence of colors
<i>figure</i>		<i>Figure</i>
<i>gid</i>		str
<i>hatch</i>		{‘/’, ‘\’, ‘ ’, ‘-’, ‘+’, ‘x’, ‘o’, ‘O’, ‘.’, ‘*’}
<i>in_layout</i>		bool
<i>joinstyle</i>		{‘miter’, ‘round’, ‘bevel’}
<i>label</i>		object
<i>linestyle</i> or <i>dashes</i> or <i>linestyles</i> or <i>ls</i>		{‘-’, ‘-’, ‘-.’, ‘:’, ‘’, (offset, on-off-seq), ...}
<i>linewidth</i> or <i>linewidths</i> or <i>lw</i>		float or sequence of floats
<i>norm</i>		<i>Normalize</i>
<i>offset_position</i>		{‘screen’, ‘data’}
<i>offsets</i>		float or sequence of floats
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		None or bool or float or callable
<i>pickradius</i>		unknown
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>transform</i>		<i>Transform</i>

Continued on next page

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	Property	Description
<i>url</i>		str
<i>urls</i>		List[str] or None
<i>visible</i>		bool
<i>zorder</i>		float

**See also:**

*fill\_betweenx* Fill between two sets of x-values.

**Notes**

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'where', 'x', 'y1', 'y2'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

**Examples using `matplotlib.axes.Axes.fill_between`**

- `sphx_glr_gallery_lines_bars_and_markers_filled_step.py`
- `sphx_glr_gallery_pyplots_whats_new_98_4_fill_between.py`

**`matplotlib.axes.Axes.fill_betweenx`**

```
Axes.fill_betweenx(self, y, x1, x2=0, where=None, step=None, interpolate=False, *,
                    data=None, **kwargs)
```

Fill the area between two vertical curves.

The curves are defined by the points ( $x1, y$ ) and ( $x2, y$ ). This creates one or multiple polygons describing the filled area.

You may exclude some vertical sections from filling using *where*.

By default, the edges connect the given points directly. Use *step* if the filling should be a step function, i.e. constant in between *y*.

**Parameters**

- y** [array (length N)] The y coordinates of the nodes defining the curves.
- x1** [array (length N) or scalar] The x coordinates of the nodes defining the first curve.
- x2** [array (length N) or scalar, optional, default: 0] The x coordinates of the nodes defining the second curve.

**where** [array of bool (length N), optional, default: None] Define *where* to exclude some vertical regions from being filled. The filled regions are defined by the coordinates *y[where]*. More precisely, fill between *y[i]* and *y[i+1]* if *where[i]* and *where[i+1]*. Note that this definition implies that an isolated *True* value between two *False* values in *where* will not result in filling. Both sides of the *True* position remain unfilled due to the adjacent *False* values.

**interpolate** [bool, optional] This option is only relevant if *where* is used and the two curves are crossing each other.

Semantically, *where* is often used for  $x_1 > x_2$  or similar. By default, the nodes of the polygon defining the filled region will only be placed at the positions in the *y* array. Such a polygon cannot describe the above semantics close to the intersection. The y-sections containing the intersection are simply clipped.

Setting *interpolate* to *True* will calculate the actual intersection point and extend the filled region up to this point.

**step** [{‘pre’, ‘post’, ‘mid’}, optional] Define *step* if the filling should be a step function, i.e. constant in between *y*. The value determines where the step will occur:

- ‘pre’: The *y* value is continued constantly to the left from every *x* position, i.e. the interval  $(x[i-1], x[i])$  has the value *y[i]*.
- ‘post’: The *y* value is continued constantly to the right from every *x* position, i.e. the interval  $[x[i], x[i+1])$  has the value *y[i]*.
- ‘mid’: Steps occur half-way between the *x* positions.

**Returns**

*PolyCollection* A *PolyCollection* containing the plotted polygons.

**Other Parameters**

**\*\*kwargs** All other keyword arguments are passed on to *PolyCollection*. They control the *Polygon* properties:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and
<i>alpha</i>		float or None
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i> or <i>antialiaseds</i>		bool or sequence of bools
<i>array</i>		ndarray
<i>capstyle</i>		{‘butt’, ‘round’, ‘projecting’}
<i>clim</i>		a length 2 sequence of floats; may be overridden in methods that have
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>cmap</i>		colormap or registered colormap name
<i>color</i>		color or sequence of rgba tuples
<i>contains</i>		callable
<i>edgecolor</i> or <i>ec</i> or <i>edgecolors</i>		color or sequence of colors or ‘face’
<i>facecolor</i> or <i>facecolors</i> or <i>fc</i>		color or sequence of colors
<i>figure</i>		<i>Figure</i>

Continued on next page

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	Property	Description
<i>gid</i>	str	
<i>hatch</i>	{'/', '\', ' ', '-', '+', 'x', 'o', 'O', ':', '*'}	
<i>in_layout</i>	bool	
<i>joinstyle</i>	{'miter', 'round', 'bevel'}	
<i>label</i>	object	
<i>linestyle</i> or <i>dashes</i> or <i>linestyles</i> or <i>ls</i>	{'-', '--', '-.', ':', '', (offset, on-off-seq), ...}	
<i>linewidth</i> or <i>linewidths</i> or <i>lw</i>	float or sequence of floats	
<i>norm</i>	<i>Normalize</i>	
<i>offset_position</i>	{'screen', 'data'}	
<i>offsets</i>	float or sequence of floats	
<i>path_effects</i>	<i>AbstractPathEffect</i>	
<i>picker</i>	None or bool or float or callable	
<i>pickradius</i>	unknown	
<i>rasterized</i>	bool or None	
<i>sketch_params</i>	(scale: float, length: float, randomness: float)	
<i>snap</i>	bool or None	
<i>transform</i>	<i>Transform</i>	
<i>url</i>	str	
<i>urls</i>	List[str] or None	
<i>visible</i>	bool	
<i>zorder</i>	float	

**See also:**

*fill\_between* Fill between two sets of y-values.

**Notes**

---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'where', 'x1', 'x2', 'y'.

Objects passed as **data** must support item access (data[<arg>]) and membership test (<arg> in data).

---

**Examples using `matplotlib.axes.Axes.fill_betweenx`**

- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_filled\_step.py

**matplotlib.axes.Axes.bar**

`Axes.bar(self, x, height, width=0.8, bottom=None, *, align='center', data=None, **kwargs)`

Make a bar plot.

The bars are positioned at  $x$  with the given *alignment*. Their dimensions are given by *width* and *height*. The vertical baseline is *bottom* (default 0).

Each of  $x$ , *height*, *width*, and *bottom* may either be a scalar applying to all bars, or it may be a sequence of length  $N$  providing a separate value for each bar.

### Parameters

**x** [sequence of scalars] The x coordinates of the bars. See also *align* for the alignment of the bars to the coordinates.

**height** [scalar or sequence of scalars] The height(s) of the bars.

**width** [scalar or array-like, optional] The width(s) of the bars (default: 0.8).

**bottom** [scalar or array-like, optional] The y coordinate(s) of the bars bases (default: 0).

**align** [{'center', 'edge'}], optional, default: 'center'] Alignment of the bars to the x coordinates:

- 'center': Center the base on the x positions.
- 'edge': Align the left edges of the bars with the x positions.

To align the bars on the right edge pass a negative *width* and `align='edge'`.

### Returns

**container** [*BarContainer*] Container with all the bars and optionally error-bars.

### Other Parameters

**color** [scalar or array-like, optional] The colors of the bar faces.

**edgecolor** [scalar or array-like, optional] The colors of the bar edges.

**linewidth** [scalar or array-like, optional] Width of the bar edge(s). If 0, don't draw edges.

**tick\_label** [string or array-like, optional] The tick labels of the bars. Default: None (Use default numeric labels.)

**xerr, yerr** [scalar or array-like of shape(N,) or shape(2,N), optional] If not *None*, add horizontal / vertical errorbars to the bar tips. The values are +/- sizes relative to the data:

- scalar: symmetric +/- values for all bars
- shape(N,): symmetric +/- values for each bar
- **shape(2,N): Separate - and + values for each bar. First row** contains the lower errors, the second row contains the upper errors.
- *None*: No errorbar. (Default)

See [/gallery/statistics/errorbar\\_features](/gallery/statistics/errorbar_features) for an example on the usage of `xerr` and `yerr`.

**ecolor** [scalar or array-like, optional, default: 'black'] The line color of the errorbars.

**capsize** [scalar, optional] The length of the error bar caps in points. Default: None, which will take the value from `rcParams["errorbar.capsize"]`.

**error\_kw** [dict, optional] Dictionary of kwargs to be passed to the *errorbar* method. Values of *ecolor* or *capsize* defined here take precedence over the independent kwargs.

**log** [bool, optional, default: False] If *True*, set the y-axis to be log scale.

**orientation** [{'vertical', 'horizontal'}, optional] *This is for internal use only.* Please use *barh* for horizontal bar plots. Default: 'vertical'.

**See also:**

*barh* Plot a horizontal bar plot.

**Notes**

The optional arguments *color*, *edgecolor*, *linewidth*, *xerr*, and *yerr* can be either scalars or sequences of length equal to the number of bars. This enables you to use *bar* as the basis for stacked bar charts, or candlestick plots. Detail: *xerr* and *yerr* are passed directly to *errorbar()*, so they can also have shape 2xN for independent specification of lower and upper errors.

Other optional kwargs:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m,
<i>alpha</i>		float or None
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i>		unknown
<i>capstyle</i>		{'butt', 'round', 'projecting'}
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>color</i>		color
<i>contains</i>		callable
<i>edgecolor</i> or <i>ec</i>		color or None or 'auto'
<i>facecolor</i> or <i>fc</i>		color or None
<i>figure</i>		<i>Figure</i>
<i>fill</i>		bool
<i>gid</i>		str
<i>hatch</i>		{'/', '\\', ' ', '-.', '+', 'x', 'o', 'O', '.', '*'}
<i>in_layout</i>		bool
<i>joinstyle</i>		{'miter', 'round', 'bevel'}
<i>label</i>		object
<i>linestyle</i> or <i>ls</i>		{'-', '-.', '-:', ':', "", (offset, on-off-seq), ...}
<i>linewidth</i> or <i>lw</i>		float or None
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		None or bool or float or callable
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>transform</i>		<i>Transform</i>
<i>url</i>		str
<i>visible</i>		bool

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	Property	Description
<code>zorder</code>	float	

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

#### Examples using `matplotlib.axes.Axes.bar`

- `sphx_glr_gallery_lines_bars_and_markers_barchart.py`
- `sphx_glr_gallery_statistics_barchart_demo.py`
- `sphx_glr_gallery_pie_and_polar_charts_bar_of_pie.py`
- `sphx_glr_gallery_pie_and_polar_charts_nested_pie.py`
- `sphx_glr_gallery_pie_and_polar_charts_polar_bar.py`
- `sphx_glr_gallery_shapes_and_collections_hatch_demo.py`

#### `matplotlib.axes.Axes.barh`

`Axes.barh(self, y, width, height=0.8, left=None, *, align='center', **kwargs)`

Make a horizontal bar plot.

The bars are positioned at `y` with the given `align`. Their dimensions are given by `width` and `height`. The horizontal baseline is `left` (default 0).

Each of `y`, `width`, `height`, and `left` may either be a scalar applying to all bars, or it may be a sequence of length N providing a separate value for each bar.

#### Parameters

**y** [scalar or array-like] The y coordinates of the bars. See also `align` for the alignment of the bars to the coordinates.

**width** [scalar or array-like] The width(s) of the bars.

**height** [sequence of scalars, optional, default: 0.8] The heights of the bars.

**left** [sequence of scalars] The x coordinates of the left sides of the bars (default: 0).

**align** [{'center', 'edge'}, optional, default: 'center'] Alignment of the base to the y coordinates\*:

- 'center': Center the bars on the y positions.
- 'edge': Align the bottom edges of the bars with the y positions.

To align the bars on the top edge pass a negative *height* and `align='edge'`.

### Returns

**container** [*BarContainer*] Container with all the bars and optionally error-bars.

### Other Parameters

**color** [scalar or array-like, optional] The colors of the bar faces.

**edgecolor** [scalar or array-like, optional] The colors of the bar edges.

**linewidth** [scalar or array-like, optional] Width of the bar edge(s). If 0, don't draw edges.

**tick\_label** [string or array-like, optional] The tick labels of the bars. Default: None (Use default numeric labels.)

**xerr, yerr** [scalar or array-like of shape(N,) or shape(2,N), optional] If not None, add horizontal / vertical errorbars to the bar tips. The values are +/- sizes relative to the data:

- scalar: symmetric +/- values for all bars
- shape(N,): symmetric +/- values for each bar
- **shape(2,N): Separate - and + values for each bar. First row** contains the lower errors, the second row contains the upper errors.
- None: No errorbar. (default)

See [/gallery/statistics/errorbar\\_features](/gallery/statistics/errorbar_features) for an example on the usage of `xerr` and `yerr`.

**ecolor** [scalar or array-like, optional, default: 'black'] The line color of the errorbars.

**capsize** [scalar, optional] The length of the error bar caps in points. Default: None, which will take the value from `rcParams["errorbar.capsize"]`.

**error\_kw** [dict, optional] Dictionary of kwargs to be passed to the `errorbar` method. Values of `ecolor` or `capsize` defined here take precedence over the independent kwargs.

**log** [bool, optional, default: False] If True, set the x-axis to be log scale.

### See also:

`bar` Plot a vertical bar plot.

### Notes

The optional arguments `color`, `edgecolor`, `linewidth`, `xerr`, and `yerr` can be either scalars or sequences of length equal to the number of bars. This enables you to use `bar` as the basis for stacked bar charts, or candlestick plots. Detail: `xerr` and `yerr` are passed directly to `errorbar()`, so they can also have shape 2xN for independent specification of lower and upper errors.

Other optional kwargs:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<i>alpha</i>		float or None
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i>		unknown
<i>capstyle</i>		{'butt', 'round', 'projecting'}
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>color</i>		color
<i>contains</i>		callable
<i>edgecolor</i> or <i>ec</i>		color or None or 'auto'
<i>facecolor</i> or <i>fc</i>		color or None
<i>figure</i>		<i>Figure</i>
<i>fill</i>		bool
<i>gid</i>		str
<i>hatch</i>		{'/', '\\', ' ', '-.', '+', 'x', 'o', 'O', ':', '*'}
<i>in_layout</i>		bool
<i>joinstyle</i>		{'miter', 'round', 'bevel'}
<i>label</i>		object
<i>linestyle</i> or <i>ls</i>		{'-', '-', '-.', ':', "", (offset, on-off-seq), ...}
<i>linewidth</i> or <i>lw</i>		float or None
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		None or bool or float or callable
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>transform</i>		<i>Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>zorder</i>		float

### Examples using `matplotlib.axes.Axes.barh`

- `sphinx_glr_gallery_lines_bars_and_markers_horizontal_barchart_distribution.py`

### `matplotlib.axes.Axes.stem`

`Axes.stem(self, *args, linefmt=None, markerfmt=None, basefmt=None, bottom=0, label=None, use_line_collection=False, data=None)`

Create a stem plot.

A stem plot plots vertical lines at each x location from the baseline to y, and places a marker there.

Call signature:

```
stem([x,] y, linefmt=None, markerfmt=None, basefmt=None)
```

The x-positions are optional. The formats may be provided either as positional or as keyword-arguments.

### Parameters

**x** [array-like, optional] The x-positions of the stems. Default: (0, 1, ..., len(y) - 1).

**y** [array-like] The y-values of the stem heads.

**linefmt** [str, optional] A string defining the properties of the vertical lines. Usually, this will be a color or a color and a linestyle:

Character	Line Style
'-'	solid line
'--'	dashed line
'-.'	dash-dot line
':'	dotted line

Default: 'C0-', i.e. solid line with the first color of the color cycle.

Note: While it is technically possible to specify valid formats other than color or color and linestyle (e.g. 'rx' or '-.'), this is beyond the intention of the method and will most likely not result in a reasonable plot.

**markerfmt** [str, optional] A string defining the properties of the markers at the stem heads. Default: 'C0o', i.e. filled circles with the first color of the color cycle.

**basefmt** [str, optional] A format string defining the properties of the baseline.

Default: 'C3-' ('C2-' in classic mode).

**bottom** [float, optional, default: 0] The y-position of the baseline.

**label** [str, optional, default: None] The label to use for the stems in legends.

**use\_line\_collection** [bool, optional, default: False] If True, store and plot the stem lines as a *LineCollection* instead of individual lines. This significantly increases performance, and will become the default option in Matplotlib 3.3. If False, defaults to the old behavior of using a list of *Line2D* objects.

### Returns

**container** [*StemContainer*] The container may be treated like a tuple (*markerline*, *stemlines*, *baseline*)

### Notes

#### See also:

The MATLAB function `stem` which inspired this method.

---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

#### Examples using `matplotlib.axes.Axes.stem`

- `sphx_glr_gallery_lines_bars_and_markers_stem_plot.py`
- `sphx_glr_gallery_lines_bars_and_markers_timeline.py`

#### `matplotlib.axes.Axes.eventplot`

```
Axes.eventplot(self, positions, orientation='horizontal', lineoffsets=1, linelengths=1,
               linewidths=None, colors=None, linestyle='solid', *, data=None,
               **kwargs)
```

Plot identical parallel lines at the given positions.

*positions* should be a 1D or 2D array-like object, with each row corresponding to a row or column of lines.

This type of plot is commonly used in neuroscience for representing neural events, where it is usually called a spike raster, dot raster, or raster plot.

However, it is useful in any situation where you wish to show the timing or position of multiple sets of discrete events, such as the arrival times of people to a business on each day of the month or the date of hurricanes each year of the last century.

#### Parameters

**positions** [1D or 2D array-like object] Each value is an event. If *positions* is a 2D array-like, each row corresponds to a row or a column of lines (depending on the *orientation* parameter).

**orientation** [{'horizontal', 'vertical'}, optional] Controls the direction of the event collections:

- 'horizontal' : the lines are arranged horizontally in rows, and are vertical.
- 'vertical' : the lines are arranged vertically in columns, and are horizontal.

**lineoffsets** [scalar or sequence of scalars, optional, default: 1] The offset of the center of the lines from the origin, in the direction orthogonal to *orientation*.

**linelengths** [scalar or sequence of scalars, optional, default: 1] The total height of the lines (i.e. the lines stretches from `lineoffset - linelength/2` to `lineoffset + linelength/2`).

**linewidths** [scalar, scalar sequence or None, optional, default: None] The line width(s) of the event lines, in points. If it is None, defaults to its rcParams setting.

**colors** [color, sequence of colors or None, optional, default: None] The color(s) of the event lines. If it is None, defaults to its rcParams setting.

**linestyles** [str or tuple or a sequence of such values, optional] Default is 'solid'. Valid strings are ['solid', 'dashed', 'dashdot', 'dotted', '-', '--', '-.', ':']. Dash tuples should be of the form:

```
(offset, onoffseq),
```

where *onoffseq* is an even length tuple of on and off ink in points.

**\*\*kwargs** [optional] Other keyword arguments are line collection properties. See *LineCollection* for a list of the valid properties.

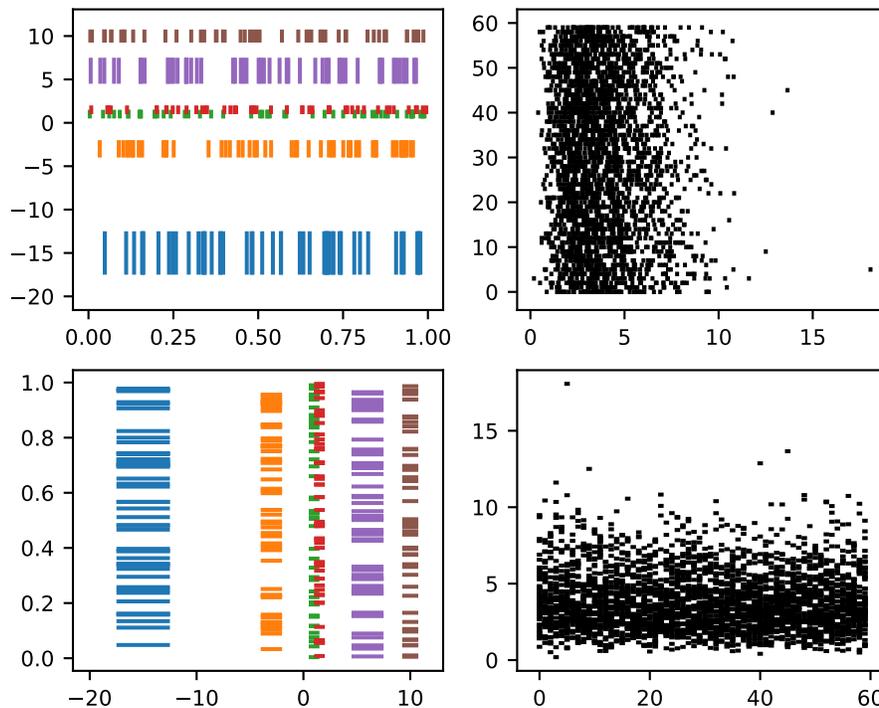
### Returns

**list** [A list of *EventCollection* objects.] Contains the *EventCollection* that were added.

### Notes

For *linelengths*, *linewidths*, *colors*, and *linestyles*, if only a single value is given, that value is applied to all lines. If an array-like is given, it must have the same length as *positions*, and each value will be applied to the corresponding row of the array.

### Examples



---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'colors', 'linelengths', 'lineoffsets', 'linestyles', 'linewidths', 'positions'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

## matplotlib.axes.Axes.pie

```
Axes.pie(self, x, explode=None, labels=None, colors=None, autopct=None, pctdistance=0.6, shadow=False, labeldistance=1.1, startangle=None, radius=None, counterclock=True, wedgeprops=None, textprops=None, center=(0, 0), frame=False, rotatelabels=False, *, data=None)
```

Plot a pie chart.

Make a pie chart of array `x`. The fractional area of each wedge is given by  $x/\text{sum}(x)$ . If  $\text{sum}(x) < 1$ , then the values of `x` give the fractional area directly and the array will not be normalized. The resulting pie will have an empty wedge of size  $1 - \text{sum}(x)$ .

The wedges are plotted counterclockwise, by default starting from the x-axis.

### Parameters

**x** [array-like] The wedge sizes.

**explode** [array-like, optional, default: None] If not *None*, is a `len(x)` array which specifies the fraction of the radius with which to offset each wedge.

**labels** [list, optional, default: None] A sequence of strings providing the labels for each wedge

**colors** [array-like, optional, default: None] A sequence of matplotlib color args through which the pie chart will cycle. If *None*, will use the colors in the currently active cycle.

**autopct** [None (default), string, or function, optional] If not *None*, is a string or function used to label the wedges with their numeric value. The label will be placed inside the wedge. If it is a format string, the label will be `fmt%pct`. If it is a function, it will be called.

**pctdistance** [float, optional, default: 0.6] The ratio between the center of each pie slice and the start of the text generated by *autopct*. Ignored if *autopct* is *None*.

**shadow** [bool, optional, default: False] Draw a shadow beneath the pie.

**labeldistance** [float or None, optional, default: 1.1] The radial distance at which the pie labels are drawn. If set to *None*, labels are not drawn, but are stored for use in `legend()`

**startangle** [float, optional, default: None] If not *None*, rotates the start of the pie chart by *angle* degrees counterclockwise from the x-axis.

**radius** [float, optional, default: None] The radius of the pie, if *radius* is *None* it will be set to 1.

**counterclock** [bool, optional, default: True] Specify fractions direction, clockwise or counterclockwise.

**wedgeprops** [dict, optional, default: None] Dict of arguments passed to the wedge objects making the pie. For example, you can pass in `wedgeprops = {'linewidth': 3}` to set the width of the wedge border lines equal to 3. For more details, look at the doc/arguments of the wedge object. By default `clip_on=False`.

**textprops** [dict, optional, default: None] Dict of arguments to pass to the text objects.

**center** [list of float, optional, default: (0, 0)] Center position of the chart. Takes value (0, 0) or is a sequence of 2 scalars.

**frame** [bool, optional, default: False] Plot axes frame with the chart if true.

**rotatelabels** [bool, optional, default: False] Rotate each label to the angle of the corresponding slice if true.

### Returns

**patches** [list] A sequence of `matplotlib.patches.Wedge` instances

**texts** [list] A list of the label `matplotlib.text.Text` instances.

**autotexts** [list] A list of `Text` instances for the numeric labels. This will only be returned if the parameter `autopct` is not `None`.

### Notes

The pie chart will probably look best if the figure and axes are square, or the Axes aspect is equal. This method sets the aspect ratio of the axis to "equal". The axes aspect ratio can be controlled with `Axes.set_aspect`.

---

**Note:** In addition to the above described arguments, this function can take a **data** key-word argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'colors', 'explode', 'labels', 'x'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

### Examples using `matplotlib.axes.Axes.pie`

- `sphinx_gallery_pie_and_polar_charts_pie_features.py`
- `sphinx_gallery_pie_and_polar_charts_pie_demo2.py`
- `sphinx_gallery_pie_and_polar_charts_bar_of_pie.py`
- `sphinx_gallery_pie_and_polar_charts_nested_pie.py`
- `sphinx_gallery_pie_and_polar_charts_pie_and_donut_labels.py`

**matplotlib.axes.Axes.stackplot**

`Axes.stackplot(x, *args, labels=(), colors=None, baseline='zero', data=None, **kwargs)`

Draw a stacked area plot.

**Parameters**

**x** [1d array of dimension N]

**y** [2d array (dimension MxN), or sequence of 1d arrays (each dimension 1xN)] The data is assumed to be unstacked. Each of the following calls is legal:

<code>stackplot(x, y)</code>	<code># where y is MxN</code>
<code>stackplot(x, y1, y2, y3, y4)</code>	<code># where y1, y2, y3, y4, are all 1xNm</code>

**baseline** [{'zero', 'sym', 'wiggle', 'weighted\_wiggle'}] Method used to calculate the baseline:

- 'zero': Constant zero baseline, i.e. a simple stacked plot.
- 'sym': Symmetric around zero and is sometimes called 'ThemeRiver'.
- 'wiggle': Minimizes the sum of the squared slopes.
- 'weighted\_wiggle': Does the same but weights to account for size of each layer. It is also called 'Streamgraph'-layout. More details can be found at <http://leebyron.com/streamgraph/>.

**labels** [Length N sequence of strings] Labels to assign to each data series.

**colors** [Length N sequence of colors] A list or tuple of colors. These will be cycled through and used to colour the stacked areas.

**\*\*kwargs** All other keyword arguments are passed to `Axes.fill_between()`.

**Returns**

**list** [list of *PolyCollection*] A list of *PolyCollection* instances, one for each element in the stacked area plot.

**Notes**


---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

**matplotlib.axes.Axes.broken\_barh**

`Axes.broken_barh(self, xrange, yrange, *, data=None, **kwargs)`

Plot a horizontal sequence of rectangles.

A rectangle is drawn for each element of *xranges*. All rectangles have the same vertical position and size defined by *yrange*.

This is a convenience function for instantiating a *BrokenBarHCollection*, adding it to the axes and autoscaling the view.

**Parameters**

**xranges** [sequence of tuples (*xmin*, *xwidth*)] The x-positions and extends of the rectangles. For each tuple (*xmin*, *xwidth*) a rectangle is drawn from *xmin* to *xmin* + *xwidth*.

**yranges** [(*ymin*, *ymax*)] The y-position and extend for all the rectangles.

**Returns**

**collection** [A *BrokenBarHCollection*]

**Other Parameters**

**\*\*kwargs** [*BrokenBarHCollection* properties] Each *kwarg* can be either a single argument applying to all rectangles, e.g.:

```
facecolors='black'
```

or a sequence of arguments over which is cycled, e.g.:

```
facecolors=('black', 'blue')
```

would create interleaving black and blue rectangles.

Supported keywords:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and
<i>alpha</i>		float or None
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i> or <i>antialiaseds</i>		bool or sequence of bools
<i>array</i>		ndarray
<i>capstyle</i>		{'butt', 'round', 'projecting'}
<i>clim</i>		a length 2 sequence of floats; may be overridden in methods that have
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>cmap</i>		colormap or registered colormap name
<i>color</i>		color or sequence of rgba tuples
<i>contains</i>		callable
<i>edgecolor</i> or <i>ec</i> or <i>edgecolors</i>		color or sequence of colors or 'face'
<i>facecolor</i> or <i>facecolors</i> or <i>fc</i>		color or sequence of colors
<i>figure</i>		<i>Figure</i>
<i>gid</i>		str
<i>hatch</i>		{'/', '\', ' ', '-.', '+', 'x', 'o', 'O', '.', '*'}
<i>in_layout</i>		bool
<i>joinstyle</i>		{'miter', 'round', 'bevel'}
<i>label</i>		object
<i>linestyle</i> or <i>dashes</i> or <i>linestyles</i> or <i>ls</i>		{'-.', '-', '-.', ':', '', (offset, on-off-seq), ...}
<i>linewidth</i> or <i>linewidths</i> or <i>lw</i>		float or sequence of floats

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Property	Description
<i>norm</i>	<i>Normalize</i>
<i>offset_position</i>	{'screen', 'data'}
<i>offsets</i>	float or sequence of floats
<i>path_effects</i>	<i>AbstractPathEffect</i>
<i>picker</i>	None or bool or float or callable
<i>pickradius</i>	unknown
<i>rasterized</i>	bool or None
<i>sketch_params</i>	(scale: float, length: float, randomness: float)
<i>snap</i>	bool or None
<i>transform</i>	<i>Transform</i>
<i>url</i>	str
<i>urls</i>	List[str] or None
<i>visible</i>	bool
<i>zorder</i>	float

## Notes

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

## matplotlib.axes.Axes.vlines

```
Axes.vlines(self, x, ymin, ymax, colors='k', linestyle='solid', label="", *, data=None,
            **kwargs)
```

Plot vertical lines.

Plot vertical lines at each *x* from *ymin* to *ymax*.

### Parameters

**x** [scalar or 1D array\_like] x-indexes where to plot the lines.

**ymin, ymax** [scalar or 1D array\_like] Respective beginning and end of each line. If scalars are provided, all lines will have same length.

**colors** [array\_like of colors, optional, default: 'k']

**linestyle** [{'solid', 'dashed', 'dashdot', 'dotted'}, optional]

**label** [string, optional, default: ""]

### Returns

**lines** [*LineCollection*]

### Other Parameters

**\*\*kwargs** [*LineCollection* properties.]

**See also:**

*hlines* horizontal lines

*axvline* vertical line across the axes

**Notes**

---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'colors', 'x', 'ymax', 'ymin'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

**matplotlib.axes.Axes.hlines**

`Axes.hlines(self, y, xmin, xmax, colors='k', linestyle='solid', label="", *, data=None, **kwargs)`

Plot horizontal lines at each *y* from *xmin* to *xmax*.

**Parameters**

**y** [scalar or sequence of scalar] y-indexes where to plot the lines.

**xmin, xmax** [scalar or 1D array\_like] Respective beginning and end of each line. If scalars are provided, all lines will have same length.

**colors** [array\_like of colors, optional, default: 'k']

**linestyles** [{'solid', 'dashed', 'dashdot', 'dotted'}, optional]

**label** [string, optional, default: ""]

**Returns**

**lines** [*LineCollection*]

**Other Parameters**

**\*\*kwargs** [*LineCollection* properties.]

**See also:**

*vlines* vertical lines

*axhline* horizontal line across the axes

**Notes**

---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'colors', 'xmax', 'xmin', 'y'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

#### Examples using `matplotlib.axes.Axes.hlines`

- `sphx_glr_gallery_color_named_colors.py`

#### `matplotlib.axes.Axes.fill`

`Axes.fill(self, *args, data=None, **kwargs)`  
Plot filled polygons.

##### Parameters

**\*args** [sequence of x, y, [color]] Each polygon is defined by the lists of x and y positions of its nodes, optionally followed by a *color* specifier. See `matplotlib.colors` for supported color specifiers. The standard color cycle is used for polygons without a color specifier.

You can plot multiple polygons by providing multiple x, y, [color] groups.

For example, each of the following is legal:

```
ax.fill(x, y)                # a polygon with default color
ax.fill(x, y, "b")          # a blue polygon
ax.fill(x, y, x2, y2)       # two polygons
ax.fill(x, y, "b", x2, y2, "r") # a blue and a red polygon
```

**data** [indexable object, optional] An object with labelled data. If given, provide the label names to plot in x and y, e.g.:

```
ax.fill("time", "signal",
        data={"time": [0, 1, 2], "signal": [0, 1, 0]})
```

##### Returns

a list of *Polygon*

##### Other Parameters

**\*\*kwargs** [*Polygon* properties]

##### Notes

Use `fill_between()` if you would like to fill the region between two curves.

#### Examples using `matplotlib.axes.Axes.fill`

- `sphx_glr_gallery_lines_bars_and_markers_fill.py`

Spans

<code>Axes.axhline</code>	Add a horizontal line across the axis.
<code>Axes.axhspan</code>	Add a horizontal span (rectangle) across the axis.
<code>Axes.axvline</code>	Add a vertical line across the axes.
<code>Axes.axvspan</code>	Add a vertical span (rectangle) across the axes.

`matplotlib.axes.Axes.axhline`

`Axes.axhline(self, y=0, xmin=0, xmax=1, **kwargs)`  
 Add a horizontal line across the axis.

**Parameters**

- y** [scalar, optional, default: 0] y position in data coordinates of the horizontal line.
- xmin** [scalar, optional, default: 0] Should be between 0 and 1, 0 being the far left of the plot, 1 the far right of the plot.
- xmax** [scalar, optional, default: 1] Should be between 0 and 1, 0 being the far left of the plot, 1 the far right of the plot.

**Returns**

**line** [*Line2D*]

**Other Parameters**

**\*\*kwargs** Valid kwargs are *Line2D* properties, with the exception of 'transform':

	Property	Description
<code>agg_filter</code>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m,
<code>alpha</code>		float
<code>animated</code>		bool
<code>antialiased</code> or <code>aa</code>		bool
<code>clip_box</code>		<i>Bbox</i>
<code>clip_on</code>		bool
<code>clip_path</code>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<code>color</code> or <code>c</code>		color
<code>contains</code>		callable
<code>dash_capstyle</code>		{'butt', 'round', 'projecting'}
<code>dash_joinstyle</code>		{'miter', 'round', 'bevel'}
<code>dashes</code>		sequence of floats (on/off ink in points) or (None, None)
<code>drawstyle</code> or <code>ds</code>		{'default', 'steps', 'steps-pre', 'steps-mid', 'steps-post'}, default: 'default'
<code>figure</code>		<i>Figure</i>
<code>fillstyle</code>		{'full', 'left', 'right', 'bottom', 'top', 'none'}
<code>gid</code>		str
<code>in_layout</code>		bool
<code>label</code>		object
<code>linestyle</code> or <code>ls</code>		{'-', '--', '-.', ':', '', (offset, on-off-seq), ...}

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Property	Description
<i>linewidth</i> or <i>lw</i>	float
<i>marker</i>	marker style
<i>markeredgewidth</i> or <i>mew</i>	float
<i>markerfacecolor</i> or <i>mfc</i>	color
<i>markerfacecoloralt</i> or <i>mfcalt</i>	color
<i>markersize</i> or <i>ms</i>	float
<i>markevery</i>	None or int or (int, int) or slice or List[int] or float or (float, float)
<i>path_effects</i>	<i>AbstractPathEffect</i>
<i>picker</i>	float or callable[[Artist, Event], Tuple[bool, dict]]
<i>pickradius</i>	float
<i>rasterized</i>	bool or None
<i>sketch_params</i>	(scale: float, length: float, randomness: float)
<i>snap</i>	bool or None
<i>solid_capstyle</i>	{'butt', 'round', 'projecting'}
<i>solid_joinstyle</i>	{'miter', 'round', 'bevel'}
<i>transform</i>	<i>matplotlib.transforms.Transform</i>
<i>url</i>	str
<i>visible</i>	bool
<i>xdata</i>	1D array
<i>ydata</i>	1D array
<i>zorder</i>	float

**See also:**

*hlines* Add horizontal lines in data coordinates.

*axhspan* Add a horizontal span (rectangle) across the axis.

**Examples**

- draw a thick red hline at 'y' = 0 that spans the xrange:

```
>>> axhline(linewidth=4, color='r')
```

- draw a default hline at 'y' = 1 that spans the xrange:

```
>>> axhline(y=1)
```

- draw a default hline at 'y' = .5 that spans the middle half of the xrange:

```
>>> axhline(y=.5, xmin=0.25, xmax=0.75)
```

**Examples using `matplotlib.axes.Axes.axhline`**

- `sphx_glr_gallery_lines_bars_and_markers_span_regions.py`
- `sphx_glr_gallery_color_color_cycle_default.py`

**matplotlib.axes.Axes.axhspan**

`Axes.axhspan(self, ymin, ymax, xmin=0, xmax=1, **kwargs)`

Add a horizontal span (rectangle) across the axis.

Draw a horizontal span (rectangle) from *ymin* to *ymax*. With the default values of *xmin* = 0 and *xmax* = 1, this always spans the xrange, regardless of the xlim settings, even if you change them, e.g., with the *set\_xlim()* command. That is, the horizontal extent is in axes coords: 0=left, 0.5=middle, 1.0=right but the y location is in data coordinates.

**Parameters**

- ymin** [float] Lower limit of the horizontal span in data units.
- ymax** [float] Upper limit of the horizontal span in data units.
- xmin** [float, optional, default: 0] Lower limit of the vertical span in axes (relative 0-1) units.
- xmax** [float, optional, default: 1] Upper limit of the vertical span in axes (relative 0-1) units.

**Returns**

**Polygon** [*Polygon*]

**Other Parameters**

**\*\*kwargs** [*Polygon* properties.]

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<i>alpha</i>		float or None
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i>		unknown
<i>capstyle</i>		{'butt', 'round', 'projecting'}
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>color</i>		color
<i>contains</i>		callable
<i>edgecolor</i> or <i>ec</i>		color or None or 'auto'
<i>facecolor</i> or <i>fc</i>		color or None
<i>figure</i>		<i>Figure</i>
<i>fill</i>		bool
<i>gid</i>		str
<i>hatch</i>		{'/', '\\', ' ', '-.', '+', 'x', 'o', 'O', ':', '*'}
<i>in_layout</i>		bool
<i>joinstyle</i>		{'miter', 'round', 'bevel'}
<i>label</i>		object
<i>linestyle</i> or <i>ls</i>		{'-', '-.', '-.-', ':', ' ', (offset, on-off-seq), ...}
<i>linewidth</i> or <i>lw</i>		float or None
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		None or bool or float or callable
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)

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	Property	Description
<i>snap</i>	bool or None	
<i>transform</i>	<i>Transform</i>	
<i>url</i>	str	
<i>visible</i>	bool	
<i>zorder</i>	float	

**See also:**

`axvspan` Add a vertical span across the axes.

**matplotlib.axes.Axes.axvline**

`Axes.axvline(self, x=0, ymin=0, ymax=1, **kwargs)`

Add a vertical line across the axes.

**Parameters**

**x** [scalar, optional, default: 0] x position in data coordinates of the vertical line.

**ymin** [scalar, optional, default: 0] Should be between 0 and 1, 0 being the bottom of the plot, 1 the top of the plot.

**ymax** [scalar, optional, default: 1] Should be between 0 and 1, 0 being the bottom of the plot, 1 the top of the plot.

**Returns**

**line** [*Line2D*]

**Other Parameters**

**\*\*kwargs** Valid kwargs are *Line2D* properties, with the exception of 'transform':

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<i>alpha</i>	float	
<i>animated</i>	bool	
<i>antialiased</i> or <i>aa</i>	bool	
<i>clip_box</i>	<i>Bbox</i>	
<i>clip_on</i>	bool	
<i>clip_path</i>	$[(Path, Transform)   Patch   None]$	
<i>color</i> or <i>c</i>	color	
<i>contains</i>	callable	
<i>dash_capstyle</i>	{'butt', 'round', 'projecting'}	
<i>dash_joinstyle</i>	{'miter', 'round', 'bevel'}	
<i>dashes</i>	sequence of floats (on/off ink in points) or (None, None)	
<i>drawstyle</i> or <i>ds</i>	{'default', 'steps', 'steps-pre', 'steps-mid', 'steps-post'}, default: 'default'	
<i>figure</i>	<i>Figure</i>	
<i>fillstyle</i>	{'full', 'left', 'right', 'bottom', 'top', 'none'}	
<i>gid</i>	str	

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	Property	Description
<i>in_layout</i>	bool	
<i>label</i>	object	
<i>linestyle</i> or <i>ls</i>	{ '-', '--', '-.', ':', '', (offset, on-off-seq), ... }	
<i>linewidth</i> or <i>lw</i>	float	
<i>marker</i>		marker style
<i>markeredgewidth</i> or <i>mec</i>	color	
<i>markeredgewidth</i> or <i>mew</i>	float	
<i>markerfacecolor</i> or <i>mfc</i>	color	
<i>markerfacecoloralt</i> or <i>mfcalt</i>	color	
<i>markersize</i> or <i>ms</i>	float	
<i>markevery</i>	None or int or (int, int) or slice or List[int] or float or (float, float)	
<i>path_effects</i>	<i>AbstractPathEffect</i>	
<i>picker</i>	float or callable[[Artist, Event], Tuple[bool, dict]]	
<i>pickradius</i>	float	
<i>rasterized</i>	bool or None	
<i>sketch_params</i>	(scale: float, length: float, randomness: float)	
<i>snap</i>	bool or None	
<i>solid_capstyle</i>	{ 'butt', 'round', 'projecting' }	
<i>solid_joinstyle</i>	{ 'miter', 'round', 'bevel' }	
<i>transform</i>	<i>matplotlib.transforms.Transform</i>	
<i>url</i>	str	
<i>visible</i>	bool	
<i>xdata</i>	1D array	
<i>ydata</i>	1D array	
<i>zorder</i>	float	

**See also:**

*vlines* Add vertical lines in data coordinates.

*axvspan* Add a vertical span (rectangle) across the axis.

**Examples**

- draw a thick red vline at  $x = 0$  that spans the yrange:

```
>>> axvline(linewidth=4, color='r')
```

- draw a default vline at  $x = 1$  that spans the yrange:

```
>>> axvline(x=1)
```

- draw a default vline at  $x = .5$  that spans the middle half of the yrange:

```
>>> axvline(x=.5, ymin=0.25, ymax=0.75)
```

**Examples using `matplotlib.axes.Axes.axvline`**

- `sphx_glr_gallery_color_color_cycle_default.py`

**matplotlib.axes.Axes.axvspan**

`Axes.axvspan(self, xmin, xmax, ymin=0, ymax=1, **kwargs)`

Add a vertical span (rectangle) across the axes.

Draw a vertical span (rectangle) from `xmin` to `xmax`. With the default values of `ymin = 0` and `ymax = 1`. This always spans the yrange, regardless of the `ylim` settings, even if you change them, e.g., with the `set_ylim()` command. That is, the vertical extent is in axes coords: 0=bottom, 0.5=middle, 1.0=top but the x location is in data coordinates.

**Parameters**

**xmin** [scalar] Number indicating the first X-axis coordinate of the vertical span rectangle in data units.

**xmax** [scalar] Number indicating the second X-axis coordinate of the vertical span rectangle in data units.

**ymin** [scalar, optional] Number indicating the first Y-axis coordinate of the vertical span rectangle in relative Y-axis units (0-1). Default to 0.

**ymax** [scalar, optional] Number indicating the second Y-axis coordinate of the vertical span rectangle in relative Y-axis units (0-1). Default to 1.

**Returns**

**rectangle** [matplotlib.patches.Polygon] Vertical span (rectangle) from (`xmin`, `ymin`) to (`xmax`, `ymax`).

**Other Parameters**

**\*\*kwargs** Optional parameters are properties of the class `matplotlib.patches.Polygon`.

**See also:**

`axhspan` Add a horizontal span across the axes.

**Examples**

Draw a vertical, green, translucent rectangle from `x = 1.25` to `x = 1.55` that spans the yrange of the axes.

```
>>> axvspan(1.25, 1.55, facecolor='g', alpha=0.5)
```

**Spectral**

<code>Axes.acorr</code>	Plot the autocorrelation of <code>x</code> .
<code>Axes.angle_spectrum</code>	Plot the angle spectrum.
<code>Axes.cohere</code>	Plot the coherence between <code>x</code> and <code>y</code> .
<code>Axes.csd</code>	Plot the cross-spectral density.
<code>Axes.magnitude_spectrum</code>	Plot the magnitude spectrum.
<code>Axes.phase_spectrum</code>	Plot the phase spectrum.
<code>Axes.psd</code>	Plot the power spectral density.
<code>Axes.spectrogram</code>	Plot a spectrogram.

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<i>Axes.xcorr</i>	Plot the cross correlation between x and y.
-------------------	---

**matplotlib.axes.Axes.acorr**

`Axes.acorr(self, x, *, data=None, **kwargs)`

Plot the autocorrelation of x.

**Parameters**

**x** [array-like]

**detrend** [callable, optional, default: `mlab.detrend_none`] x is detrended by the *detrend* callable. This must be a function `x = detrend(x)` accepting and returning a `numpy.array`. Default is no normalization.

**normed** [bool, optional, default: True] If True, input vectors are normalised to unit length.

**usevlines** [bool, optional, default: True] Determines the plot style.

If True, vertical lines are plotted from 0 to the `acorr` value using `Axes.vlines`. Additionally, a horizontal line is plotted at `y=0` using `Axes.axhline`.

If False, markers are plotted at the `acorr` values using `Axes.plot`.

**maxlags** [int, optional, default: 10] Number of lags to show. If None, will return all  $2 * \text{len}(x) - 1$  lags.

**Returns**

**lags** [array (length  $2 * \text{maxlags} + 1$ )] The lag vector.

**c** [array (length  $2 * \text{maxlags} + 1$ )] The auto correlation vector.

**line** [`LineCollection` or `Line2D`] Artist added to the axes of the correlation:

- `LineCollection` if `usevlines` is True.
- `Line2D` if `usevlines` is False.

**b** [`Line2D` or None] Horizontal line at 0 if `usevlines` is True None `usevlines` is False.

**Other Parameters**

**linestyle** [`Line2D` property, optional] The linestyle for plotting the data points. Only used if `usevlines` is False.

**marker** [str, optional, default: 'o'] The marker for plotting the data points. Only used if `usevlines` is False.

**Notes**

The cross correlation is performed with `numpy.correlate()` with `mode = "full"`.

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

#### Examples using `matplotlib.axes.Axes.acorr`

- `sphx_glr_gallery_lines_bars_and_markers_xcorr_acorr_demo.py`

#### `matplotlib.axes.Axes.angle_spectrum`

```
Axes.angle_spectrum(self, x, Fs=None, Fc=None, window=None, pad_to=None,
                    sides=None, *, data=None, **kwargs)
```

Plot the angle spectrum.

Compute the angle spectrum (wrapped phase spectrum) of `x`. Data is padded to a length of `pad_to` and the windowing function `window` is applied to the signal.

#### Parameters

**x** [1-D array or sequence] Array or sequence containing the data.

**Fs** [scalar] The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, `freqs`, in cycles per time unit. The default value is 2.

**window** [callable or ndarray] A function or a vector of length `NFFT`. To create window vectors see `window_hanning`, `window_none`, `numpy.blackman`, `numpy.hamming`, `numpy.bartlett`, `scipy.signal`, `scipy.signal.get_window`, etc. The default is `window_hanning`. If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.

**sides** [{'default', 'onesided', 'twosided'}] Specifies which sides of the spectrum to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. 'onesided' forces the return of a one-sided spectrum, while 'twosided' forces two-sided.

**pad\_to** [int] The number of points to which the data segment is padded when performing the FFT. While not increasing the actual resolution of the spectrum (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the `n` parameter in the call to `fft()`. The default is `None`, which sets `pad_to` equal to the length of the input signal (i.e. no padding).

**Fc** [int] The center frequency of `x` (defaults to 0), which offsets the x extents of the plot to reflect the frequency range used when a signal is acquired and then filtered and downsampled to baseband.

#### Returns

**spectrum** [1-D array] The values for the angle spectrum in radians (real valued).

**freqs** [1-D array] The frequencies corresponding to the elements in `spectrum`.

**line** [a *Line2D* instance] The line created by this function.

**Other Parameters**

**\*\*kwargs** Keyword arguments control the *Line2D* properties:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<i>alpha</i>		float
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i>		bool
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>color</i> or <i>c</i>		color
<i>contains</i>		callable
<i>dash_capstyle</i>		{'butt', 'round', 'projecting'}
<i>dash_joinstyle</i>		{'miter', 'round', 'bevel'}
<i>dashes</i>		sequence of floats (on/off ink in points) or (None, None)
<i>drawstyle</i> or <i>ds</i>		{'default', 'steps', 'steps-pre', 'steps-mid', 'steps-post'}, default: 'default'
<i>figure</i>		<i>Figure</i>
<i>fillstyle</i>		{'full', 'left', 'right', 'bottom', 'top', 'none'}
<i>gid</i>		str
<i>in_layout</i>		bool
<i>label</i>		object
<i>linestyle</i> or <i>ls</i>		{'-', '--', '-.', ':', '', (offset, on-off-seq), ...}
<i>linewidth</i> or <i>lw</i>		float
<i>marker</i>		marker style
<i>markeredgewidth</i> or <i>mec</i>		float
<i>markeredgecolor</i> or <i>mec</i>		color
<i>markerfacecolor</i> or <i>mfc</i>		color
<i>markerfacecoloralt</i> or <i>mfcalt</i>		color
<i>markersize</i> or <i>ms</i>		float
<i>markevery</i>		None or int or (int, int) or slice or List[int] or float or (float, float)
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		float or callable[[ <i>Artist</i> , <i>Event</i> ], Tuple[bool, dict]]
<i>pickradius</i>		float
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>solid_capstyle</i>		{'butt', 'round', 'projecting'}
<i>solid_joinstyle</i>		{'miter', 'round', 'bevel'}
<i>transform</i>		<i>matplotlib.transforms.Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>xdata</i>		1D array
<i>ydata</i>		1D array
<i>zorder</i>		float

**See also:**

*magnitude\_spectrum()* *angle\_spectrum()* plots the magnitudes of the corresponding frequencies.

`phase_spectrum()` `phase_spectrum()` plots the unwrapped version of this function.

`specgram()` `specgram()` can plot the angle spectrum of segments within the signal in a `colormap`.

## Notes

---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

## matplotlib.axes.Axes.cohere

```
Axes.cohere(self, x, y, NFFT=256, Fs=2, Fc=0, detrend=<function de-
    trend_none at 0x7f69881a1378>, window=<function window_hanning
    at 0x7f6988216bf8>, noverlap=0, pad_to=None, sides='default',
    scale_by_freq=None, *, data=None, **kwargs)
```

Plot the coherence between x and y.

Plot the coherence between x and y. Coherence is the normalized cross spectral density:

$$C_{xy} = \frac{|P_{xy}|^2}{P_{xx}P_{yy}}$$

## Parameters

**Fs** [scalar] The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, `freqs`, in cycles per time unit. The default value is 2.

**window** [callable or ndarray] A function or a vector of length `NFFT`. To create window vectors see `window_hanning`, `window_none`, `numpy.blackman`, `numpy.hamming`, `numpy.bartlett`, `scipy.signal`, `scipy.signal.get_window`, etc. The default is `window_hanning`. If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.

**sides** [{ 'default', 'onesided', 'twosided' }] Specifies which sides of the spectrum to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. 'onesided' forces the return of a one-sided spectrum, while 'twosided' forces two-sided.

**pad\_to** [int] The number of points to which the data segment is padded when performing the FFT. This can be different from `NFFT`, which specifies the number of data points used. While not increasing the actual resolution of the spectrum (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the `n` parameter in the call to `fft()`. The default is `None`, which sets `pad_to` equal to `NFFT`

**NFFT** [int] The number of data points used in each block for the FFT. A power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use *pad\_to* for this instead.

**detrend** [{'none', 'mean', 'linear'} or callable, default 'none'] The function applied to each segment before fft-ing, designed to remove the mean or linear trend. Unlike in MATLAB, where the *detrend* parameter is a vector, in Matplotlib is it a function. The *mlab* module defines *detrend\_none*, *detrend\_mean*, and *detrend\_linear*, but you can use a custom function as well. You can also use a string to choose one of the functions: 'none' calls *detrend\_none*. 'mean' calls *detrend\_mean*. 'linear' calls *detrend\_linear*.

**scale\_by\_freq** [bool, optional] Specifies whether the resulting density values should be scaled by the scaling frequency, which gives density in units of Hz<sup>-1</sup>. This allows for integration over the returned frequency values. The default is True for MATLAB compatibility.

**noverlap** [int] The number of points of overlap between blocks. The default value is 0 (no overlap).

**Fc** [int] The center frequency of x (defaults to 0), which offsets the x extents of the plot to reflect the frequency range used when a signal is acquired and then filtered and downsampled to baseband.

**Returns**

**Cxy** [1-D array] The coherence vector.

**freqs** [1-D array] The frequencies for the elements in Cxy.

**Other Parameters**

**\*\*kwargs** Keyword arguments control the *Line2D* properties:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<i>alpha</i>	float	
<i>animated</i>	bool	
<i>antialiased</i> or <i>aa</i>	bool	
<i>clip_box</i>	<i>Bbox</i>	
<i>clip_on</i>	bool	
<i>clip_path</i>	[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]	
<i>color</i> or <i>c</i>	color	
<i>contains</i>	callable	
<i>dash_capstyle</i>	{'butt', 'round', 'projecting'}	
<i>dash_joinstyle</i>	{'miter', 'round', 'bevel'}	
<i>dashes</i>	sequence of floats (on/off ink in points) or (None, None)	
<i>drawstyle</i> or <i>ds</i>	{'default', 'steps', 'steps-pre', 'steps-mid', 'steps-post'}, default: 'default'	
<i>figure</i>	<i>Figure</i>	
<i>fillstyle</i>	{'full', 'left', 'right', 'bottom', 'top', 'none'}	
<i>gid</i>	str	
<i>in_layout</i>	bool	
<i>label</i>	object	
<i>linestyle</i> or <i>ls</i>	{'-', '--', '-.', ':', "", (offset, on-off-seq), ...}	
<i>linewidth</i> or <i>lw</i>	float	

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	Property	Description
<i>marker</i>		marker style
<i>markeredgewidth</i> or <i>mew</i>		float
<i>markerfacecolor</i> or <i>mfc</i>		color
<i>markerfacecoloralt</i> or <i>mfcalt</i>		color
<i>markersize</i> or <i>ms</i>		float
<i>markevery</i>		None or int or (int, int) or slice or List[int] or float or (float, float)
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		float or callable[[Artist, Event], Tuple[bool, dict]]
<i>pickradius</i>		float
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>solid_capstyle</i>		{'butt', 'round', 'projecting'}
<i>solid_joinstyle</i>		{'miter', 'round', 'bevel'}
<i>transform</i>		<i>matplotlib.transforms.Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>xdata</i>		1D array
<i>ydata</i>		1D array
<i>zorder</i>		float

## Notes

**Note:** In addition to the above described arguments, this function can take a **data** key-word argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x', 'y'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

## References

Bendat & Piersol – Random Data: Analysis and Measurement Procedures, John Wiley & Sons (1986)

### matplotlib.axes.Axes.csd

```
Axes.csd(self, x, y, NFFT=None, Fs=None, Fc=None, detrend=None, window=None,
         noverlap=None, pad_to=None, sides=None, scale_by_freq=None, re-
         turn_line=None, *, data=None, **kwargs)
```

Plot the cross-spectral density.

The cross spectral density  $P_{xy}$  by Welch's average periodogram method. The vectors  $x$  and  $y$  are divided into  $NFFT$  length segments. Each segment is detrended by function

*detrend* and windowed by function *window*. *noverlap* gives the length of the overlap between segments. The product of the direct FFTs of *x* and *y* are averaged over each segment to compute  $P_{xy}$ , with a scaling to correct for power loss due to windowing.

If  $\text{len}(x) < NFFT$  or  $\text{len}(y) < NFFT$ , they will be zero padded to  $NFFT$ .

### Parameters

**x, y** [1-D arrays or sequences] Arrays or sequences containing the data.

**Fs** [scalar] The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, *freqs*, in cycles per time unit. The default value is 2.

**window** [callable or ndarray] A function or a vector of length  $NFFT$ . To create window vectors see `window_hanning`, `window_none`, `numpy.blackman`, `numpy.hamming`, `numpy.bartlett`, `scipy.signal`, `scipy.signal.get_window`, etc. The default is `window_hanning`. If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.

**sides** [{'default', 'onesided', 'twosided'}] Specifies which sides of the spectrum to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. 'onesided' forces the return of a one-sided spectrum, while 'twosided' forces two-sided.

**pad\_to** [int] The number of points to which the data segment is padded when performing the FFT. This can be different from  $NFFT$ , which specifies the number of data points used. While not increasing the actual resolution of the spectrum (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the *n* parameter in the call to `fft()`. The default is `None`, which sets *pad\_to* equal to  $NFFT$

**NFFT** [int] The number of data points used in each block for the FFT. A power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use *pad\_to* for this instead.

**detrend** [{'none', 'mean', 'linear'} or callable, default 'none'] The function applied to each segment before `fft`-ing, designed to remove the mean or linear trend. Unlike in MATLAB, where the *detrend* parameter is a vector, in Matplotlib it is a function. The *mlab* module defines `detrend_none`, `detrend_mean`, and `detrend_linear`, but you can use a custom function as well. You can also use a string to choose one of the functions: 'none' calls `detrend_none`. 'mean' calls `detrend_mean`. 'linear' calls `detrend_linear`.

**scale\_by\_freq** [bool, optional] Specifies whether the resulting density values should be scaled by the scaling frequency, which gives density in units of  $\text{Hz}^{-1}$ . This allows for integration over the returned frequency values. The default is `True` for MATLAB compatibility.

**noverlap** [int] The number of points of overlap between segments. The default value is 0 (no overlap).

**Fc** [int] The center frequency of *x* (defaults to 0), which offsets the *x* extents of the plot to reflect the frequency range used when a signal is acquired and then filtered and downsampled to baseband.

**return\_line** [bool] Whether to include the line object plotted in the returned values. Default is False.

**Returns**

**Pxy** [1-D array] The values for the cross spectrum  $P_{\{xy\}}$  before scaling (complex valued).

**freqs** [1-D array] The frequencies corresponding to the elements in  $P_{xy}$ .

**line** [a *Line2D* instance] The line created by this function. Only returned if *return\_line* is True.

**Other Parameters**

**\*\*kwargs** Keyword arguments control the *Line2D* properties:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<i>alpha</i>		float
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i>		bool
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>color</i> or <i>c</i>		color
<i>contains</i>		callable
<i>dash_capstyle</i>		{'butt', 'round', 'projecting'}
<i>dash_joinstyle</i>		{'miter', 'round', 'bevel'}
<i>dashes</i>		sequence of floats (on/off ink in points) or (None, None)
<i>drawstyle</i> or <i>ds</i>		{'default', 'steps', 'steps-pre', 'steps-mid', 'steps-post'}, default: 'default'
<i>figure</i>		<i>Figure</i>
<i>fillstyle</i>		{'full', 'left', 'right', 'bottom', 'top', 'none'}
<i>gid</i>		str
<i>in_layout</i>		bool
<i>label</i>		object
<i>linestyle</i> or <i>ls</i>		{'-', '--', '-.', ':', '', (offset, on-off-seq), ...}
<i>linewidth</i> or <i>lw</i>		float
<i>marker</i>		marker style
<i>markeredgewidth</i> or <i>mec</i>		color
<i>markeredgewidth</i> or <i>mew</i>		float
<i>markerfacecolor</i> or <i>mfc</i>		color
<i>markerfacecoloralt</i> or <i>mfcalt</i>		color
<i>markersize</i> or <i>ms</i>		float
<i>markevery</i>		None or int or (int, int) or slice or List[int] or float or (float, float)
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		float or callable[[ <i>Artist</i> , <i>Event</i> ], Tuple[bool, dict]]
<i>pickradius</i>		float
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>solid_capstyle</i>		{'butt', 'round', 'projecting'}
<i>solid_joinstyle</i>		{'miter', 'round', 'bevel'}
<i>transform</i>		<i>matplotlib.transforms.Transform</i>

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	Property	Description
<i>url</i>		str
<i>visible</i>		bool
<i>xdata</i>		1D array
<i>ydata</i>		1D array
<i>zorder</i>		float

**See also:**

`psd()` `psd()` is the equivalent to setting `y=x`.

**Notes**

For plotting, the power is plotted as  $10 \log_{10}(P_{xy})$  for decibels, though  $P_{xy}$  itself is returned.

**References**

Bendat & Piersol – Random Data: Analysis and Measurement Procedures, John Wiley & Sons (1986)

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**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x', 'y'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

**matplotlib.axes.Axes.magnitude\_spectrum**

`Axes.magnitude_spectrum(self, x, Fs=None, Fc=None, window=None, pad_to=None, sides=None, scale=None, *, data=None, **kwargs)`

Plot the magnitude spectrum.

Compute the magnitude spectrum of `x`. Data is padded to a length of `pad_to` and the windowing function `window` is applied to the signal.

**Parameters**

**x** [1-D array or sequence] Array or sequence containing the data.

**Fs** [scalar] The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, `freqs`, in cycles per time unit. The default value is 2.

**window** [callable or ndarray] A function or a vector of length `NFFT`. To create window vectors see `window_hanning`, `window_none`, `numpy.blackman`, `numpy.hamming`, `numpy.bartlett`, `scipy.signal`, `scipy.signal.get_window`,

etc. The default is `window_hanning`. If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.

**sides** [`'default'`, `'onesided'`, `'twosided'`] Specifies which sides of the spectrum to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. `'onesided'` forces the return of a one-sided spectrum, while `'twosided'` forces two-sided.

**pad\_to** [int] The number of points to which the data segment is padded when performing the FFT. While not increasing the actual resolution of the spectrum (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the  $n$  parameter in the call to `fft()`. The default is `None`, which sets `pad_to` equal to the length of the input signal (i.e. no padding).

**scale** [`'default'`, `'linear'`, `'dB'`] The scaling of the values in the *spec*. `'linear'` is no scaling. `'dB'` returns the values in dB scale, i.e., the dB amplitude ( $20 * \log_{10}$ ). `'default'` is `'linear'`.

**fc** [int] The center frequency of  $x$  (defaults to 0), which offsets the  $x$  extents of the plot to reflect the frequency range used when a signal is acquired and then filtered and downsampled to baseband.

## Returns

**spectrum** [1-D array] The values for the magnitude spectrum before scaling (real valued).

**freqs** [1-D array] The frequencies corresponding to the elements in *spectrum*.

**line** [a *Line2D* instance] The line created by this function.

## Other Parameters

**\*\*kwargs** Keyword arguments control the *Line2D* properties:

	Property	Description
<code>agg_filter</code>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<code>alpha</code>		float
<code>animated</code>		bool
<code>antialiased</code> or <code>aa</code>		bool
<code>clip_box</code>		<i>Bbox</i>
<code>clip_on</code>		bool
<code>clip_path</code>		$[(Path, Transform)   Patch   None]$
<code>color</code> or <code>c</code>		color
<code>contains</code>		callable
<code>dash_capstyle</code>		<code>{'butt', 'round', 'projecting'}</code>
<code>dash_joinstyle</code>		<code>{'miter', 'round', 'bevel'}</code>
<code>dashes</code>		sequence of floats (on/off ink in points) or (None, None)
<code>drawstyle</code> or <code>ds</code>		<code>{'default', 'steps', 'steps-pre', 'steps-mid', 'steps-post'}</code> , default: <code>'default'</code>
<code>figure</code>		<i>Figure</i>
<code>fillstyle</code>		<code>{'full', 'left', 'right', 'bottom', 'top', 'none'}</code>
<code>gid</code>		str
<code>in_layout</code>		bool
<code>label</code>		object

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	Property	Description
<i>linestyle</i> or <i>ls</i>	{'-' , '-' , '-.' , ':' , '' , (offset, on-off-seq), ...}	
<i>linewidth</i> or <i>lw</i>	float	
<i>marker</i>		marker style
<i>markeredgecolor</i> or <i>mec</i>		color
<i>markeredgewidth</i> or <i>mew</i>		float
<i>markerfacecolor</i> or <i>mfc</i>		color
<i>markerfacecoloralt</i> or <i>mfcalt</i>		color
<i>markersize</i> or <i>ms</i>		float
<i>markerevery</i>		None or int or (int, int) or slice or List[int] or float or (float, float)
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		float or callable[[Artist, Event], Tuple[bool, dict]]
<i>pickradius</i>		float
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>solid_capstyle</i>		{'butt', 'round', 'projecting'}
<i>solid_joinstyle</i>		{'miter', 'round', 'bevel'}
<i>transform</i>		<i>matplotlib.transforms.Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>xdata</i>		1D array
<i>ydata</i>		1D array
<i>zorder</i>		float

**See also:**

*psd()* *psd()* plots the power spectral density.'

*angle\_spectrum()* *angle\_spectrum()* plots the angles of the corresponding frequencies.

*phase\_spectrum()* *phase\_spectrum()* plots the phase (unwrapped angle) of the corresponding frequencies.

*specgram()* *specgram()* can plot the magnitude spectrum of segments within the signal in a colormap.

**Notes**

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

`matplotlib.axes.Axes.phase_spectrum`

`Axes.phase_spectrum(self, x, Fs=None, Fc=None, window=None, pad_to=None, sides=None, *, data=None, **kwargs)`

Plot the phase spectrum.

Compute the phase spectrum (unwrapped angle spectrum) of  $x$ . Data is padded to a length of `pad_to` and the windowing function `window` is applied to the signal.

**Parameters**

- x** [1-D array or sequence] Array or sequence containing the data
- Fs** [scalar] The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, `freqs`, in cycles per time unit. The default value is 2.
- window** [callable or ndarray] A function or a vector of length `NFFT`. To create window vectors see `window_hanning`, `window_none`, `numpy.blackman`, `numpy.hamming`, `numpy.bartlett`, `scipy.signal`, `scipy.signal.get_window`, etc. The default is `window_hanning`. If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.
- sides** [{'default', 'onesided', 'twosided'}] Specifies which sides of the spectrum to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. 'onesided' forces the return of a one-sided spectrum, while 'twosided' forces two-sided.
- pad\_to** [int] The number of points to which the data segment is padded when performing the FFT. While not increasing the actual resolution of the spectrum (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the  $n$  parameter in the call to `fft()`. The default is `None`, which sets `pad_to` equal to the length of the input signal (i.e. no padding).
- Fc** [int] The center frequency of  $x$  (defaults to 0), which offsets the  $x$  extents of the plot to reflect the frequency range used when a signal is acquired and then filtered and downsampled to baseband.

**Returns**

- spectrum** [1-D array] The values for the phase spectrum in radians (real valued).
- freqs** [1-D array] The frequencies corresponding to the elements in `spectrum`.
- line** [a `Line2D` instance] The line created by this function.

**Other Parameters**

**\*\*kwargs** Keyword arguments control the `Line2D` properties:

	Property	Description
<code>agg_filter</code>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m,
<code>alpha</code>		float
<code>animated</code>		bool
<code>antialiased</code> or <code>aa</code>		bool

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Property	Description
<i>clip_box</i>	<i>Bbox</i>
<i>clip_on</i>	bool
<i>clip_path</i>	[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>color</i> or <i>c</i>	color
<i>contains</i>	callable
<i>dash_capstyle</i>	{'butt', 'round', 'projecting'}
<i>dash_joinstyle</i>	{'miter', 'round', 'bevel'}
<i>dashes</i>	sequence of floats (on/off ink in points) or (None, None)
<i>drawstyle</i> or <i>ds</i>	{'default', 'steps', 'steps-pre', 'steps-mid', 'steps-post'}, default: 'default'
<i>figure</i>	<i>Figure</i>
<i>fillstyle</i>	{'full', 'left', 'right', 'bottom', 'top', 'none'}
<i>gid</i>	str
<i>in_layout</i>	bool
<i>label</i>	object
<i>linestyle</i> or <i>ls</i>	{'-', '--', '-.', ':', '', (offset, on-off-seq), ...}
<i>linewidth</i> or <i>lw</i>	float
<i>marker</i>	marker style
<i>markeredgecolor</i> or <i>mec</i>	color
<i>markeredgewidth</i> or <i>mew</i>	float
<i>markerfacecolor</i> or <i>mfc</i>	color
<i>markerfacecoloralt</i> or <i>mfcalt</i>	color
<i>markersize</i> or <i>ms</i>	float
<i>markevery</i>	None or int or (int, int) or slice or List[int] or float or (float, float)
<i>path_effects</i>	<i>AbstractPathEffect</i>
<i>picker</i>	float or callable[[ <i>Artist</i> , <i>Event</i> ], Tuple[bool, dict]]
<i>pickradius</i>	float
<i>rasterized</i>	bool or None
<i>sketch_params</i>	(scale: float, length: float, randomness: float)
<i>snap</i>	bool or None
<i>solid_capstyle</i>	{'butt', 'round', 'projecting'}
<i>solid_joinstyle</i>	{'miter', 'round', 'bevel'}
<i>transform</i>	<i>matplotlib.transforms.Transform</i>
<i>url</i>	str
<i>visible</i>	bool
<i>xdata</i>	1D array
<i>ydata</i>	1D array
<i>zorder</i>	float

**See also:**

*magnitude\_spectrum()* *magnitude\_spectrum()* plots the magnitudes of the corresponding frequencies.

*angle\_spectrum()* *angle\_spectrum()* plots the wrapped version of this function.

*specgram()* *specgram()* can plot the phase spectrum of segments within the signal in a colormap.

**Notes**

---

**Note:** In addition to the above described arguments, this function can take a **data** key-word argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

## matplotlib.axes.Axes.psd

```
Axes.psd(self, x, NFFT=None, Fs=None, Fc=None, detrend=None, window=None,
         noverlap=None, pad_to=None, sides=None, scale_by_freq=None,
         return_line=None, *, data=None, **kwargs)
```

Plot the power spectral density.

The power spectral density  $P_{xx}$  by Welch's average periodogram method. The vector  $x$  is divided into  $NFFT$  length segments. Each segment is detrended by function *detrend* and windowed by function *window*. *noverlap* gives the length of the overlap between segments. The  $|\text{fft}(i)|^2$  of each segment  $i$  are averaged to compute  $P_{xx}$ , with a scaling to correct for power loss due to windowing.

If  $\text{len}(x) < NFFT$ , it will be zero padded to  $NFFT$ .

### Parameters

**x** [1-D array or sequence] Array or sequence containing the data

**Fs** [scalar] The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, *freqs*, in cycles per time unit. The default value is 2.

**window** [callable or ndarray] A function or a vector of length  $NFFT$ . To create window vectors see `window_hanning`, `window_none`, `numpy.blackman`, `numpy.hamming`, `numpy.bartlett`, `scipy.signal`, `scipy.signal.get_window`, etc. The default is `window_hanning`. If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.

**sides** [{'default', 'onesided', 'twosided'}] Specifies which sides of the spectrum to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. 'onesided' forces the return of a one-sided spectrum, while 'twosided' forces two-sided.

**pad\_to** [int] The number of points to which the data segment is padded when performing the FFT. This can be different from  $NFFT$ , which specifies the number of data points used. While not increasing the actual resolution of the spectrum (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the  $n$  parameter in the call to `fft()`. The default is `None`, which sets *pad\_to* equal to  $NFFT$

**NFFT** [int] The number of data points used in each block for the FFT. A power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use *pad\_to* for this instead.

**detrend** [{'none', 'mean', 'linear'} or callable, default 'none'] The function applied to each segment before fft-ing, designed to remove the mean or linear trend. Unlike in MATLAB, where the *detrend* parameter is a vector, in Matplotlib is it a function. The *mlab* module defines *detrend\_none*, *detrend\_mean*, and *detrend\_linear*, but you can use a custom function as well. You can also use a string to choose one of the functions: 'none' calls *detrend\_none*. 'mean' calls *detrend\_mean*. 'linear' calls *detrend\_linear*.

**scale\_by\_freq** [bool, optional] Specifies whether the resulting density values should be scaled by the scaling frequency, which gives density in units of  $\text{Hz}^{-1}$ . This allows for integration over the returned frequency values. The default is True for MATLAB compatibility.

**noverlap** [int] The number of points of overlap between segments. The default value is 0 (no overlap).

**Fc** [int] The center frequency of *x* (defaults to 0), which offsets the *x* extents of the plot to reflect the frequency range used when a signal is acquired and then filtered and downsampled to baseband.

**return\_line** [bool] Whether to include the line object plotted in the returned values. Default is False.

**Returns**

**Pxx** [1-D array] The values for the power spectrum  $P_{\{xx\}}$  before scaling (real valued).

**freqs** [1-D array] The frequencies corresponding to the elements in *Pxx*.

**line** [a *Line2D* instance] The line created by this function. Only returned if *return\_line* is True.

**Other Parameters**

**\*\*kwargs** Keyword arguments control the *Line2D* properties:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m,
<i>alpha</i>		float
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i>		bool
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>color</i> or <i>c</i>		color
<i>contains</i>		callable
<i>dash_capstyle</i>		{'butt', 'round', 'projecting'}
<i>dash_joinstyle</i>		{'miter', 'round', 'bevel'}
<i>dashes</i>		sequence of floats (on/off ink in points) or (None, None)
<i>drawstyle</i> or <i>ds</i>		{'default', 'steps', 'steps-pre', 'steps-mid', 'steps-post'}, default: 'default'
<i>figure</i>		<i>Figure</i>
<i>fillstyle</i>		{'full', 'left', 'right', 'bottom', 'top', 'none'}
<i>gid</i>		str
<i>in_layout</i>		bool
<i>label</i>		object
<i>linestyle</i> or <i>ls</i>		{'-', '--', '-.', ':', '', (offset, on-off-seq), ...}

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Property	Description
<i>linewidth</i> or <i>lw</i>	float
<i>marker</i>	marker style
<i>markeredgewidth</i> or <i>mew</i>	float
<i>markerfacecolor</i> or <i>mfc</i>	color
<i>markerfacecoloralt</i> or <i>mfcalt</i>	color
<i>markersize</i> or <i>ms</i>	float
<i>markevery</i>	None or int or (int, int) or slice or List[int] or float or (float, float)
<i>path_effects</i>	<i>AbstractPathEffect</i>
<i>picker</i>	float or callable[[Artist, Event], Tuple[bool, dict]]
<i>pickradius</i>	float
<i>rasterized</i>	bool or None
<i>sketch_params</i>	(scale: float, length: float, randomness: float)
<i>snap</i>	bool or None
<i>solid_capstyle</i>	{'butt', 'round', 'projecting'}
<i>solid_joinstyle</i>	{'miter', 'round', 'bevel'}
<i>transform</i>	<i>matplotlib.transforms.Transform</i>
<i>url</i>	str
<i>visible</i>	bool
<i>xdata</i>	1D array
<i>ydata</i>	1D array
<i>zorder</i>	float

**See also:**

*specgram()* *specgram()* differs in the default overlap; in not returning the mean of the segment periodograms; in returning the times of the segments; and in plotting a colormap instead of a line.

*magnitude\_spectrum()* *magnitude\_spectrum()* plots the magnitude spectrum.

*csd()* *csd()* plots the spectral density between two signals.

**Notes**

For plotting, the power is plotted as  $10 \log_{10}(P_{xx})$  for decibels, though  $P_{xx}$  itself is returned.

**References**

Bendat & Piersol – Random Data: Analysis and Measurement Procedures, John Wiley & Sons (1986)

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

### matplotlib.axes.Axes.specgram

```
Axes.specgram(self, x, NFFT=None, Fs=None, Fc=None, detrend=None, window=None, noverlap=None, cmap=None, xextent=None, pad_to=None, sides=None, scale_by_freq=None, mode=None, scale=None, vmin=None, vmax=None, *, data=None, **kwargs)
```

Plot a spectrogram.

Compute and plot a spectrogram of data in `x`. Data are split into `NFFT` length segments and the spectrum of each section is computed. The windowing function `window` is applied to each segment, and the amount of overlap of each segment is specified with `noverlap`. The spectrogram is plotted as a colormap (using `imshow`).

#### Parameters

- x** [1-D array or sequence] Array or sequence containing the data.
- Fs** [scalar] The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, `freqs`, in cycles per time unit. The default value is 2.
- window** [callable or ndarray] A function or a vector of length `NFFT`. To create window vectors see `window_hanning`, `window_none`, `numpy.blackman`, `numpy.hamming`, `numpy.bartlett`, `scipy.signal`, `scipy.signal.get_window`, etc. The default is `window_hanning`. If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.
- sides** [{'default', 'onesided', 'twosided'}] Specifies which sides of the spectrum to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. 'onesided' forces the return of a one-sided spectrum, while 'twosided' forces two-sided.
- pad\_to** [int] The number of points to which the data segment is padded when performing the FFT. This can be different from `NFFT`, which specifies the number of data points used. While not increasing the actual resolution of the spectrum (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the `n` parameter in the call to `fft()`. The default is `None`, which sets `pad_to` equal to `NFFT`.
- NFFT** [int] The number of data points used in each block for the FFT. A power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use `pad_to` for this instead.
- detrend** [{'none', 'mean', 'linear'} or callable, default 'none'] The function applied to each segment before `fft`-ing, designed to remove the mean or linear trend. Unlike in MATLAB, where the `detrend` parameter is a vector, in Matplotlib it is a function. The `mlab` module defines `detrend_none`, `detrend_mean`, and `detrend_linear`, but you can use a custom function as well. You can also use a string to choose one of the functions: 'none' calls `detrend_none`. 'mean' calls `detrend_mean`. 'linear' calls `detrend_linear`.

**scale\_by\_freq** [bool, optional] Specifies whether the resulting density values should be scaled by the scaling frequency, which gives density in units of  $\text{Hz}^{-1}$ . This allows for integration over the returned frequency values. The default is True for MATLAB compatibility.

**mode** [{'default', 'psd', 'magnitude', 'angle', 'phase'}] What sort of spectrum to use. Default is 'psd', which takes the power spectral density. 'magnitude' returns the magnitude spectrum. 'angle' returns the phase spectrum without unwrapping. 'phase' returns the phase spectrum with unwrapping.

**noverlap** [int] The number of points of overlap between blocks. The default value is 128.

**scale** [{'default', 'linear', 'dB'}] The scaling of the values in the *spec*. 'linear' is no scaling. 'dB' returns the values in dB scale. When *mode* is 'psd', this is dB power ( $10 * \log_{10}$ ). Otherwise this is dB amplitude ( $20 * \log_{10}$ ). 'default' is 'dB' if *mode* is 'psd' or 'magnitude' and 'linear' otherwise. This must be 'linear' if *mode* is 'angle' or 'phase'.

**Fc** [int] The center frequency of *x* (defaults to 0), which offsets the *x* extents of the plot to reflect the frequency range used when a signal is acquired and then filtered and downsampled to baseband.

**cmap** A *matplotlib.colors.Colormap* instance; if *None*, use default determined by *rc*

**xextent** [*None* or (*xmin*, *xmax*)] The image extent along the *x*-axis. The default sets *xmin* to the left border of the first bin (*spectrum* column) and *xmax* to the right border of the last bin. Note that for *noverlap*>0 the width of the bins is smaller than those of the segments.

**\*\*kwargs** Additional kwargs are passed on to *imshow* which makes the spectrogram image.

## Returns

**spectrum** [2-D array] Columns are the periodograms of successive segments.

**freqs** [1-D array] The frequencies corresponding to the rows in *spectrum*.

**t** [1-D array] The times corresponding to midpoints of segments (i.e., the columns in *spectrum*).

**im** [instance of class *AxesImage*] The image created by *imshow* containing the spectrogram

## See also:

*psd()* *psd()* differs in the default overlap; in returning the mean of the segment periodograms; in not returning times; and in generating a line plot instead of colormap.

*magnitude\_spectrum()* A single spectrum, similar to having a single segment when *mode* is 'magnitude'. Plots a line instead of a colormap.

*angle\_spectrum()* A single spectrum, similar to having a single segment when *mode* is 'angle'. Plots a line instead of a colormap.

*phase\_spectrum()* A single spectrum, similar to having a single segment when *mode* is 'phase'. Plots a line instead of a colormap.

## Notes

The parameters *detrend* and *scale\_by\_freq* do only apply when *mode* is set to 'psd'.

---

**Note:** In addition to the above described arguments, this function can take a **data** key-word argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

## Examples using `matplotlib.axes.Axes.specgram`

- `sphx_glr_gallery_images_contours_and_fields_specgram_demo.py`

## `matplotlib.axes.Axes.xcorr`

```
Axes.xcorr(self, x, y, normed=True, detrend=<function detrend_none at 0x7f69881a1378>, usevlines=True, maxlags=10, *, data=None, **kwargs)
```

Plot the cross correlation between x and y.

The correlation with lag k is defined as  $\sum_n x[n+k] \cdot y^*[n]$ , where  $y^*$  is the complex conjugate of  $y$ .

### Parameters

**x** [array-like of length n]

**y** [array-like of length n]

**detrend** [callable, optional, default: `mlab.detrend_none`] x and y are detrended by the *detrend* callable. This must be a function `x = detrend(x)` accepting and returning a `numpy.array`. Default is no normalization.

**normed** [bool, optional, default: True] If True, input vectors are normalised to unit length.

**usevlines** [bool, optional, default: True] Determines the plot style.

If True, vertical lines are plotted from 0 to the xcorr value using `Axes.vlines`. Additionally, a horizontal line is plotted at `y=0` using `Axes.axhline`.

If False, markers are plotted at the xcorr values using `Axes.plot`.

**maxlags** [int, optional, default: 10] Number of lags to show. If None, will return all  $2 * \text{len}(x) - 1$  lags.

### Returns

**lags** [array (length  $2 * \text{maxlags} + 1$ )] The lag vector.

**c** [array (length  $2 * \text{maxlags} + 1$ )] The auto correlation vector.

**line** [`LineCollection` or `Line2D`] *Artist* added to the axes of the correlation:

- *LineCollection* if *usevlines* is True.
- *Line2D* if *usevlines* is False.

**b** [*Line2D* or None] Horizontal line at 0 if *usevlines* is True None *usevlines* is False.

### Other Parameters

**linestyle** [*Line2D* property, optional] The linestyle for plotting the data points. Only used if *usevlines* is False.

**marker** [str, optional, default: 'o'] The marker for plotting the data points. Only used if *usevlines* is False.

### Notes

The cross correlation is performed with `numpy.correlate()` with `mode = "full"`.

---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x', 'y'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

### Examples using `matplotlib.axes.Axes.xcorr`

- `sphx_glr_gallery_lines_bars_and_markers_xcorr_acorr_demo.py`

### Statistics

<code>Axes.boxplot</code>	Make a box and whisker plot.
<code>Axes.violinplot</code>	Make a violin plot.
<code>Axes.violin</code>	Drawing function for violin plots.
<code>Axes.bxp</code>	Drawing function for box and whisker plots.

### `matplotlib.axes.Axes.boxplot`

`Axes.boxplot(self, x, notch=None, sym=None, vert=None, whis=None, positions=None, widths=None, patch_artist=None, bootstrap=None, usermedians=None, conf_intervals=None, meanline=None, showmeans=None, showcaps=None, showbox=None, showfliers=None, boxprops=None, labels=None, flierprops=None, medianprops=None, meanprops=None, capprops=None, whiskerprops=None, manage_ticks=True, autorange=False, zorder=None, *, data=None)`

Make a box and whisker plot.

Make a box and whisker plot for each column of `x` or each vector in sequence `x`. The box extends from the lower to upper quartile values of the data, with a line at the median.

The whiskers extend from the box to show the range of the data. Flier points are those past the end of the whiskers.

### Parameters

**x** [Array or a sequence of vectors.] The input data.

**notch** [bool, optional (False)] If `True`, will produce a notched box plot. Otherwise, a rectangular boxplot is produced. The notches represent the confidence interval (CI) around the median. See the entry for the `bootstrap` parameter for information regarding how the locations of the notches are computed.

---

**Note:** In cases where the values of the CI are less than the lower quartile or greater than the upper quartile, the notches will extend beyond the box, giving it a distinctive “flipped” appearance. This is expected behavior and consistent with other statistical visualization packages.

---

**sym** [str, optional] The default symbol for flier points. Enter an empty string (“”) if you don’t want to show fliers. If `None`, then the fliers default to ‘b+’ if you want more control use the `flierprops` kwarg.

**vert** [bool, optional (True)] If `True` (default), makes the boxes vertical. If `False`, everything is drawn horizontally.

**whis** [float, sequence, or string (default = 1.5)] As a float, determines the reach of the whiskers to the beyond the first and third quartiles. In other words, where IQR is the interquartile range ( $Q3 - Q1$ ), the upper whisker will extend to last datum less than  $Q3 + whis * IQR$ . Similarly, the lower whisker will extend to the first datum greater than  $Q1 - whis * IQR$ . Beyond the whiskers, data are considered outliers and are plotted as individual points. Set this to an unreasonably high value to force the whiskers to show the min and max values. Alternatively, set this to an ascending sequence of percentile (e.g., [5, 95]) to set the whiskers at specific percentiles of the data. Finally, `whis` can be the string ‘range’ to force the whiskers to the min and max of the data.

**bootstrap** [int, optional] Specifies whether to bootstrap the confidence intervals around the median for notched boxplots. If `bootstrap` is `None`, no bootstrapping is performed, and notches are calculated using a Gaussian-based asymptotic approximation (see McGill, R., Tukey, J.W., and Larsen, W.A., 1978, and Kendall and Stuart, 1967). Otherwise, `bootstrap` specifies the number of times to bootstrap the median to determine its 95% confidence intervals. Values between 1000 and 10000 are recommended.

**usermedians** [array-like, optional] An array or sequence whose first dimension (or length) is compatible with `x`. This overrides the medians computed by matplotlib for each element of `usermedians` that is not `None`. When an element of `usermedians` is `None`, the median will be computed by matplotlib as normal.

**conf\_intervals** [array-like, optional] Array or sequence whose first dimension (or length) is compatible with `x` and whose second dimension is 2. When an element of `conf_intervals` is not `None`, the notch locations computed by matplotlib are overridden (provided `notch` is `True`). When

an element of `conf_intervals` is `None`, the notches are computed by the method specified by the other kwargs (e.g., `bootstrap`).

**positions** [array-like, optional] Sets the positions of the boxes. The ticks and limits are automatically set to match the positions. Defaults to `range(1, N+1)` where `N` is the number of boxes to be drawn.

**widths** [scalar or array-like] Sets the width of each box either with a scalar or a sequence. The default is `0.5`, or `0.15*(distance between extreme positions)`, if that is smaller.

**patch\_artist** [bool, optional (False)] If `False` produces boxes with the `Line2D` artist. Otherwise, boxes and drawn with `Patch` artists.

**labels** [sequence, optional] Labels for each dataset. Length must be compatible with dimensions of `x`.

**manage\_ticks** [bool, optional (True)] If `True`, the tick locations and labels will be adjusted to match the boxplot positions.

**autorange** [bool, optional (False)] When `True` and the data are distributed such that the 25th and 75th percentiles are equal, `whis` is set to `'range'` such that the whisker ends are at the minimum and maximum of the data.

**meanline** [bool, optional (False)] If `True` (and `showmeans` is `True`), will try to render the mean as a line spanning the full width of the box according to `meanprops` (see below). Not recommended if `shownotches` is also `True`. Otherwise, means will be shown as points.

**zorder** [scalar, optional (None)] Sets the zorder of the boxplot.

## Returns

**result** [dict] A dictionary mapping each component of the boxplot to a list of the `matplotlib.lines.Line2D` instances created. That dictionary has the following keys (assuming vertical boxplots):

- `boxes`: the main body of the boxplot showing the quartiles and the median's confidence intervals if enabled.
- `medians`: horizontal lines at the median of each box.
- `whiskers`: the vertical lines extending to the most extreme, non-outlier data points.
- `caps`: the horizontal lines at the ends of the whiskers.
- `fliers`: points representing data that extend beyond the whiskers (fliers).
- `means`: points or lines representing the means.

## Other Parameters

**showcaps** [bool, optional (True)] Show the caps on the ends of whiskers.

**showbox** [bool, optional (True)] Show the central box.

**showfliers** [bool, optional (True)] Show the outliers beyond the caps.

**showmeans** [bool, optional (False)] Show the arithmetic means.

**capprops** [dict, optional (None)] Specifies the style of the caps.

**boxprops** [dict, optional (None)] Specifies the style of the box.

**whiskerprops** [dict, optional (None)] Specifies the style of the whiskers.

**flierprops** [dict, optional (None)] Specifies the style of the fliers.

**medianprops** [dict, optional (None)] Specifies the style of the median.

**meanprops** [dict, optional (None)] Specifies the style of the mean.

## Notes

---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

## Examples using `matplotlib.axes.Axes.boxplot`

- `sphx_glr_gallery_pyplots_boxplot_demo_pyplot.py`

## `matplotlib.axes.Axes.violinplot`

```
Axes.violinplot(self, dataset, positions=None, vert=True, widths=0.5,
                showmeans=False, showextrema=True, showmedians=False,
                points=100, bw_method=None, *, data=None)
```

Make a violin plot.

Make a violin plot for each column of *dataset* or each vector in sequence *dataset*. Each filled area extends to represent the entire data range, with optional lines at the mean, the median, the minimum, and the maximum.

### Parameters

**dataset** [Array or a sequence of vectors.] The input data.

**positions** [array-like, default = [1, 2, ..., n]] Sets the positions of the violins. The ticks and limits are automatically set to match the positions.

**vert** [bool, default = True.] If true, creates a vertical violin plot. Otherwise, creates a horizontal violin plot.

**widths** [array-like, default = 0.5] Either a scalar or a vector that sets the maximal width of each violin. The default is 0.5, which uses about half of the available horizontal space.

**showmeans** [bool, default = False] If `True`, will toggle rendering of the means.

**showextrema** [bool, default = True] If `True`, will toggle rendering of the extrema.

**showmedians** [bool, default = False] If `True`, will toggle rendering of the medians.

**points** [scalar, default = 100] Defines the number of points to evaluate each of the gaussian kernel density estimations at.

**bw\_method** [str, scalar or callable, optional] The method used to calculate the estimator bandwidth. This can be 'scott', 'silverman', a scalar constant or a callable. If a scalar, this will be used directly as `kde.factor`. If a callable, it should take a `GaussianKDE` instance as its only parameter and return a scalar. If `None` (default), 'scott' is used.

### Returns

**result** [dict] A dictionary mapping each component of the violinplot to a list of the corresponding collection instances created. The dictionary has the following keys:

- **bodies**: A list of the `matplotlib.collections.PolyCollection` instances containing the filled area of each violin.
- **cmeans**: A `matplotlib.collections.LineCollection` instance created to identify the mean values of each of the violin's distribution.
- **cmims**: A `matplotlib.collections.LineCollection` instance created to identify the bottom of each violin's distribution.
- **cmaxes**: A `matplotlib.collections.LineCollection` instance created to identify the top of each violin's distribution.
- **cbars**: A `matplotlib.collections.LineCollection` instance created to identify the centers of each violin's distribution.
- **cmedians**: A `matplotlib.collections.LineCollection` instance created to identify the median values of each of the violin's distribution.

### Notes

---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'dataset'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

### matplotlib.axes.Axes.violin

`Axes.violin(self, vpstats, positions=None, vert=True, widths=0.5, showmeans=False, showextrema=True, showmedians=False)`  
Drawing function for violin plots.

Draw a violin plot for each column of `vpstats`. Each filled area extends to represent the entire data range, with optional lines at the mean, the median, the minimum, and the maximum.

### Parameters

**vpstats** [list of dicts] A list of dictionaries containing stats for each violin plot. Required keys are:

- **coords**: A list of scalars containing the coordinates that the violin's kernel density estimate were evaluated at.
- **vals**: A list of scalars containing the values of the kernel density estimate at each of the coordinates given in *coords*.
- **mean**: The mean value for this violin's dataset.
- **median**: The median value for this violin's dataset.
- **min**: The minimum value for this violin's dataset.
- **max**: The maximum value for this violin's dataset.

**positions** [array-like, default = [1, 2, ..., n]] Sets the positions of the violins. The ticks and limits are automatically set to match the positions.

**vert** [bool, default = True.] If true, plots the violins vertically. Otherwise, plots the violins horizontally.

**widths** [array-like, default = 0.5] Either a scalar or a vector that sets the maximal width of each violin. The default is 0.5, which uses about half of the available horizontal space.

**showmeans** [bool, default = False] If true, will toggle rendering of the means.

**showextrema** [bool, default = True] If true, will toggle rendering of the extrema.

**showmedians** [bool, default = False] If true, will toggle rendering of the medians.

## Returns

**result** [dict] A dictionary mapping each component of the violinplot to a list of the corresponding collection instances created. The dictionary has the following keys:

- **bodies**: A list of the *matplotlib.collections.PolyCollection* instances containing the filled area of each violin.
- **cmeans**: A *matplotlib.collections.LineCollection* instance created to identify the mean values of each of the violin's distribution.
- **cmims**: A *matplotlib.collections.LineCollection* instance created to identify the bottom of each violin's distribution.
- **cmaxes**: A *matplotlib.collections.LineCollection* instance created to identify the top of each violin's distribution.
- **cbars**: A *matplotlib.collections.LineCollection* instance created to identify the centers of each violin's distribution.
- **cmedians**: A *matplotlib.collections.LineCollection* instance created to identify the median values of each of the violin's distribution.

**matplotlib.axes.Axes.bxp**

```

Axes.bxp(self, bxpstats, positions=None, widths=None, vert=True, patch_artist=False,
          shownotches=False, showmeans=False, showcaps=True, showbox=True,
          showfliers=True, boxprops=None, whiskerprops=None, flierprops=None, medianprops=None,
          capprops=None, meanprops=None, meanline=False, manage_ticks=True, zorder=None)

```

Drawing function for box and whisker plots.

Make a box and whisker plot for each column of  $x$  or each vector in sequence  $x$ . The box extends from the lower to upper quartile values of the data, with a line at the median. The whiskers extend from the box to show the range of the data. Flier points are those past the end of the whiskers.

**Parameters**

**bxpstats** [list of dicts] A list of dictionaries containing stats for each box-plot. Required keys are:

- **med**: The median (scalar float).
- **q1**: The first quartile (25th percentile) (scalar float).
- **q3**: The third quartile (75th percentile) (scalar float).
- **whislo**: Lower bound of the lower whisker (scalar float).
- **whishi**: Upper bound of the upper whisker (scalar float).

Optional keys are:

- **mean**: The mean (scalar float). Needed if `showmeans=True`.
- **fliers**: Data beyond the whiskers (sequence of floats). Needed if `showfliers=True`.
- **ci10** & **cihi**: Lower and upper confidence intervals about the median. Needed if `shownotches=True`.
- **label**: Name of the dataset (string). If available, this will be used a tick label for the boxplot

**positions** [array-like, default = [1, 2, ..., n]] Sets the positions of the boxes. The ticks and limits are automatically set to match the positions.

**widths** [array-like, default = None] Either a scalar or a vector and sets the width of each box. The default is  $0.15 \times (\text{distance between extreme positions})$ , clipped to no less than 0.15 and no more than 0.5.

**vert** [bool, default = True] If `True` (default), makes the boxes vertical. If `False`, makes horizontal boxes.

**patch\_artist** [bool, default = False] If `False` produces boxes with the `Line2D` artist. If `True` produces boxes with the `Patch` artist.

**shownotches** [bool, default = False] If `False` (default), produces a rectangular box plot. If `True`, will produce a notched box plot

**showmeans** [bool, default = False] If `True`, will toggle on the rendering of the means

**showcaps** [bool, default = True] If `True`, will toggle on the rendering of the caps

- showbox** [bool, default = True] If `True`, will toggle on the rendering of the box
- showfliers** [bool, default = True] If `True`, will toggle on the rendering of the fliers
- boxprops** [dict or None (default)] If provided, will set the plotting style of the boxes
- whiskerprops** [dict or None (default)] If provided, will set the plotting style of the whiskers
- capprops** [dict or None (default)] If provided, will set the plotting style of the caps
- flierprops** [dict or None (default)] If provided will set the plotting style of the fliers
- medianprops** [dict or None (default)] If provided, will set the plotting style of the medians
- meanprops** [dict or None (default)] If provided, will set the plotting style of the means
- meanline** [bool, default = False] If `True` (and `showmeans` is `True`), will try to render the mean as a line spanning the full width of the box according to `meanprops`. Not recommended if `shownotches` is also `True`. Otherwise, means will be shown as points.
- manage\_ticks** [bool, default = True] If `True`, the tick locations and labels will be adjusted to match the boxplot positions.
- zorder** [scalar, default = None] The zorder of the resulting boxplot.

### Returns

- result** [dict] A dictionary mapping each component of the boxplot to a list of the `matplotlib.lines.Line2D` instances created. That dictionary has the following keys (assuming vertical boxplots):
- `boxes`: the main body of the boxplot showing the quartiles and the median's confidence intervals if enabled.
  - `medians`: horizontal lines at the median of each box.
  - `whiskers`: the vertical lines extending to the most extreme, non-outlier data points.
  - `caps`: the horizontal lines at the ends of the whiskers.
  - `fliers`: points representing data that extend beyond the whiskers (fliers).
  - `means`: points or lines representing the means.

### Examples

#### Binned

---

`Axes.hexbin`

Make a hexagonal binning plot.

---

Continued on next page

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<code>Axes.hist</code>	Plot a histogram.
<code>Axes.hist2d</code>	Make a 2D histogram plot.

**matplotlib.axes.Axes.hexbin**

```
Axes.hexbin(self, x, y, C=None, gridsize=100, bins=None, xscale='linear',
            yscale='linear', extent=None, cmap=None, norm=None, vmin=None,
            vmax=None, alpha=None, linewidths=None, edgecolors='face',
            reduce_C_function=<function mean at 0x7f6977bac268>, mincnt=None,
            marginals=False, *, data=None, **kwargs)
```

Make a hexagonal binning plot.

Make a hexagonal binning plot of  $x$  versus  $y$ , where  $x$ ,  $y$  are 1-D sequences of the same length,  $N$ . If  $C$  is *None* (the default), this is a histogram of the number of occurrences of the observations at  $(x[i], y[i])$ .

If  $C$  is specified, it specifies values at the coordinate  $(x[i], y[i])$ . These values are accumulated for each hexagonal bin and then reduced according to *reduce\_C\_function*, which defaults to `numpy.mean`. (If  $C$  is specified, it must also be a 1-D sequence of the same length as  $x$  and  $y$ .)

**Parameters**

**x, y** [array or masked array]

**C** [array or masked array, optional, default is *None*]

**gridsize** [int or (int, int), optional, default is 100] The number of hexagons in the  $x$ -direction, default is 100. The corresponding number of hexagons in the  $y$ -direction is chosen such that the hexagons are approximately regular. Alternatively, *gridsize* can be a tuple with two elements specifying the number of hexagons in the  $x$ -direction and the  $y$ -direction.

**bins** ['log' or int or sequence, optional, default is *None*] If *None*, no binning is applied; the color of each hexagon directly corresponds to its count value.

If 'log', use a logarithmic scale for the color map. Internally,  $\log_{10}(i + 1)$  is used to determine the hexagon color.

If an integer, divide the counts in the specified number of bins, and color the hexagons accordingly.

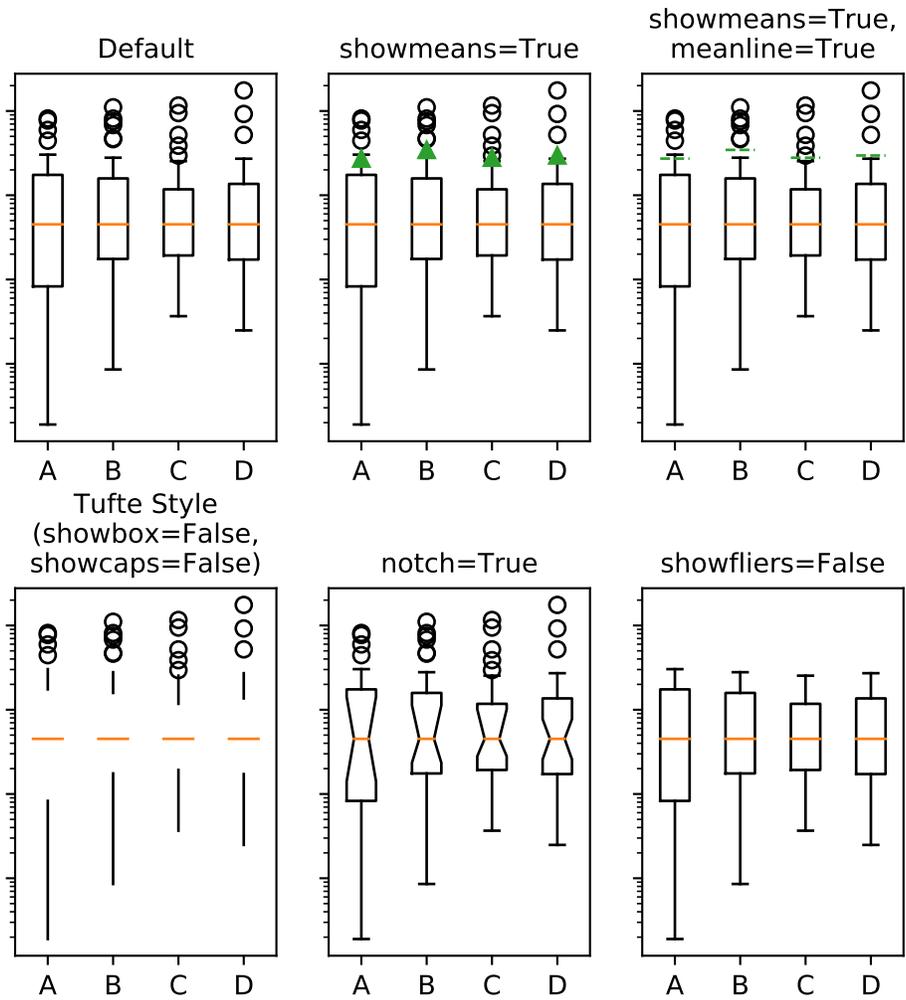
If a sequence of values, the values of the lower bound of the bins to be used.

**xscale** [{'linear', 'log'}], optional, default is 'linear'] Use a linear or log10 scale on the horizontal axis.

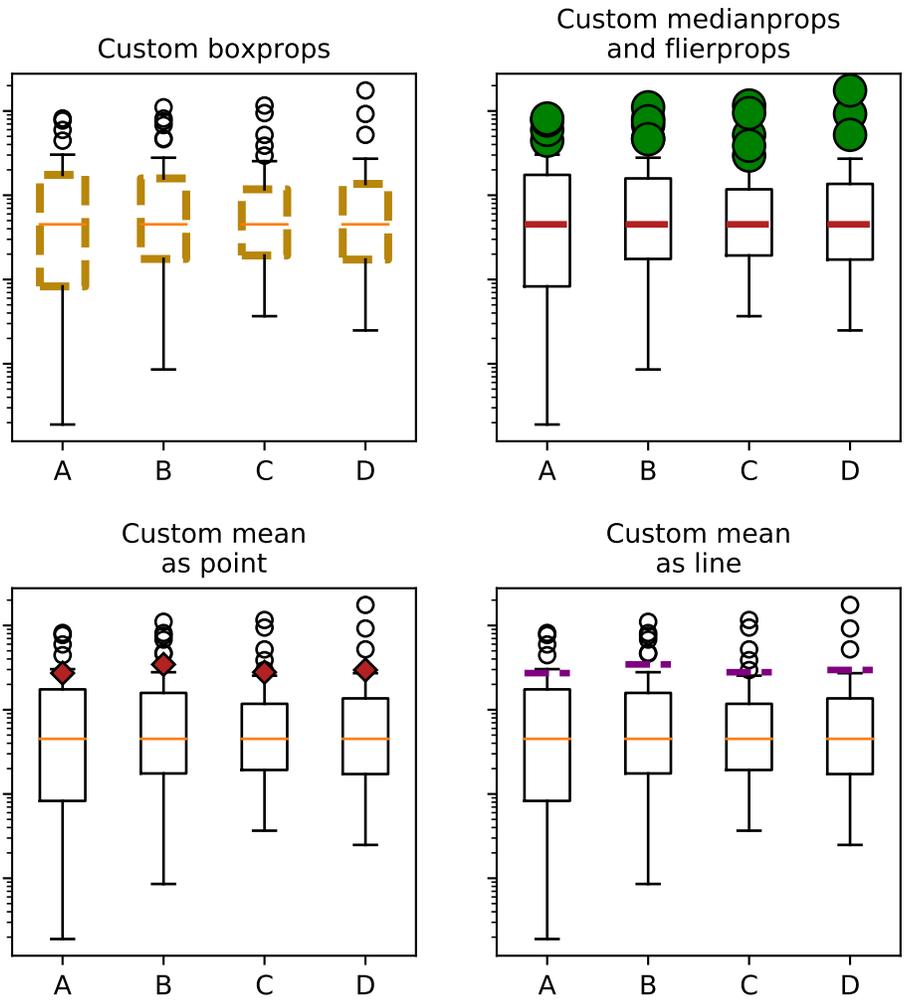
**yscale** [{'linear', 'log'}], optional, default is 'linear'] Use a linear or log10 scale on the vertical axis.

**mincnt** [int > 0, optional, default is *None*] If not *None*, only display cells with more than *mincnt* number of points in the cell

**marginals** [bool, optional, default is *False*] if *marginals* is *True*, plot the marginal density as colormapped rectangles along the bottom of the  $x$ -axis and left of the  $y$ -axis



I never said they'd be pretty



**extent** [scalar, optional, default is *None*] The limits of the bins. The default assigns the limits based on *gridsize*, *x*, *y*, *xscale* and *yscale*.

If *xscale* or *yscale* is set to 'log', the limits are expected to be the exponent for a power of 10. E.g. for x-limits of 1 and 50 in 'linear' scale and y-limits of 10 and 1000 in 'log' scale, enter (1, 50, 1, 3).

Order of scalars is (left, right, bottom, top).

### Returns

**polycollection** A *PolyCollection* instance; use *PolyCollection.get\_array* on this to get the counts in each hexagon.

If *marginals* is *True*, horizontal bar and vertical bar (both *PolyCollections*) will be attached to the return collection as attributes *hbar* and *vbar*.

### Other Parameters

**cmap** [object, optional, default is *None*] a *matplotlib.colors.Colormap* instance. If *None*, defaults to `rc image.cmap`.

**norm** [object, optional, default is *None*] *matplotlib.colors.Normalize* instance is used to scale luminance data to 0,1.

**vmin, vmax** [scalar, optional, default is *None*] *vmin* and *vmax* are used in conjunction with *norm* to normalize luminance data. If *None*, the min and max of the color array *C* are used. Note if you pass a *norm* instance your settings for *vmin* and *vmax* will be ignored.

**alpha** [scalar between 0 and 1, optional, default is *None*] the alpha value for the patches

**linewidths** [scalar, optional, default is *None*] If *None*, defaults to 1.0.

**edgecolors** [{'face', 'none', *None*} or color, optional] If 'face' (the default), draws the edges in the same color as the fill color.

If 'none', no edge is drawn; this can sometimes lead to unsightly unpainted pixels between the hexagons.

If *None*, draws outlines in the default color.

If a matplotlib color arg, draws outlines in the specified color.

### Notes

The standard descriptions of all the *Collection* parameters:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and
<i>alpha</i>		float or <i>None</i>
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i> or <i>antialiaseds</i>		bool or sequence of bools
<i>array</i>		ndarray
<i>capstyle</i>		{'butt', 'round', 'projecting'}
<i>clim</i>		a length 2 sequence of floats; may be overridden in methods that have
<i>clip_box</i>		<i>Bbox</i>

Continued on next page

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	Property	Description
<code>clip_on</code>		bool
<code>clip_path</code>		<code>[(Path, Transform)   Patch   None]</code>
<code>cmap</code>		colormap or registered colormap name
<code>color</code>		color or sequence of rgba tuples
<code>contains</code>		callable
<code>edgecolor</code> or <code>ec</code> or <code>edgecolors</code>		color or sequence of colors or 'face'
<code>facecolor</code> or <code>facecolors</code> or <code>fc</code>		color or sequence of colors
<code>figure</code>		<i>Figure</i>
<code>gid</code>		str
<code>hatch</code>		{'/', '\', ' ', '-', '+', 'x', 'o', 'O', '.', '*'}
<code>in_layout</code>		bool
<code>joinstyle</code>		{'miter', 'round', 'bevel'}
<code>label</code>		object
<code>linestyle</code> or <code>dashes</code> or <code>linestyles</code> or <code>ls</code>		{'-', '-', '-.', ':', "", (offset, on-off-seq), ...}
<code>linewidth</code> or <code>linewidths</code> or <code>lw</code>		float or sequence of floats
<code>norm</code>		<i>Normalize</i>
<code>offset_position</code>		{'screen', 'data'}
<code>offsets</code>		float or sequence of floats
<code>path_effects</code>		<i>AbstractPathEffect</i>
<code>picker</code>		None or bool or float or callable
<code>pickradius</code>		unknown
<code>rasterized</code>		bool or None
<code>sketch_params</code>		(scale: float, length: float, randomness: float)
<code>snap</code>		bool or None
<code>transform</code>		<i>Transform</i>
<code>url</code>		str
<code>urls</code>		List[str] or None
<code>visible</code>		bool
<code>zorder</code>		float

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x', 'y'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

### matplotlib.axes.Axes.hist

```

Axes.hist(self, x, bins=None, range=None, density=None, weights=None, cumulative=False, bottom=None, histtype='bar', align='mid', orientation='vertical', rwidth=None, log=False, color=None, label=None, stacked=False, normed=None, *, data=None, **kwargs)

```

Plot a histogram.

Compute and draw the histogram of  $x$ . The return value is a tuple ( $n$ ,  $bins$ ,  $patches$ ) or ( $[n_0, n_1, \dots]$ ,  $bins$ ,  $[patches_0, patches_1, \dots]$ ) if the input contains multiple data. See the documentation of the *weights* parameter to draw a histogram of already-binned data.

Multiple data can be provided via  $x$  as a list of datasets of potentially different length ( $[x_0, x_1, \dots]$ ), or as a 2-D ndarray in which each column is a dataset. Note that the ndarray form is transposed relative to the list form.

Masked arrays are not supported at present.

### Parameters

**x** [(n,) array or sequence of (n,) arrays] Input values, this takes either a single array or a sequence of arrays which are not required to be of the same length.

**bins** [int or sequence or str, optional] If an integer is given,  $bins + 1$  bin edges are calculated and returned, consistent with `numpy.histogram`.

If *bins* is a sequence, gives bin edges, including left edge of first bin and right edge of last bin. In this case, *bins* is returned unmodified.

All but the last (righthand-most) bin is half-open. In other words, if *bins* is:

```
[1, 2, 3, 4]
```

then the first bin is [1, 2) (including 1, but excluding 2) and the second [2, 3). The last bin, however, is [3, 4], which *includes* 4.

Unequally spaced bins are supported if *bins* is a sequence.

With Numpy 1.11 or newer, you can alternatively provide a string describing a binning strategy, such as 'auto', 'sturges', 'fd', 'doane', 'scott', 'rice' or 'sqrt', see `numpy.histogram`.

The default is taken from `rcParams["hist.bins"]`.

**range** [tuple or None, optional] The lower and upper range of the bins. Lower and upper outliers are ignored. If not provided, *range* is (`x.min()`, `x.max()`). Range has no effect if *bins* is a sequence.

If *bins* is a sequence or *range* is specified, autoscaling is based on the specified bin range instead of the range of  $x$ .

Default is None

**density** [bool, optional] If True, the first element of the return tuple will be the counts normalized to form a probability density, i.e., the area (or integral) under the histogram will sum to 1. This is achieved by dividing the count by the number of observations times the bin width and not dividing by the total number of observations. If *stacked* is also True, the sum of the histograms is normalized to 1.

Default is None for both *normed* and *density*. If either is set, then that value will be used. If neither are set, then the args will be treated as False.

If both *density* and *normed* are set an error is raised.

**weights** [(n, ) array like or None, optional] An array of weights, of the same shape as  $x$ . Each value in  $x$  only contributes its associated weight towards the bin count (instead of 1). If *normed* or *density* is True, the

weights are normalized, so that the integral of the density over the range remains 1.

Default is `None`.

This parameter can be used to draw a histogram of data that has already been binned, e.g. using `np.histogram` (by treating each bin as a single point with a weight equal to its count)

```
counts, bins = np.histogram(data)
plt.hist(bins[:-1], bins, weights=counts)
```

(or you may alternatively use `bar()`).

**cumulative** [`bool`, optional] If `True`, then a histogram is computed where each bin gives the counts in that bin plus all bins for smaller values. The last bin gives the total number of datapoints. If `normed` or `density` is also `True` then the histogram is normalized such that the last bin equals 1. If `cumulative` evaluates to less than 0 (e.g., -1), the direction of accumulation is reversed. In this case, if `normed` and/or `density` is also `True`, then the histogram is normalized such that the first bin equals 1.

Default is `False`

**bottom** [`array_like`, `scalar`, or `None`] Location of the bottom baseline of each bin. If a `scalar`, the base line for each bin is shifted by the same amount. If an `array`, each bin is shifted independently and the length of `bottom` must match the number of bins. If `None`, defaults to 0.

Default is `None`

**histtype** [`{'bar', 'barstacked', 'step', 'stepfilled'}`, optional] The type of histogram to draw.

- `'bar'` is a traditional bar-type histogram. If multiple data are given the bars are arranged side by side.
- `'barstacked'` is a bar-type histogram where multiple data are stacked on top of each other.
- `'step'` generates a lineplot that is by default unfilled.
- `'stepfilled'` generates a lineplot that is by default filled.

Default is `'bar'`

**align** [`{'left', 'mid', 'right'}`, optional] Controls how the histogram is plotted.

- `'left'`: bars are centered on the left bin edges.
- `'mid'`: bars are centered between the bin edges.
- `'right'`: bars are centered on the right bin edges.

Default is `'mid'`

**orientation** [`{'horizontal', 'vertical'}`, optional] If `'horizontal'`, `barh` will be used for bar-type histograms and the `bottom` kwarg will be the left edges.

**rwidth** [`scalar` or `None`, optional] The relative width of the bars as a fraction of the bin width. If `None`, automatically compute the width.

Ignored if `histtype` is `'step'` or `'stepfilled'`.

Default is `None`

**log** [bool, optional] If `True`, the histogram axis will be set to a log scale. If `log` is `True` and `x` is a 1D array, empty bins will be filtered out and only the non-empty (`n`, `bins`, `patches`) will be returned.

Default is `False`

**color** [color or array\_like of colors or `None`, optional] Color spec or sequence of color specs, one per dataset. Default (`None`) uses the standard line color sequence.

Default is `None`

**label** [str or `None`, optional] String, or sequence of strings to match multiple datasets. Bar charts yield multiple patches per dataset, but only the first gets the label, so that the legend command will work as expected.

default is `None`

**stacked** [bool, optional] If `True`, multiple data are stacked on top of each other. If `False` multiple data are arranged side by side if `histtype` is `'bar'` or on top of each other if `histtype` is `'step'`

Default is `False`

**normed** [bool, optional] Deprecated; use the `density` keyword argument instead.

### Returns

**n** [array or list of arrays] The values of the histogram bins. See *density* and *weights* for a description of the possible semantics. If input `x` is an array, then this is an array of length `nbins`. If input is a sequence of arrays [`data1`, `data2`, ...], then this is a list of arrays with the values of the histograms for each of the arrays in the same order. The dtype of the array `n` (or of its element arrays) will always be float even if no weighting or normalization is used.

**bins** [array] The edges of the bins. Length `nbins + 1` (`nbins` left edges and right edge of last bin). Always a single array even when multiple data sets are passed in.

**patches** [list or list of lists] Silent list of individual patches used to create the histogram or list of such list if multiple input datasets.

### Other Parameters

**\*\*kwargs** [*Patch* properties]

### See also:

*hist2d* 2D histograms

### Notes

---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'weights', 'x'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

#### Examples using `matplotlib.axes.Axes.hist`

- `sphx_glr_gallery_statistics_histogram_features.py`
- `sphx_glr_gallery_pyplots_fig_axes_labels_simple.py`
- `sphx_glr_gallery_misc_histogram_path.py`

#### `matplotlib.axes.Axes.hist2d`

```
Axes.hist2d(self, x, y, bins=10, range=None, density=False, weights=None,
             cmin=None, cmax=None, *, data=None, **kwargs)
```

Make a 2D histogram plot.

##### Parameters

**x, y** [array\_like, shape (n, )] Input values

**bins** [None or int or [int, int] or array\_like or [array, array]] The bin specification:

- If int, the number of bins for the two dimensions (`nx=ny=bins`).
- If [int, int], the number of bins in each dimension (`nx, ny = bins`).
- If array\_like, the bin edges for the two dimensions (`x_edges=y_edges=bins`).
- If [array, array], the bin edges in each dimension (`x_edges, y_edges = bins`).

The default value is 10.

**range** [array\_like shape(2, 2), optional, default: None] The leftmost and rightmost edges of the bins along each dimension (if not specified explicitly in the bins parameters): `[[xmin, xmax], [ymin, ymax]]`. All values outside of this range will be considered outliers and not tallied in the histogram.

**density** [bool, optional, default: False] Normalize histogram. *normed* is a deprecated synonym for this parameter.

**weights** [array\_like, shape (n, ), optional, default: None] An array of values `wi` weighing each sample (`xi, yi`).

**cmin** [scalar, optional, default: None] All bins that has count less than `cmin` will not be displayed and these count values in the return value count histogram will also be set to nan upon return

**cmax** [scalar, optional, default: None] All bins that has count more than `cmax` will not be displayed (set to none before passing to `imshow`) and these count values in the return value count histogram will also be set to nan upon return

**Returns**

**h** [2D array] The bi-dimensional histogram of samples *x* and *y*. Values in *x* are histogrammed along the first dimension and values in *y* are histogrammed along the second dimension.

**xedges** [1D array] The bin edges along the *x* axis.

**yedges** [1D array] The bin edges along the *y* axis.

**image** [*QuadMesh*]

**Other Parameters**

**cmap** [Colormap or str, optional] A *colors.Colormap* instance. If not set, use rc settings.

**norm** [Normalize, optional] A *colors.Normalize* instance is used to scale luminance data to [0, 1]. If not set, defaults to *colors.Normalize()*.

**vmin/vmax** [None or scalar, optional] Arguments passed to the *Normalize* instance.

**alpha** [0 <= scalar <= 1 or None, optional] The alpha blending value.

**See also:**

*hist* 1D histogram plotting

**Notes**

- Currently *hist2d* calculates its own axis limits, and any limits previously set are ignored.
- Rendering the histogram with a logarithmic color scale is accomplished by passing a *colors.LogNorm* instance to the *norm* keyword argument. Likewise, power-law normalization (similar in effect to gamma correction) can be accomplished with *colors.PowerNorm*.

---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'weights', 'x', 'y'.

Objects passed as **data** must support item access (*data[<arg>]*) and membership test (*<arg>* in *data*).

---

**Examples using `matplotlib.axes.Axes.hist2d`**

- `sphx_glr_gallery_scales_power_norm.py`

**Contours**

<code>Axes.clabel</code>	Label a contour plot.
<code>Axes.contour</code>	Plot contours.
<code>Axes.contourf</code>	Plot contours.

**matplotlib.axes.Axes.clabel**

`Axes.clabel(self, CS, *args, **kwargs)`  
 Label a contour plot.

Call signature:

```
clabel(cs, [levels,] **kwargs)
```

Adds labels to line contours in *cs*, where *cs* is a *ContourSet* object returned by `contour()`.

**Parameters**

**cs** [*ContourSet*] The *ContourSet* to label.

**levels** [array-like, optional] A list of level values, that should be labeled. The list must be a subset of `cs.levels`. If not given, all levels are labeled.

**fontsize** [string or float, optional] Size in points or relative size e.g., 'smaller', 'x-large'. See `Text.set_size` for accepted string values.

**colors** [color-spec, optional] The label colors:

- If *None*, the color of each label matches the color of the corresponding contour.
- If one string color, e.g., `colors = 'r'` or `colors = 'red'`, all labels will be plotted in this color.
- If a tuple of matplotlib color args (string, float, rgb, etc), different labels will be plotted in different colors in the order specified.

**inline** [bool, optional] If `True` the underlying contour is removed where the label is placed. Default is `True`.

**inline\_spacing** [float, optional] Space in pixels to leave on each side of label when placing inline. Defaults to 5.

This spacing will be exact for labels at locations where the contour is straight, less so for labels on curved contours.

**fmt** [string or dict, optional] A format string for the label. Default is `'%1.3f'`

Alternatively, this can be a dictionary matching contour levels with arbitrary strings to use for each contour level (i.e., `fmt[level]=string`), or it can be any callable, such as a *Formatter* instance, that returns a string when called with a numeric contour level.

**manual** [bool or iterable, optional] If `True`, contour labels will be placed manually using mouse clicks. Click the first button near a contour to add a label, click the second button (or potentially both mouse buttons at once) to finish adding labels. The third button can be used to remove the last label added, but only if labels are not inline. Alternatively, the keyboard can be used to select label locations (enter to end label placement, delete or backspace act like the third mouse button, and any other key will select a label location).

*manual* can also be an iterable object of x,y tuples. Contour labels will be created as if mouse is clicked at each x,y positions.

**rightside\_up** [bool, optional] If `True`, label rotations will always be plus or minus 90 degrees from level. Default is `True`.

**use\_clabeltext** [bool, optional] If `True`, `ClabelText` class (instead of `Text`) is used to create labels. `ClabelText` recalculates rotation angles of texts during the drawing time, therefore this can be used if aspect of the axes changes. Default is `False`.

### Returns

**labels** A list of `Text` instances for the labels.

### Examples using `matplotlib.axes.Axes.clabel`

- `sphx_glr_gallery_images_contours_and_fields_contour_demo.py`
- `sphx_glr_gallery_images_contours_and_fields_contour_label_demo.py`
- `sphx_glr_gallery_images_contours_and_fields_contourf_demo.py`

### `matplotlib.axes.Axes.contour`

`Axes.contour(self, *args, data=None, **kwargs)`

Plot contours.

Call signature:

```
contour([X, Y,] Z, [levels], **kwargs)
```

`contour` and `contourf` draw contour lines and filled contours, respectively. Except as noted, function signatures and return values are the same for both versions.

### Parameters

**X, Y** [array-like, optional] The coordinates of the values in *Z*.

*X* and *Y* must both be 2-D with the same shape as *Z* (e.g. created via `numpy.meshgrid`), or they must both be 1-D such that `len(X) == M` is the number of columns in *Z* and `len(Y) == N` is the number of rows in *Z*.

If not given, they are assumed to be integer indices, i.e. `X = range(M)`, `Y = range(N)`.

**Z** [array-like(N, M)] The height values over which the contour is drawn.

**levels** [int or array-like, optional] Determines the number and positions of the contour lines / regions.

If an int *n*, use *n* data intervals; i.e. draw *n+1* contour lines. The level heights are automatically chosen.

If array-like, draw contour lines at the specified levels. The values must be in increasing order.

### Returns

**c** [`QuadContourSet`]

## Other Parameters

**corner\_mask** [bool, optional] Enable/disable corner masking, which only has an effect if *Z* is a masked array. If `False`, any quad touching a masked point is masked out. If `True`, only the triangular corners of quads nearest those points are always masked out, other triangular corners comprising three unmasked points are contoured as usual.

Defaults to `rcParams["contour.corner_mask"]`, which defaults to `True`.

**colors** [color string or sequence of colors, optional] The colors of the levels, i.e. the lines for *contour* and the areas for *contourf*.

The sequence is cycled for the levels in ascending order. If the sequence is shorter than the number of levels, it's repeated.

As a shortcut, single color strings may be used in place of one-element lists, i.e. 'red' instead of ['red'] to color all levels with the same color. This shortcut does only work for color strings, not for other ways of specifying colors.

By default (value *None*), the colormap specified by *cmap* will be used.

**alpha** [float, optional] The alpha blending value, between 0 (transparent) and 1 (opaque).

**cmap** [str or *Colormap*, optional] A *Colormap* instance or registered colormap name. The colormap maps the level values to colors. Defaults to `rcParams["image.cmap"]`.

If given, *colors* take precedence over *cmap*.

**norm** [*Normalize*, optional] If a colormap is used, the *Normalize* instance scales the level values to the canonical colormap range [0, 1] for mapping to colors. If not given, the default linear scaling is used.

**vmin, vmax** [float, optional] If not *None*, either or both of these values will be supplied to the *Normalize* instance, overriding the default color scaling based on *levels*.

**origin** [{*None*, 'upper', 'lower', 'image'}, optional] Determines the orientation and exact position of *Z* by specifying the position of *Z*[0, 0]. This is only relevant, if *X*, *Y* are not given.

- *None*: *Z*[0, 0] is at *X*=0, *Y*=0 in the lower left corner.
- 'lower': *Z*[0, 0] is at *X*=0.5, *Y*=0.5 in the lower left corner.
- 'upper': *Z*[0, 0] is at *X*=*N*+0.5, *Y*=0.5 in the upper left corner.
- 'image': Use the value from `rcParams["image.origin"]`.

**extent** [(*x0*, *x1*, *y0*, *y1*), optional] If *origin* is not *None*, then *extent* is interpreted as in *imshow*: it gives the outer pixel boundaries. In this case, the position of *Z*[0,0] is the center of the pixel, not a corner. If *origin* is *None*, then (*x0*, *y0*) is the position of *Z*[0,0], and (*x1*, *y1*) is the position of *Z*[-1,-1].

This argument is ignored if *X* and *Y* are specified in the call to *contour*.

**locator** [ticker.Locator subclass, optional] The locator is used to determine the contour levels if they are not given explicitly via *levels*. Defaults to *MaxNLocator*.

**extend** [{'neither', 'both', 'min', 'max'}], optional, default: 'neither'] Determines the `contourf`-coloring of values that are outside the *levels* range.

If 'neither', values outside the *levels* range are not colored. If 'min', 'max' or 'both', color the values below, above or below and above the *levels* range.

Values below `min(levels)` and above `max(levels)` are mapped to the under/over values of the *Colormap*. Note, that most colormaps do not have dedicated colors for these by default, so that the over and under values are the edge values of the colormap. You may want to set these values explicitly using *Colormap.set\_under* and *Colormap.set\_over*.

---

**Note:** An existing *QuadContourSet* does not get notified if properties of its colormap are changed. Therefore, an explicit call `QuadContourSet.changed()` is needed after modifying the colormap. The explicit call can be left out, if a colorbar is assigned to the *QuadContourSet* because it internally calls `QuadContourSet.changed()`.

---

Example:

```
x = np.arange(1, 10)
y = x.reshape(-1, 1)
h = x * y

cs = plt.contourf(h, levels=[10, 30, 50],
                 colors=['#808080', '#A0A0A0', '#C0C0C0'], extend='both')
cs.cmap.set_over('red')
cs.cmap.set_under('blue')
cs.changed()
```

**xunits, yunits** [registered units, optional] Override axis units by specifying an instance of a *matplotlib.units.ConversionInterface*.

**antialiased** [bool, optional] Enable antialiasing, overriding the defaults. For filled contours, the default is *True*. For line contours, it is taken from `rcParams["lines.antialiased"]`.

**Nchunk** [int >= 0, optional] If 0, no subdivision of the domain. Specify a positive integer to divide the domain into subdomains of *nchunk* by *nchunk* quads. Chunking reduces the maximum length of polygons generated by the contouring algorithm which reduces the rendering workload passed on to the backend and also requires slightly less RAM. It can however introduce rendering artifacts at chunk boundaries depending on the backend, the *antialiased* flag and value of *alpha*.

**linewidths** [float or sequence of float, optional] *Only applies to contour.*

The line width of the contour lines.

If a number, all levels will be plotted with this linewidth.

If a sequence, the levels in ascending order will be plotted with the linewidths in the order specified.

Defaults to `rcParams["lines.linewidth"]`.

**linestyles** [*None*, 'solid', 'dashed', 'dashdot', 'dotted'], optional] *Only applies to contour.*

If *linestyles* is *None*, the default is 'solid' unless the lines are monochrome. In that case, negative contours will take their linestyle from `rcParams["contour.negative_linestyle"]` setting.

*linestyles* can also be an iterable of the above strings specifying a set of linestyles to be used. If this iterable is shorter than the number of contour levels it will be repeated as necessary.

**hatches** [List[str], optional] *Only applies to contourf.*

A list of cross hatch patterns to use on the filled areas. If *None*, no hatching will be added to the contour. Hatching is supported in the PostScript, PDF, SVG and Agg backends only.

### Notes

1. *contourf* differs from the MATLAB version in that it does not draw the polygon edges. To draw edges, add line contours with calls to *contour*.
2. *contourf* fills intervals that are closed at the top; that is, for boundaries *z1* and *z2*, the filled region is:

```
z1 < Z <= z2
```

except for the lowest interval, which is closed on both sides (i.e. it includes the lowest value).

### Examples using `matplotlib.axes.Axes.contour`

- `sphx_glr_gallery_images_contours_and_fields_contour_corner_mask.py`
- `sphx_glr_gallery_images_contours_and_fields_contour_demo.py`
- `sphx_glr_gallery_images_contours_and_fields_contour_image.py`
- `sphx_glr_gallery_images_contours_and_fields_contour_label_demo.py`
- `sphx_glr_gallery_images_contours_and_fields_contourf_demo.py`
- `sphx_glr_gallery_images_contours_and_fields_contourf_hatching.py`
- `sphx_glr_gallery_images_contours_and_fields_image_transparency_blend.py`
- `sphx_glr_gallery_images_contours_and_fields_irregulardatagrid.py`

### `matplotlib.axes.Axes.contourf`

`Axes.contourf(self, *args, data=None, **kwargs)`  
Plot contours.

Call signature:

```
contour([X, Y,] Z, [levels], **kwargs)
```

`contour` and `contourf` draw contour lines and filled contours, respectively. Except as noted, function signatures and return values are the same for both versions.

### Parameters

**X, Y** [array-like, optional] The coordinates of the values in *Z*.

*X* and *Y* must both be 2-D with the same shape as *Z* (e.g. created via `numpy.meshgrid`), or they must both be 1-D such that `len(X) == M` is the number of columns in *Z* and `len(Y) == N` is the number of rows in *Z*.

If not given, they are assumed to be integer indices, i.e. `X = range(M)`, `Y = range(N)`.

**Z** [array-like(N, M)] The height values over which the contour is drawn.

**levels** [int or array-like, optional] Determines the number and positions of the contour lines / regions.

If an int *n*, use *n* data intervals; i.e. draw *n+1* contour lines. The level heights are automatically chosen.

If array-like, draw contour lines at the specified levels. The values must be in increasing order.

### Returns

**c** [`QuadContourSet`]

### Other Parameters

**corner\_mask** [bool, optional] Enable/disable corner masking, which only has an effect if *Z* is a masked array. If `False`, any quad touching a masked point is masked out. If `True`, only the triangular corners of quads nearest those points are always masked out, other triangular corners comprising three unmasked points are contoured as usual.

Defaults to `rcParams["contour.corner_mask"]`, which defaults to `True`.

**colors** [color string or sequence of colors, optional] The colors of the levels, i.e. the lines for `contour` and the areas for `contourf`.

The sequence is cycled for the levels in ascending order. If the sequence is shorter than the number of levels, it's repeated.

As a shortcut, single color strings may be used in place of one-element lists, i.e. `'red'` instead of `['red']` to color all levels with the same color. This shortcut does only work for color strings, not for other ways of specifying colors.

By default (value `None`), the colormap specified by `cmap` will be used.

**alpha** [float, optional] The alpha blending value, between 0 (transparent) and 1 (opaque).

**cmap** [str or `Colormap`, optional] A `Colormap` instance or registered colormap name. The colormap maps the level values to colors. Defaults to `rcParams["image.cmap"]`.

If given, `colors` take precedence over `cmap`.

**norm** [`Normalize`, optional] If a colormap is used, the `Normalize` instance scales the level values to the canonical colormap range `[0, 1]` for mapping to colors. If not given, the default linear scaling is used.

**vmin, vmax** [float, optional] If not *None*, either or both of these values will be supplied to the *Normalize* instance, overriding the default color scaling based on *levels*.

**origin** [{*None*, 'upper', 'lower', 'image'}, optional] Determines the orientation and exact position of *Z* by specifying the position of *Z*[0, 0]. This is only relevant, if *X*, *Y* are not given.

- *None*: *Z*[0, 0] is at *X*=0, *Y*=0 in the lower left corner.
- 'lower': *Z*[0, 0] is at *X*=0.5, *Y*=0.5 in the lower left corner.
- 'upper': *Z*[0, 0] is at *X*=*N*+0.5, *Y*=0.5 in the upper left corner.
- 'image': Use the value from `rcParams["image.origin"]`.

**extent** [(*x0*, *x1*, *y0*, *y1*), optional] If *origin* is not *None*, then *extent* is interpreted as in *imshow*: it gives the outer pixel boundaries. In this case, the position of *Z*[0,0] is the center of the pixel, not a corner. If *origin* is *None*, then (*x0*, *y0*) is the position of *Z*[0,0], and (*x1*, *y1*) is the position of *Z*[-1,-1].

This argument is ignored if *X* and *Y* are specified in the call to `contour`.

**locator** [ticker.Locator subclass, optional] The locator is used to determine the contour levels if they are not given explicitly via *levels*. Defaults to *MaxNLocator*.

**extend** [{'neither', 'both', 'min', 'max'}, optional, default: 'neither'] Determines the `contourf`-coloring of values that are outside the *levels* range.

If 'neither', values outside the *levels* range are not colored. If 'min', 'max' or 'both', color the values below, above or below and above the *levels* range.

Values below `min(levels)` and above `max(levels)` are mapped to the under/over values of the *Colormap*. Note, that most colormaps do not have dedicated colors for these by default, so that the over and under values are the edge values of the colormap. You may want to set these values explicitly using `Colormap.set_under` and `Colormap.set_over`.

---

**Note:** An existing *QuadContourSet* does not get notified if properties of its colormap are changed. Therefore, an explicit call `QuadContourSet.changed()` is needed after modifying the colormap. The explicit call can be left out, if a colorbar is assigned to the *QuadContourSet* because it internally calls `QuadContourSet.changed()`.

---

Example:

```
x = np.arange(1, 10)
y = x.reshape(-1, 1)
h = x * y

cs = plt.contourf(h, levels=[10, 30, 50],
                  colors=['#808080', '#A0A0A0', '#C0C0C0'], extend='both')
cs.cmap.set_over('red')
cs.cmap.set_under('blue')
cs.changed()
```

**xunits, yunits** [registered units, optional] Override axis units by specifying an instance of a `matplotlib.units.ConversionInterface`.

**antialiased** [bool, optional] Enable antialiasing, overriding the defaults. For filled contours, the default is `True`. For line contours, it is taken from `rcParams["lines.antialiased"]`.

**Nchunk** [int  $\geq 0$ , optional] If 0, no subdivision of the domain. Specify a positive integer to divide the domain into subdomains of `nchunk` by `nchunk` quads. Chunking reduces the maximum length of polygons generated by the contouring algorithm which reduces the rendering workload passed on to the backend and also requires slightly less RAM. It can however introduce rendering artifacts at chunk boundaries depending on the backend, the `antialiased` flag and value of `alpha`.

**linewidths** [float or sequence of float, optional] *Only applies to `contour`.*

The line width of the contour lines.

If a number, all levels will be plotted with this linewidth.

If a sequence, the levels in ascending order will be plotted with the linewidths in the order specified.

Defaults to `rcParams["lines.linewidth"]`.

**linestyles** [`{None, 'solid', 'dashed', 'dashdot', 'dotted'}`, optional] *Only applies to `contour`.*

If `linestyles` is `None`, the default is `'solid'` unless the lines are monochrome. In that case, negative contours will take their linestyle from `rcParams["contour.negative_linestyle"]` setting.

`linestyles` can also be an iterable of the above strings specifying a set of linestyles to be used. If this iterable is shorter than the number of contour levels it will be repeated as necessary.

**hatches** [List[str], optional] *Only applies to `contourf`.*

A list of cross hatch patterns to use on the filled areas. If `None`, no hatching will be added to the contour. Hatching is supported in the PostScript, PDF, SVG and Agg backends only.

## Notes

1. `contourf` differs from the MATLAB version in that it does not draw the polygon edges. To draw edges, add line contours with calls to `contour`.
2. `contourf` fills intervals that are closed at the top; that is, for boundaries `z1` and `z2`, the filled region is:

$$z1 < Z \leq z2$$

except for the lowest interval, which is closed on both sides (i.e. it includes the lowest value).

## Examples using `matplotlib.axes.Axes.contourf`

- `sphx_glr_gallery_images_contours_and_fields_contour_corner_mask.py`

- sphx\_glr\_gallery\_images\_contours\_and\_fields\_contourf\_demo.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_contourf\_hatching.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_contourf\_log.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_irregulardatagrid.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_pcolormesh\_levels.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_triinterp\_demo.py

## Array

<code>Axes.imshow</code>	Display an image, i.e.
<code>Axes.matshow</code>	Plot the values of a 2D matrix or array as color-coded image.
<code>Axes.pcolor</code>	Create a pseudocolor plot with a non-regular rectangular grid.
<code>Axes.pcolorfast</code>	Create a pseudocolor plot with a non-regular rectangular grid.
<code>Axes.pcolormesh</code>	Create a pseudocolor plot with a non-regular rectangular grid.
<code>Axes.spy</code>	Plot the sparsity pattern of a 2D array.

## matplotlib.axes.Axes.imshow

`Axes.imshow(self, X, cmap=None, norm=None, aspect=None, interpolation=None, alpha=None, vmin=None, vmax=None, origin=None, extent=None, shape=<deprecated parameter>, filternorm=1, filterrad=4.0, imlim=<deprecated parameter>, resample=None, url=None, *, data=None, **kwargs)`

Display an image, i.e. data on a 2D regular raster.

### Parameters

**X** [array-like or PIL image] The image data. Supported array shapes are:

- (M, N): an image with scalar data. The data is visualized using a colormap.
- (M, N, 3): an image with RGB values (0-1 float or 0-255 int).
- (M, N, 4): an image with RGBA values (0-1 float or 0-255 int), i.e. including transparency.

The first two dimensions (M, N) define the rows and columns of the image.

Out-of-range RGB(A) values are clipped.

**cmap** [str or *Colormap*, optional] The Colormap instance or registered colormap name used to map scalar data to colors. This parameter is ignored for RGB(A) data. Defaults to `rcParams["image.cmap"]`.

**norm** [*Normalize*, optional] The *Normalize* instance used to scale scalar data to the [0, 1] range before mapping to colors using *cmap*. By default, a

linear scaling mapping the lowest value to 0 and the highest to 1 is used. This parameter is ignored for RGB(A) data.

**aspect** [{`'equal'`, `'auto'`} or float, optional] Controls the aspect ratio of the axes. The aspect is of particular relevance for images since it may distort the image, i.e. pixel will not be square.

This parameter is a shortcut for explicitly calling `Axes.set_aspect`. See there for further details.

- `'equal'`: Ensures an aspect ratio of 1. Pixels will be square (unless pixel sizes are explicitly made non-square in data coordinates using `extent`).
- `'auto'`: The axes is kept fixed and the aspect is adjusted so that the data fit in the axes. In general, this will result in non-square pixels.

If not given, use `rcParams["image.aspect"]` (default: `'equal'`).

**interpolation** [str, optional] The interpolation method used. If `None` `rcParams["image.interpolation"]` is used, which defaults to `'nearest'`.

Supported values are `'none'`, `'nearest'`, `'bilinear'`, `'bicubic'`, `'spline16'`, `'spline36'`, `'hanning'`, `'hamming'`, `'hermite'`, `'kaiser'`, `'quadric'`, `'catrom'`, `'gaussian'`, `'bessel'`, `'mitchell'`, `'sinc'`, `'lanczos'`.

If `interpolation` is `'none'`, then no interpolation is performed on the Agg, ps, pdf and svg backends. Other backends will fall back to `'nearest'`. Note that most SVG renders perform interpolation at rendering and that the default interpolation method they implement may differ.

See `/gallery/images_contours_and_fields/interpolation_methods` for an overview of the supported interpolation methods.

Some interpolation methods require an additional radius parameter, which can be set by `filterrad`. Additionally, the antigrain image resize filter is controlled by the parameter `filternorm`.

**alpha** [scalar, optional] The alpha blending value, between 0 (transparent) and 1 (opaque). This parameter is ignored for RGBA input data.

**vmin, vmax** [scalar, optional] When using scalar data and no explicit `norm`, `vmin` and `vmax` define the data range that the colormap covers. By default, the colormap covers the complete value range of the supplied data. `vmin`, `vmax` are ignored if the `norm` parameter is used.

**origin** [{`'upper'`, `'lower'`}, optional] Place the [0,0] index of the array in the upper left or lower left corner of the axes. The convention `'upper'` is typically used for matrices and images. If not given, `rcParams["image.origin"]` is used, defaulting to `'upper'`.

Note that the vertical axes points upward for `'lower'` but downward for `'upper'`.

See the *origin and extent in imshow* tutorial for examples and a more detailed description.

**extent** [scalars (left, right, bottom, top), optional] The bounding box in data coordinates that the image will fill. The image is stretched individually along x and y to fill the box.

The default extent is determined by the following conditions. Pixels have unit size in data coordinates. Their centers are on integer coordinates,

and their center coordinates range from 0 to columns-1 horizontally and from 0 to rows-1 vertically.

Note that the direction of the vertical axis and thus the default values for top and bottom depend on *origin*:

- For `origin == 'upper'` the default is `(-0.5, numcols-0.5, numrows-0.5, -0.5)`.
- For `origin == 'lower'` the default is `(-0.5, numcols-0.5, -0.5, numrows-0.5)`.

See the *origin and extent in imshow* tutorial for examples and a more detailed description.

**filternorm** [bool, optional, default: True] A parameter for the antigrain image resize filter (see the antigrain documentation). If *filternorm* is set, the filter normalizes integer values and corrects the rounding errors. It doesn't do anything with the source floating point values, it corrects only integers according to the rule of 1.0 which means that any sum of pixel weights must be equal to 1.0. So, the filter function must produce a graph of the proper shape.

**filterrad** [float > 0, optional, default: 4.0] The filter radius for filters that have a radius parameter, i.e. when interpolation is one of: 'sinc', 'lanczos' or 'blackman'.

**resample** [bool, optional] When *True*, use a full resampling method. When *False*, only resample when the output image is larger than the input image.

**url** [str, optional] Set the url of the created *AxesImage*. See *Artist.set\_url*.

## Returns

**image** [*AxesImage*]

## Other Parameters

**\*\*kwargs** [*Artist* properties] These parameters are passed on to the constructor of the *AxesImage* artist.

## See also:

*matshow* Plot a matrix or an array as an image.

## Notes

Unless *extent* is used, pixel centers will be located at integer coordinates. In other words: the origin will coincide with the center of pixel (0, 0).

There are two common representations for RGB images with an alpha channel:

- Straight (unassociated) alpha: R, G, and B channels represent the color of the pixel, disregarding its opacity.
- Premultiplied (associated) alpha: R, G, and B channels represent the color of the pixel, adjusted for its opacity by multiplication.

*imshow* expects RGB images adopting the straight (unassociated) alpha representation.

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

#### Examples using `matplotlib.axes.Axes.imshow`

- `sphinx_gallery_images_contours_and_fields_affine_image.py`
- `sphinx_gallery_images_contours_and_fields_barcode_demo.py`
- `sphinx_gallery_images_contours_and_fields_contour_image.py`
- `sphinx_gallery_images_contours_and_fields_image_annotated_heatmap.py`
- `sphinx_gallery_images_contours_and_fields_image_clip_path.py`
- `sphinx_gallery_images_contours_and_fields_image_demo.py`
- `sphinx_gallery_images_contours_and_fields_image_masked.py`
- `sphinx_gallery_images_contours_and_fields_image_transparency_blend.py`
- `sphinx_gallery_images_contours_and_fields_image_zcoord.py`
- `sphinx_gallery_images_contours_and_fields_interpolation_methods.py`
- `sphinx_gallery_images_contours_and_fields_layer_images.py`
- `sphinx_gallery_images_contours_and_fields_multi_image.py`
- `sphinx_gallery_images_contours_and_fields_pcolor_demo.py`
- `sphinx_gallery_images_contours_and_fields_shading_example.py`
- `sphinx_gallery_subplots_axes_and_figures_zoom_inset_axes.py`
- `sphinx_gallery_color_colorbar_basics.py`
- `sphinx_gallery_color_colormap_reference.py`
- `sphinx_gallery_color_custom_cmap.py`

#### `matplotlib.axes.Axes.matshow`

`Axes.matshow(self, Z, **kwargs)`

Plot the values of a 2D matrix or array as color-coded image.

The matrix will be shown the way it would be printed, with the first row at the top. Row and column numbering is zero-based.

##### **Parameters**

**Z** [array-like(M, N)] The matrix to be displayed.

##### **Returns**

**image** [*AxesImage*]

### Other Parameters

**\*\*kwargs** [*imshow* arguments]

### See also:

*imshow* More general function to plot data on a 2D regular raster.

### Notes

This is just a convenience function wrapping *imshow* to set useful defaults for a displaying a matrix. In particular:

- Set `origin='upper'`.
- Set `interpolation='nearest'`.
- Set `aspect='equal'`.
- Ticks are placed to the left and above.
- Ticks are formatted to show integer indices.

### Examples using `matplotlib.axes.Axes.imshow`

- `sphx_glr_gallery_images_contours_and_fields_matshow.py`

### `matplotlib.axes.Axes.pcolor`

`Axes.pcolor(self, *args, alpha=None, norm=None, cmap=None, vmin=None, vmax=None, data=None, **kwargs)`

Create a pseudocolor plot with a non-regular rectangular grid.

Call signature:

```
pcolor([X, Y,] C, **kwargs)
```

*X* and *Y* can be used to specify the corners of the quadrilaterals.

---

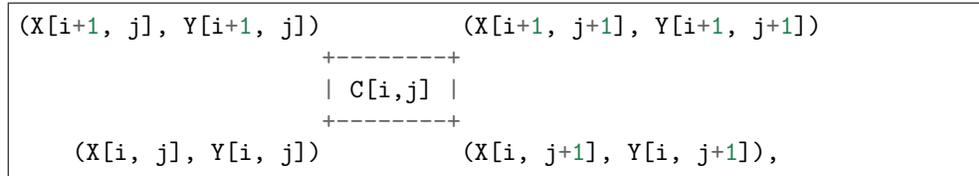
**Hint:** `pcolor()` can be very slow for large arrays. In most cases you should use the similar but much faster `pcolormesh` instead. See there for a discussion of the differences.

---

### Parameters

**C** [*array\_like*] A scalar 2-D array. The values will be color-mapped.

**X, Y** [*array\_like, optional*] The coordinates of the quadrilateral corners. The quadrilateral for `C[i, j]` has corners at:



Note that the column index corresponds to the x-coordinate, and the row index corresponds to y. For details, see the *Notes* section below.

The dimensions of  $X$  and  $Y$  should be one greater than those of  $C$ . Alternatively,  $X$ ,  $Y$  and  $C$  may have equal dimensions, in which case the last row and column of  $C$  will be ignored.

If  $X$  and/or  $Y$  are 1-D arrays or column vectors they will be expanded as needed into the appropriate 2-D arrays, making a rectangular grid.

**cmap** [str or *Colormap*, optional] A *Colormap* instance or registered colormap name. The colormap maps the  $C$  values to colors. Defaults to `rcParams["image.cmap"]`.

**norm** [*Normalize*, optional] The *Normalize* instance scales the data values to the canonical colormap range [0, 1] for mapping to colors. By default, the data range is mapped to the colorbar range using linear scaling.

**vmin, vmax** [scalar, optional, default: None] The colorbar range. If *None*, suitable min/max values are automatically chosen by the *Normalize* instance (defaults to the respective min/max values of  $C$  in case of the default linear scaling).

**edgecolors** [{‘none’, None, ‘face’, color, color sequence}, optional] The color of the edges. Defaults to ‘none’. Possible values:

- ‘none’ or “: No edge.
- *None*: `rcParams["patch.edgecolor"]` will be used. Note that currently `rcParams["patch.force_edgecolor"]` has to be True for this to work.
- ‘face’: Use the adjacent face color.
- An mpl color or sequence of colors will set the edge color.

The singular form *edgecolor* works as an alias.

**alpha** [scalar, optional, default: None] The alpha blending value of the face color, between 0 (transparent) and 1 (opaque). Note: The edgecolor is currently not affected by this.

**snap** [bool, optional, default: False] Whether to snap the mesh to pixel boundaries.

## Returns

**collection** [*matplotlib.collections.Collection*]

## Other Parameters

**antialiaseds** [bool, optional, default: False] The default *antialiaseds* is False if the default *edgecolors*="none" is used. This eliminates artificial lines at patch boundaries, and works regardless of the value of alpha. If *edgecolors* is not "none", then the default *antialiaseds* is taken from `rcParams["patch.antialiased"]`, which defaults to True. Stroking the edges may be preferred if *alpha* is 1, but will cause artifacts otherwise.

**\*\*kwargs** Additionally, the following arguments are allowed. They are passed along to the *PolyCollection* constructor:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and
<i>alpha</i>		float or None
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i> or <i>antialiaseds</i>		bool or sequence of bools
<i>array</i>		ndarray
<i>capstyle</i>		{'butt', 'round', 'projecting'}
<i>clip</i>		a length 2 sequence of floats; may be overridden in methods that have
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>cmap</i>		colormap or registered colormap name
<i>color</i>		color or sequence of rgba tuples
<i>contains</i>		callable
<i>edgecolor</i> or <i>ec</i> or <i>edgecolors</i>		color or sequence of colors or 'face'
<i>facecolor</i> or <i>facecolors</i> or <i>fc</i>		color or sequence of colors
<i>figure</i>		<i>Figure</i>
<i>gid</i>		str
<i>hatch</i>		{'/', '\', ' ', '-', '+', 'x', 'o', 'O', '.', '*'}
<i>in_layout</i>		bool
<i>joinstyle</i>		{'miter', 'round', 'bevel'}
<i>label</i>		object
<i>linestyle</i> or <i>dashes</i> or <i>linestyles</i> or <i>ls</i>		{'-', '--', '-.', ':', "", (offset, on-off-seq), ...}
<i>linewidth</i> or <i>linewidths</i> or <i>lw</i>		float or sequence of floats
<i>norm</i>		<i>Normalize</i>
<i>offset_position</i>		{'screen', 'data'}
<i>offsets</i>		float or sequence of floats
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		None or bool or float or callable
<i>pickradius</i>		unknown
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>transform</i>		<i>Transform</i>
<i>url</i>		str
<i>urls</i>		List[str] or None
<i>visible</i>		bool
<i>zorder</i>		float

### See also:

*pcolormesh* for an explanation of the differences between *pcolor* and *pcolormesh*.

*imshow* If X and Y are each equidistant, *imshow* can be a faster alternative.

### Notes

### Masked arrays

$X$ ,  $Y$  and  $C$  may be masked arrays. If either  $C[i, j]$ , or one of the vertices surrounding  $C[i, j]$  ( $X$  or  $Y$  at  $[i, j]$ ,  $[i+1, j]$ ,  $[i, j+1]$ ,  $[i+1, j+1]$ ) is masked, nothing is plotted.

### Grid orientation

The grid orientation follows the standard matrix convention: An array  $C$  with shape  $(nrows, ncolumns)$  is plotted with the column number as  $X$  and the row number as  $Y$ .

### Handling of `pcolor()` end-cases

`pcolor()` displays all columns of  $C$  if  $X$  and  $Y$  are not specified, or if  $X$  and  $Y$  have one more column than  $C$ . If  $X$  and  $Y$  have the same number of columns as  $C$  then the last column of  $C$  is dropped. Similarly for the rows.

Note: This behavior is different from MATLAB's `pcolor()`, which always discards the last row and column of  $C$ .

---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

### Examples using `matplotlib.axes.Axes.pcolor`

- `sphx_glr_gallery_images_contours_and_fields_pcolor_demo.py`
- `sphx_glr_gallery_subplots_axes_and_figures_axes_margins.py`

### `matplotlib.axes.Axes.pcolorfast`

`Axes.pcolorfast(self, *args, alpha=None, norm=None, cmap=None, vmin=None, vmax=None, data=None, **kwargs)`

Create a pseudocolor plot with a non-regular rectangular grid.

Call signature:

```
ax.pcolorfast([X, Y], C, /, **kwargs)
```

This method is similar to `~.Axes.pcolor'` and `pcolormesh`. It's designed to provide the fastest pcolor-type plotting with the Agg backend. To achieve this, it uses different algorithms internally depending on the complexity of the input grid (regular rectangular, non-regular rectangular or arbitrary quadrilateral).

**Warning:** This method is experimental. Compared to `pcolor` or `pcolormesh` it has some limitations:

- It supports only flat shading (no outlines)
- It lacks support for log scaling of the axes.
- It does not have a pyplot wrapper.

## Parameters

**C** [array-like(M, N)] A 2D array or masked array. The values will be color-mapped. This argument can only be passed positionally.

C can in some cases be 3D with the last dimension as `rgb(a)`. This is available when C qualifies for `image` or `pcolorimage` type, will throw a `TypeError` if C is 3D and `quadmesh`.

**X, Y** [tuple or array-like, default: (0, N), (0, M)] X and Y are used to specify the coordinates of the quadrilaterals. There are different ways to do this:

- Use tuples  $X=(x_{\min}, x_{\max})$  and  $Y=(y_{\min}, y_{\max})$  to define a *uniform rectangular grid*.

The tuples define the outer edges of the grid. All individual quadrilaterals will be of the same size. This is the fastest version.

- Use 1D arrays  $X, Y$  to specify a *non-uniform rectangular grid*.

In this case  $X$  and  $Y$  have to be monotonic 1D arrays of length  $N+1$  and  $M+1$ , specifying the x and y boundaries of the cells.

The speed is intermediate. Note: The grid is checked, and if found to be uniform the fast version is used.

- Use 2D arrays  $X, Y$  if you need an *arbitrary quadrilateral grid* (i.e. if the quadrilaterals are not rectangular).

In this case  $X$  and  $Y$  are 2D arrays with shape (M, N), specifying the x and y coordinates of the corners of the colored quadrilaterals. See `pcolormesh` for details.

This is the most general, but the slowest to render. It may produce faster and more compact output using ps, pdf, and svg backends, however.

These arguments can only be passed positionally.

**cmap** [str or *Colormap*, optional] A *Colormap* instance or registered colormap name. The colormap maps the C values to colors. Defaults to `rcParams["image.cmap"]`.

**norm** [*Normalize*, optional] The *Normalize* instance scales the data values to the canonical colormap range [0, 1] for mapping to colors. By default, the data range is mapped to the colorbar range using linear scaling.

**vmin, vmax** [scalar, optional, default: None] The colorbar range. If *None*, suitable min/max values are automatically chosen by the *Normalize* instance (defaults to the respective min/max values of C in case of the default linear scaling).

**alpha** [scalar, optional, default: None] The alpha blending value, between 0 (transparent) and 1 (opaque).

**snap** [bool, optional, default: False] Whether to snap the mesh to pixel boundaries.

## Returns

**image** [*AxesImage* or *PcolorImage* or *QuadMesh*] The return type depends on the type of grid:

- *AxesImage* for a regular rectangular grid.

- *PcolorImage* for a non-regular rectangular grid.
- *QuadMesh* for a non-rectangular grid.

### Notes

---

**Note:** In addition to the above described arguments, this function can take a **data** key-word argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

### Examples using `matplotlib.axes.Axes.pcolorfast`

- `sphx_glr_gallery_images_contours_and_fields_pcolor_demo.py`

### `matplotlib.axes.Axes.pcolormesh`

`Axes.pcolormesh(self, *args, alpha=None, norm=None, cmap=None, vmin=None, vmax=None, shading='flat', antialiased=False, data=None, **kwargs)`

Create a pseudocolor plot with a non-regular rectangular grid.

Call signature:

```
pcolor([X, Y,] C, **kwargs)
```

X and Y can be used to specify the corners of the quadrilaterals.

---

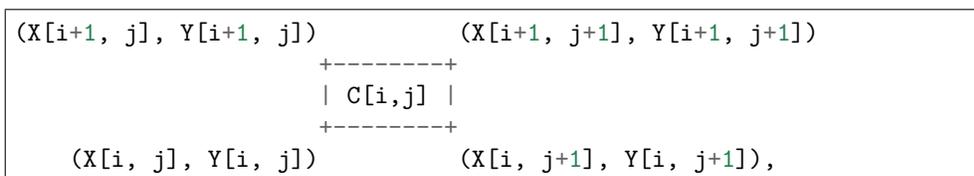
**Note:** `pcolormesh()` is similar to `pcolor()`. It's much faster and preferred in most cases. For a detailed discussion on the differences see *Differences between `pcolor()` and `pcolormesh()`*.

---

### Parameters

**C** [array\_like] A scalar 2-D array. The values will be color-mapped.

**X, Y** [array\_like, optional] The coordinates of the quadrilateral corners. The quadrilateral for `C[i, j]` has corners at:



Note that the column index corresponds to the x-coordinate, and the row index corresponds to y. For details, see the *Notes* section below.

The dimensions of *X* and *Y* should be one greater than those of *C*. Alternatively, *X*, *Y* and *C* may have equal dimensions, in which case the last row and column of *C* will be ignored.

If *X* and/or *Y* are 1-D arrays or column vectors they will be expanded as needed into the appropriate 2-D arrays, making a rectangular grid.

**cmap** [str or *Colormap*, optional] A *Colormap* instance or registered colormap name. The colormap maps the *C* values to colors. Defaults to `rcParams["image.cmap"]`.

**norm** [*Normalize*, optional] The *Normalize* instance scales the data values to the canonical colormap range [0, 1] for mapping to colors. By default, the data range is mapped to the colorbar range using linear scaling.

**vmin, vmax** [scalar, optional, default: None] The colorbar range. If *None*, suitable min/max values are automatically chosen by the *Normalize* instance (defaults to the respective min/max values of *C* in case of the default linear scaling).

**edgecolors** [{'none', None, 'face', color, color sequence}, optional] The color of the edges. Defaults to 'none'. Possible values:

- 'none' or "": No edge.
- *None*: `rcParams["patch.edgecolor"]` will be used. Note that currently `rcParams["patch.force_edgecolor"]` has to be True for this to work.
- 'face': Use the adjacent face color.
- An mpl color or sequence of colors will set the edge color.

The singular form *edgecolor* works as an alias.

**alpha** [scalar, optional, default: None] The alpha blending value, between 0 (transparent) and 1 (opaque).

**shading** [{'flat', 'gouraud'}, optional] The fill style, Possible values:

- 'flat': A solid color is used for each quad. The color of the quad (i, j), (i+1, j), (i, j+1), (i+1, j+1) is given by `C[i, j]`.
- 'gouraud': Each quad will be Gouraud shaded: The color of the corners (i', j') are given by `C[i', j']`. The color values of the area in between is interpolated from the corner values. When Gouraud shading is used, *edgecolors* is ignored.

**snap** [bool, optional, default: False] Whether to snap the mesh to pixel boundaries.

## Returns

**mesh** [*matplotlib.collections.QuadMesh*]

## Other Parameters

**\*\*kwargs** Additionally, the following arguments are allowed. They are passed along to the *QuadMesh* constructor:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and
<i>alpha</i>		float or None
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i> or <i>antialiaseds</i>		bool or sequence of bools
<i>array</i>		ndarray
<i>capstyle</i>		{'butt', 'round', 'projecting'}
<i>clip</i>		a length 2 sequence of floats; may be overridden in methods that have
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>cmap</i>		colormap or registered colormap name
<i>color</i>		color or sequence of rgba tuples
<i>contains</i>		callable
<i>edgecolor</i> or <i>ec</i> or <i>edgecolors</i>		color or sequence of colors or 'face'
<i>facecolor</i> or <i>facecolors</i> or <i>fc</i>		color or sequence of colors
<i>figure</i>		<i>Figure</i>
<i>gid</i>		str
<i>hatch</i>		{'/', '\\', ' ', '-', '+', 'x', 'o', 'O', '.', '*'}
<i>in_layout</i>		bool
<i>joinstyle</i>		{'miter', 'round', 'bevel'}
<i>label</i>		object
<i>linestyle</i> or <i>dashes</i> or <i>linestyles</i> or <i>ls</i>		{'-', '--', '-.', ':', '', (offset, on-off-seq), ...}
<i>linewidth</i> or <i>linewidths</i> or <i>lw</i>		float or sequence of floats
<i>norm</i>		<i>Normalize</i>
<i>offset_position</i>		{'screen', 'data'}
<i>offsets</i>		float or sequence of floats
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		None or bool or float or callable
<i>pickradius</i>		unknown
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>transform</i>		<i>Transform</i>
<i>url</i>		str
<i>urls</i>		List[str] or None
<i>visible</i>		bool
<i>zorder</i>		float

**See also:**

*pcolor* An alternative implementation with slightly different features. For a detailed discussion on the differences see *Differences between pcolor() and pcolormesh()*.

*imshow* If *X* and *Y* are each equidistant, *imshow* can be a faster alternative.

**Notes**

**Masked arrays**

*C* may be a masked array. If *C*[*i*, *j*] is masked, the corresponding quadrilateral will be

transparent. Masking of  $X$  and  $Y$  is not supported. Use `pcolor` if you need this functionality.

### Grid orientation

The grid orientation follows the standard matrix convention: An array  $C$  with shape (nrows, ncolumns) is plotted with the column number as  $X$  and the row number as  $Y$ .

### Differences between `pcolor()` and `pcolormesh()`

Both methods are used to create a pseudocolor plot of a 2-D array using quadrilaterals.

The main difference lies in the created object and internal data handling: While `pcolor` returns a `PolyCollection`, `pcolormesh` returns a `QuadMesh`. The latter is more specialized for the given purpose and thus is faster. It should almost always be preferred.

There is also a slight difference in the handling of masked arrays. Both `pcolor` and `pcolormesh` support masked arrays for  $C$ . However, only `pcolor` supports masked arrays for  $X$  and  $Y$ . The reason lies in the internal handling of the masked values. `pcolor` leaves out the respective polygons from the `PolyCollection`. `pcolormesh` sets the facecolor of the masked elements to transparent. You can see the difference when using edgecolors. While all edges are drawn irrespective of masking in a `QuadMesh`, the edge between two adjacent masked quadrilaterals in `pcolor` is not drawn as the corresponding polygons do not exist in the `PolyCollection`.

Another difference is the support of Gouraud shading in `pcolormesh`, which is not available with `pcolor`.

---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

### Examples using `matplotlib.axes.Axes.pcolormesh`

- `sphx_glr_gallery_images_contours_and_fields_pcolor_demo.py`
- `sphx_glr_gallery_images_contours_and_fields_pcolormesh_levels.py`
- `sphx_glr_gallery_images_contours_and_fields_quadmesh_demo.py`
- *Creating Colormaps in Matplotlib*

### `matplotlib.axes.Axes.spy`

`Axes.spy(self, Z, precision=0, marker=None, markersize=None, aspect='equal', origin='upper', **kwargs)`

Plot the sparsity pattern of a 2D array.

This visualizes the non-zero values of the array.

Two plotting styles are available: `image` and `marker`. Both are available for full arrays, but only the `marker` style works for `scipy.sparse.spmatrix` instances.

### Image style

If *marker* and *markersize* are *None*, *imshow* is used. Any extra remaining kwargs are passed to this method.

### Marker style

If *Z* is a `scipy.sparse.spmatrix` or *marker* or *markersize* are *None*, a *Line2D* object will be returned with the value of *marker* determining the marker type, and any remaining kwargs passed to *plot*.

#### Parameters

**Z** [array-like (M, N)] The array to be plotted.

**precision** [float or 'present', optional, default: 0] If *precision* is 0, any non-zero value will be plotted. Otherwise, values of  $|Z| > precision$  will be plotted.

For `scipy.sparse.spmatrix` instances, you can also pass 'present'. In this case any value present in the array will be plotted, even if it is identically zero.

**origin** [{'upper', 'lower'}, optional] Place the [0,0] index of the array in the upper left or lower left corner of the axes. The convention 'upper' is typically used for matrices and images. If not given, `rcParams["image.origin"]` is used, defaulting to 'upper'.

**aspect** [{'equal', 'auto', None} or float, optional] Controls the aspect ratio of the axes. The aspect is of particular relevance for images since it may distort the image, i.e. pixel will not be square.

This parameter is a shortcut for explicitly calling `Axes.set_aspect`. See there for further details.

- 'equal': Ensures an aspect ratio of 1. Pixels will be square.
- 'auto': The axes is kept fixed and the aspect is adjusted so that the data fit in the axes. In general, this will result in non-square pixels.
- *None*: Use `rcParams["image.aspect"]` (default: 'equal').

Default: 'equal'

#### Returns

**ret** [*AxesImage* or *Line2D*] The return type depends on the plotting style (see above).

#### Other Parameters

**\*\*kwargs** The supported additional parameters depend on the plotting style.

For the image style, you can pass the following additional parameters of *imshow*:

- *cmap*
- *alpha*
- *url*
- any *Artist* properties (passed on to the *AxesImage*)

For the marker style, you can pass any *Line2D* property except for *linestyle*:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<i>alpha</i>		float
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i>		bool
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		<i>[(Path, Transform)   Patch   None]</i>
<i>color</i> or <i>c</i>		color
<i>contains</i>		callable
<i>dash_capstyle</i>		{'butt', 'round', 'projecting'}
<i>dash_joinstyle</i>		{'miter', 'round', 'bevel'}
<i>dashes</i>		sequence of floats (on/off ink in points) or (None, None)
<i>drawstyle</i> or <i>ds</i>		{'default', 'steps', 'steps-pre', 'steps-mid', 'steps-post'}, default: 'default'
<i>figure</i>		<i>Figure</i>
<i>fillstyle</i>		{'full', 'left', 'right', 'bottom', 'top', 'none'}
<i>gid</i>		str
<i>in_layout</i>		bool
<i>label</i>		object
<i>linestyle</i> or <i>ls</i>		{'-', '--', '-.', ':', '', (offset, on-off-seq), ...}
<i>linewidth</i> or <i>lw</i>		float
<i>marker</i>		marker style
<i>markeredgewidth</i> or <i>mec</i>		float
<i>markeredgecolor</i> or <i>mew</i>		color
<i>markerfacecolor</i> or <i>mfc</i>		color
<i>markerfacecoloralt</i> or <i>mfcalt</i>		color
<i>markersize</i> or <i>ms</i>		float
<i>markevery</i>		None or int or (int, int) or slice or List[int] or float or (float, float)
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		float or callable[[ <i>Artist</i> , <i>Event</i> ], Tuple[bool, dict]]
<i>pickradius</i>		float
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>solid_capstyle</i>		{'butt', 'round', 'projecting'}
<i>solid_joinstyle</i>		{'miter', 'round', 'bevel'}
<i>transform</i>		<i>matplotlib.transforms.Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>xdata</i>		1D array
<i>ydata</i>		1D array
<i>zorder</i>		float

#### Examples using `matplotlib.axes.Axes.spy`

- `sphx_glr_gallery_images_contours_and_fields_spy_demos.py`

## Unstructured Triangles

<code>Axes.tripcolor</code>	Create a pseudocolor plot of an unstructured triangular grid.
<code>Axes.triplot</code>	Draw a unstructured triangular grid as lines and/or markers.
<code>Axes.tricontour</code>	Draw contours on an unstructured triangular grid.
<code>Axes.tricontourf</code>	Draw contours on an unstructured triangular grid.

### matplotlib.axes.Axes.tripcolor

`Axes.tripcolor(ax, *args, alpha=1.0, norm=None, cmap=None, vmin=None, vmax=None, shading='flat', facecolors=None, **kwargs)`  
Create a pseudocolor plot of an unstructured triangular grid.

The triangulation can be specified in one of two ways; either:

```
tripcolor(triangulation, ...)
```

where `triangulation` is a `matplotlib.tri.Triangulation` object, or

```
tripcolor(x, y, ...)  
tripcolor(x, y, triangles, ...)  
tripcolor(x, y, triangles=triangles, ...)  
tripcolor(x, y, mask=mask, ...)  
tripcolor(x, y, triangles, mask=mask, ...)
```

in which case a `Triangulation` object will be created. See `Triangulation` for a explanation of these possibilities.

The next argument must be `C`, the array of color values, either one per point in the triangulation if color values are defined at points, or one per triangle in the triangulation if color values are defined at triangles. If there are the same number of points and triangles in the triangulation it is assumed that color values are defined at points; to force the use of color values at triangles use the kwarg `facecolors=C` instead of just `C`.

`shading` may be `'flat'` (the default) or `'gouraud'`. If `shading` is `'flat'` and `C` values are defined at points, the color values used for each triangle are from the mean `C` of the triangle's three points. If `shading` is `'gouraud'` then color values must be defined at points.

The remaining kwargs are the same as for `pcolor()`.

### Examples using matplotlib.axes.Axes.tripcolor

- `sphx_glr_gallery_images_contours_and_fields_tripcolor_demo.py`

### matplotlib.axes.Axes.triplot

`Axes.triplot(ax, *args, **kwargs)`  
Draw a unstructured triangular grid as lines and/or markers.

The triangulation to plot can be specified in one of two ways; either:

```
triplot(triangulation, ...)
```

where *triangulation* is a `matplotlib.tri.Triangulation` object, or

```
triplot(x, y, ...)
triplot(x, y, triangles, ...)
triplot(x, y, triangles=triangles, ...)
triplot(x, y, mask=mask, ...)
triplot(x, y, triangles, mask=mask, ...)
```

in which case a `Triangulation` object will be created. See *Triangulation* for a explanation of these possibilities.

The remaining args and kwargs are the same as for `plot()`.

Return a list of 2 *Line2D* containing respectively:

- the lines plotted for triangles edges
- the markers plotted for triangles nodes

#### Examples using `matplotlib.axes.Axes.triplot`

- `sphx_glr_gallery_images_contours_and_fields_tricontour_smooth_delaunay.py`
- `sphx_glr_gallery_images_contours_and_fields_trigradient_demo.py`
- `sphx_glr_gallery_images_contours_and_fields_triinterp_demo.py`
- `sphx_glr_gallery_images_contours_and_fields_triplot_demo.py`

#### `matplotlib.axes.Axes.tricontour`

`Axes.tricontour(ax, *args, **kwargs)`

Draw contours on an unstructured triangular grid.

`tricontour` and `tricontourf` draw contour lines and filled contours, respectively. Except as noted, function signatures and return values are the same for both versions.

The triangulation can be specified in one of two ways; either

```
tricontour(triangulation, ...)
```

where *triangulation* is a `matplotlib.tri.Triangulation` object, or

```
tricontour(x, y, ...)
tricontour(x, y, triangles, ...)
tricontour(x, y, triangles=triangles, ...)
tricontour(x, y, mask=mask, ...)
tricontour(x, y, triangles, mask=mask, ...)
```

in which case a *Triangulation* object will be created. See that class' docstring for an explanation of these cases.

The remaining arguments may be:

```
tricontour(..., Z)
```

where  $Z$  is the array of values to contour, one per point in the triangulation. The level values are chosen automatically.

```
tricontour(..., Z, N)
```

contour up to  $N+1$  automatically chosen contour levels ( $N$  intervals).

```
tricontour(..., Z, V)
```

draw contour lines at the values specified in sequence  $V$ , which must be in increasing order.

```
tricontourf(..., Z, V)
```

fill the  $(\text{len}(V)-1)$  regions between the values in  $V$ , which must be in increasing order.

```
tricontour(Z, **kwargs)
```

Use keyword args to control colors, linewidth, origin, cmap ... see below for more details.

`tricontour(...)` returns a `TriContourSet` object.

Optional keyword arguments:

*colors*: [ *None* | string | (mpl\_colors) ] If *None*, the colormap specified by *cmap* will be used.

If a string, like 'r' or 'red', all levels will be plotted in this color.

If a tuple of matplotlib color args (string, float, rgb, etc), different levels will be plotted in different colors in the order specified.

*alpha*: float The alpha blending value

*cmap*: [ *None* | Colormap ] A *cm Colormap* instance or *None*. If *cmap* is *None* and *colors* is *None*, a default Colormap is used.

*norm*: [ *None* | Normalize ] A *matplotlib.colors.Normalize* instance for scaling data values to colors. If *norm* is *None* and *colors* is *None*, the default linear scaling is used.

*levels* [level0, level1, ..., leveln] A list of floating point numbers indicating the level curves to draw, in increasing order; e.g., to draw just the zero contour pass `levels=[0]`

*origin*: [ *None* | 'upper' | 'lower' | 'image' ] If *None*, the first value of  $Z$  will correspond to the lower left corner, location (0,0). If 'image', the `rc` value for `image.origin` will be used.

This keyword is not active if  $X$  and  $Y$  are specified in the call to contour.

*extent*: [ *None* | (x0,x1,y0,y1) ]

If *origin* is not *None*, then *extent* is interpreted as in `matplotlib.pyplot.imshow()`: it gives the outer pixel boundaries. In this case, the position of  $Z[0,0]$  is the center of the pixel, not a corner. If *origin* is *None*, then  $(x0, y0)$  is the position of  $Z[0,0]$ , and  $(x1, y1)$  is the position of  $Z[-1,-1]$ .

This keyword is not active if  $X$  and  $Y$  are specified in the call to contour.

*locator*: [ *None* | `ticker.Locator` subclass ] If *locator* is *None*, the default *MaxNLocator* is used. The locator is used to determine the contour levels if they are not given explicitly via the *V* argument.

*extend*: [ 'neither' | 'both' | 'min' | 'max' ] Unless this is 'neither', contour levels are automatically added to one or both ends of the range so that all data are included. These added ranges are then mapped to the special colormap values which default to the ends of the colormap range, but can be set via `matplotlib.colors.Colormap.set_under()` and `matplotlib.colors.Colormap.set_over()` methods.

*xunits, yunits*: [ *None* | registered units ] Override axis units by specifying an instance of a `matplotlib.units.ConversionInterface`.

tricontour-only keyword arguments:

*linewidths*: [ *None* | number | tuple of numbers ] If *linewidths* is *None*, defaults to `rc:lines.linewidth`.

If a number, all levels will be plotted with this linewidth.

If a tuple, different levels will be plotted with different linewidths in the order specified

*linestyles*: [ *None* | 'solid' | 'dashed' | 'dashdot' | 'dotted' ] If *linestyles* is *None*, the 'solid' is used.

*linestyles* can also be an iterable of the above strings specifying a set of linestyles to be used. If this iterable is shorter than the number of contour levels it will be repeated as necessary.

If contour is using a monochrome colormap and the contour level is less than 0, then the linestyle specified in `rcParams["contour.negative_linestyle"]` will be used.

tricontourf-only keyword arguments:

*antialiased*: bool enable antialiasing

Note: *tricontourf* fills intervals that are closed at the top; that is, for boundaries *z1* and *z2*, the filled region is:

$$z1 < Z \leq z2$$

except for the lowest interval, which is closed on both sides (i.e. it includes the lowest value).

#### Examples using `matplotlib.axes.Axes.tricontour`

- `sphx_glr_gallery_images_contours_and_fields_irregulardatagrid.py`
- `sphx_glr_gallery_images_contours_and_fields_tricontour_smooth_delaunay.py`
- `sphx_glr_gallery_images_contours_and_fields_tricontour_smooth_user.py`
- `sphx_glr_gallery_images_contours_and_fields_trigradient_demo.py`

**matplotlib.axes.Axes.tricontourf**

`Axes.tricontourf(ax, *args, **kwargs)`

Draw contours on an unstructured triangular grid.

`tricontour` and `tricontourf` draw contour lines and filled contours, respectively. Except as noted, function signatures and return values are the same for both versions.

The triangulation can be specified in one of two ways; either

```
tricontour(triangulation, ...)
```

where `triangulation` is a `matplotlib.tri.Triangulation` object, or

```
tricontour(x, y, ...)
tricontour(x, y, triangles, ...)
tricontour(x, y, triangles=triangles, ...)
tricontour(x, y, mask=mask, ...)
tricontour(x, y, triangles, mask=mask, ...)
```

in which case a `Triangulation` object will be created. See that class' docstring for an explanation of these cases.

The remaining arguments may be:

```
tricontour(..., Z)
```

where `Z` is the array of values to contour, one per point in the triangulation. The level values are chosen automatically.

```
tricontour(..., Z, N)
```

contour up to  $N+1$  automatically chosen contour levels ( $N$  intervals).

```
tricontour(..., Z, V)
```

draw contour lines at the values specified in sequence `V`, which must be in increasing order.

```
tricontourf(..., Z, V)
```

fill the  $(\text{len}(V)-1)$  regions between the values in `V`, which must be in increasing order.

```
tricontour(Z, **kwargs)
```

Use keyword args to control colors, linewidth, origin, cmap ... see below for more details.

`tricontour(...)` returns a `TriContourSet` object.

Optional keyword arguments:

*colors*: [ *None* | string | (mpl\_colors) ] If *None*, the colormap specified by `cmap` will be used.

If a string, like 'r' or 'red', all levels will be plotted in this color.

If a tuple of matplotlib color args (string, float, rgb, etc), different levels will be plotted in different colors in the order specified.

*alpha*: float The alpha blending value

*cmap*: [ *None* | *Colormap* ] A cm *Colormap* instance or *None*. If *cmap* is *None* and *colors* is *None*, a default *Colormap* is used.

*norm*: [ *None* | *Normalize* ] A *matplotlib.colors.Normalize* instance for scaling data values to colors. If *norm* is *None* and *colors* is *None*, the default linear scaling is used.

*levels* [level0, level1, ..., leveln] A list of floating point numbers indicating the level curves to draw, in increasing order; e.g., to draw just the zero contour pass `levels=[0]`

*origin*: [ *None* | 'upper' | 'lower' | 'image' ] If *None*, the first value of *Z* will correspond to the lower left corner, location (0,0). If 'image', the rc value for `image.origin` will be used.

This keyword is not active if *X* and *Y* are specified in the call to `contour`.

*extent*: [ *None* | (x0,x1,y0,y1) ]

If *origin* is not *None*, then *extent* is interpreted as in `matplotlib.pyplot.imshow()`: it gives the outer pixel boundaries. In this case, the position of `Z[0,0]` is the center of the pixel, not a corner. If *origin* is *None*, then (x0, y0) is the position of `Z[0,0]`, and (x1, y1) is the position of `Z[-1,-1]`.

This keyword is not active if *X* and *Y* are specified in the call to `contour`.

*locator*: [ *None* | `ticker.Locator` subclass ] If *locator* is *None*, the default *MaxNLocator* is used. The locator is used to determine the contour levels if they are not given explicitly via the *V* argument.

*extend*: [ 'neither' | 'both' | 'min' | 'max' ] Unless this is 'neither', contour levels are automatically added to one or both ends of the range so that all data are included. These added ranges are then mapped to the special colormap values which default to the ends of the colormap range, but can be set via `matplotlib.colors.Colormap.set_under()` and `matplotlib.colors.Colormap.set_over()` methods.

*xunits, yunits*: [ *None* | registered units ] Override axis units by specifying an instance of a `matplotlib.units.ConversionInterface`.

tricontour-only keyword arguments:

*linewidths*: [ *None* | number | tuple of numbers ] If *linewidths* is *None*, defaults to `rc:lines.linewidth`.

If a number, all levels will be plotted with this linewidth.

If a tuple, different levels will be plotted with different linewidths in the order specified

*linestyles*: [ *None* | 'solid' | 'dashed' | 'dashdot' | 'dotted' ] If *linestyles* is *None*, the 'solid' is used.

*linestyles* can also be an iterable of the above strings specifying a set of linestyles to be used. If this iterable is shorter than the number of contour levels it will be repeated as necessary.

If `contour` is using a monochrome colormap and the contour level is less than 0, then the linestyle specified in `rcParams["contour.negative_linestyle"]` will be used.

tricontourf-only keyword arguments:

*antialiased*: bool enable antialiasing

Note: *tricontourf* fills intervals that are closed at the top; that is, for boundaries *z1* and *z2*, the filled region is:

$$z1 < Z \leq z2$$

except for the lowest interval, which is closed on both sides (i.e. it includes the lowest value).

#### Examples using `matplotlib.axes.Axes.tricontourf`

- `sphx_glr_gallery_images_contours_and_fields_irregulardatagrid.py`
- `sphx_glr_gallery_images_contours_and_fields_tricontour_demo.py`
- `sphx_glr_gallery_images_contours_and_fields_tricontour_smooth_delaunay.py`
- `sphx_glr_gallery_images_contours_and_fields_tricontour_smooth_user.py`
- `sphx_glr_gallery_images_contours_and_fields_triinterp_demo.py`

#### Text and Annotations

<code>Axes.annotate</code>	Annotate the point <i>xy</i> with text <i>text</i> .
<code>Axes.text</code>	Add text to the axes.
<code>Axes.table</code>	Add a table to an <i>Axes</i> .
<code>Axes.arrow</code>	Add an arrow to the axes.
<code>Axes.inset_axes</code>	Add a child inset axes to this existing axes.
<code>Axes.indicate_inset</code>	Add an inset indicator to the axes.
<code>Axes.indicate_inset_zoom</code>	Add an inset indicator rectangle to the axes based on the axis limits for an <i>inset_ax</i> and draw connectors between <i>inset_ax</i> and the rectangle.
<code>Axes.secondary_xaxis</code>	Add a second x-axis to this axes.
<code>Axes.secondary_yaxis</code>	Add a second y-axis to this axes.

#### `matplotlib.axes.Axes.annotate`

`Axes.annotate(self, s, xy, *args, **kwargs)`

Annotate the point *xy* with text *text*.

In the simplest form, the text is placed at *xy*.

Optionally, the text can be displayed in another position *xytext*. An arrow pointing from the text to the annotated point *xy* can then be added by defining *arrowprops*.

#### Parameters

**text** [str] The text of the annotation. *s* is a deprecated synonym for this parameter.

**xy** [(float, float)] The point (*x*,*y*) to annotate.

**xytext** [(float, float), optional] The position (*x*,*y*) to place the text at. If *None*, defaults to *xy*.

**xycoords** [str, *Artist*, *Transform*, callable or tuple, optional] The coordinate system that *xy* is given in. The following types of values are supported:

- One of the following strings:

Value	Description
'figure points'	Points from the lower left of the figure
'figure pixels'	Pixels from the lower left of the figure
'figure fraction'	Fraction of figure from lower left
'axes points'	Points from lower left corner of axes
'axes pixels'	Pixels from lower left corner of axes
'axes fraction'	Fraction of axes from lower left
'data'	Use the coordinate system of the object being annotated (default)
'polar'	$(\theta, r)$ if not native 'data' coordinates

- An *Artist*: *xy* is interpreted as a fraction of the artists *Bbox*. E.g.  $(0, 0)$  would be the lower left corner of the bounding box and  $(0.5, 1)$  would be the center top of the bounding box.
- A *Transform* to transform *xy* to screen coordinates.
- A function with one of the following signatures:

```
def transform(renderer) -> Bbox
def transform(renderer) -> Transform
```

where *renderer* is a *RendererBase* subclass.

The result of the function is interpreted like the *Artist* and *Transform* cases above.

- A tuple  $(xcoords, ycoords)$  specifying separate coordinate systems for *x* and *y*. *xcoords* and *ycoords* must each be of one of the above described types.

See *Advanced Annotation* for more details.

Defaults to 'data'.

**textcoords** [str, *Artist*, *Transform*, callable or tuple, optional] The coordinate system that *xytext* is given in.

All *xycoords* values are valid as well as the following strings:

Value	Description
'offset points'	Offset (in points) from the <i>xy</i> value
'offset pixels'	Offset (in pixels) from the <i>xy</i> value

Defaults to the value of *xycoords*, i.e. use the same coordinate system for annotation point and text position.

**arrowprops** [dict, optional] The properties used to draw a *FancyArrowPatch* arrow between the positions *xy* and *xytext*.

If *arrowprops* does not contain the key 'arrowstyle' the allowed keys are:

Key	Description
width	The width of the arrow in points
headwidth	The width of the base of the arrow head in points
headlength	The length of the arrow head in points
shrink	Fraction of total length to shrink from both ends
?	Any key to <i>matplotlib.patches.FancyArrowPatch</i>

If *arrowprops* contains the key 'arrowstyle' the above keys are forbidden. The allowed values of 'arrowstyle' are:

Name	Attrs
'-'	None
'->'	head_length=0.4,head_width=0.2
'-['	widthB=1.0,lengthB=0.2,angleB=None
' -'	widthA=1.0,widthB=1.0
'-> '	head_length=0.4,head_width=0.2
'<-'	head_length=0.4,head_width=0.2
'<->'	head_length=0.4,head_width=0.2
'< -'	head_length=0.4,head_width=0.2
'< ->'	head_length=0.4,head_width=0.2
'fancy'	head_length=0.4,head_width=0.4,tail_width=0.4
'simple'	head_length=0.5,head_width=0.5,tail_width=0.2
'wedge'	tail_width=0.3,shrink_factor=0.5

Valid keys for *FancyArrowPatch* are:

Key	Description
arrowstyle	the arrow style
connectionstyle	the connection style
relpos	default is (0.5, 0.5)
patchA	default is bounding box of the text
patchB	default is None
shrinkA	default is 2 points
shrinkB	default is 2 points
mutation_scale	default is text size (in points)
mutation_aspect	default is 1.
?	any key for <i>matplotlib.patches.PathPatch</i>

Defaults to None, i.e. no arrow is drawn.

**annotation\_clip** [bool or None, optional] Whether to draw the annotation when the annotation point *xy* is outside the axes area.

- If *True*, the annotation will only be drawn when *xy* is within the axes.
- If *False*, the annotation will always be drawn.
- If *None*, the annotation will only be drawn when *xy* is within the axes and *xycoords* is 'data'.

Defaults to *None*.

**\*\*kwargs** Additional kwargs are passed to *Text*.

**Returns****annotation** [*Annotation*]**See also:*****Advanced Annotation*****Examples using `matplotlib.axes.Axes.annotate`**

- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_barchart.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_timeline.py
- sphx\_glr\_gallery\_statistics\_barchart\_demo.py
- sphx\_glr\_gallery\_pyplots\_annotate\_transform.py
- sphx\_glr\_gallery\_pyplots\_annotation\_basic.py
- sphx\_glr\_gallery\_pyplots\_annotation\_polar.py
- sphx\_glr\_gallery\_pyplots\_text\_commands.py
- sphx\_glr\_gallery\_pyplots\_whats\_new\_98\_4\_fancy.py
- sphx\_glr\_gallery\_shapes\_and\_collections\_donut.py
- sphx\_glr\_gallery\_userdemo\_connectionstyle\_demo.py

**`matplotlib.axes.Axes.text`**`Axes.text(self, x, y, s, fontdict=None, withdash=<deprecated parameter>, **kwargs)`

Add text to the axes.

Add the text *s* to the axes at location *x*, *y* in data coordinates.**Parameters****x, y** [scalars] The position to place the text. By default, this is in data coordinates. The coordinate system can be changed using the *transform* parameter.**s** [str] The text.**fontdict** [dictionary, optional, default: None] A dictionary to override the default text properties. If fontdict is None, the defaults are determined by your rc parameters.**withdash** [boolean, optional, default: False] Creates a *TextWithDash* instance instead of a *Text* instance.**Returns****text** [*Text*] The created *Text* instance.**Other Parameters****\*\*kwargs** [*Text* properties.] Other miscellaneous text parameters.

## Examples

Individual keyword arguments can be used to override any given parameter:

```
>>> text(x, y, s, fontsize=12)
```

The default transform specifies that text is in data coords, alternatively, you can specify text in axis coords (0,0 is lower-left and 1,1 is upper-right). The example below places text in the center of the axes:

```
>>> text(0.5, 0.5, 'matplotlib', horizontalalignment='center',  
...      verticalalignment='center', transform=ax.transAxes)
```

You can put a rectangular box around the text instance (e.g., to set a background color) by using the keyword `bbox`. `bbox` is a dictionary of *Rectangle* properties. For example:

```
>>> text(x, y, s, bbox=dict(facecolor='red', alpha=0.5))
```

## Examples using `matplotlib.axes.Axes.text`

- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_horizontal\_barchart\_distribution.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_demo\_text\_rotation\_mode.py
- sphx\_glr\_gallery\_pyplots\_pyplot\_mathtext.py
- sphx\_glr\_gallery\_pyplots\_text\_commands.py
- sphx\_glr\_gallery\_pyplots\_text\_layout.py
- sphx\_glr\_gallery\_pyplots\_whats\_new\_98\_4\_fancy.py
- sphx\_glr\_gallery\_color\_named\_colors.py

## `matplotlib.axes.Axes.table`

```
Axes.table(ax, cellText=None, cellColours=None, cellLoc='right', colWidths=None,  
           rowLabels=None, rowColours=None, rowLoc='left', colLabels=None, col-  
           Colours=None, colLoc='center', loc='bottom', bbox=None, edges='closed',  
           **kwargs)
```

Add a table to an *Axes*.

At least one of `cellText` or `cellColours` must be specified. These parameters must be 2D lists, in which the outer lists define the rows and the inner list define the column values per row. Each row must have the same number of elements.

The table can optionally have row and column headers, which are configured using `rowLabels`, `rowColours`, `rowLoc` and `colLabels`, `colColours`, `colLoc` respectively.

For finer grained control over tables, use the *Table* class and add it to the axes with `Axes.add_table`.

### Parameters

**cellText** [2D list of str, optional] The texts to place into the table cells.

*Note:* Line breaks in the strings are currently not accounted for and will result in the text exceeding the cell boundaries.

**cellColours** [2D list of matplotlib color specs, optional] The background colors of the cells.

**cellLoc** [{'left', 'center', 'right'}, default: 'right'] The alignment of the text within the cells.

**colWidths** [list of float, optional] The column widths in units of the axes. If not given, all columns will have a width of  $1 / ncols$ .

**rowLabels** [list of str, optional] The text of the row header cells.

**rowColours** [list of matplotlib color specs, optional] The colors of the row header cells.

**rowLoc** [{'left', 'center', 'right'}, optional, default: 'left'] The text alignment of the row header cells.

**colLabels** [list of str, optional] The text of the column header cells.

**colColours** [list of matplotlib color specs, optional] The colors of the column header cells.

**rowLoc** [{'left', 'center', 'right'}, optional, default: 'left'] The text alignment of the column header cells.

**loc** [str, optional] The position of the cell with respect to *ax*. This must be one of the *codes*.

**bbox** [*Bbox*, optional] A bounding box to draw the table into. If this is not *None*, this overrides *loc*.

**edges** [substring of 'BRTL' or {'open', 'closed', 'horizontal', 'vertical'}] The cell edges to be drawn with a line. See also *visible\_edges*.

### Returns

**table** [*Table*] The created table.

### Other Parameters

**\*\*kwargs** *Table* properties.

Property	Description
<i>agg_filter</i>	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
<i>alpha</i>	float
<i>animated</i>	bool
<i>clip_box</i>	<i>Bbox</i>
<i>clip_on</i>	bool
<i>clip_path</i>	[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>contains</i>	callable
<i>figure</i>	<i>Figure</i>
<i>fontsize</i>	float
<i>gid</i>	str
<i>in_layout</i>	bool
<i>label</i>	object
<i>path_effect</i>	<i>AbstractPathEffect</i>
<i>picker</i>	None or bool or float or callable
<i>rasterized</i>	bool or None
<i>sketch_params</i>	(scale: float, length: float, randomness: float)
<i>snap</i>	bool or None
<i>transform</i>	<i>Transform</i>
<i>url</i>	str
<i>visible</i>	bool
<i>zorder</i>	float

### matplotlib.axes.Axes.arrow

`Axes.arrow(self, x, y, dx, dy, **kwargs)`

Add an arrow to the axes.

This draws an arrow from (x, y) to (x+dx, y+dy).

#### Parameters

**x, y** [float] The x and y coordinates of the arrow base.

**dx, dy** [float] The length of the arrow along x and y direction.

#### Returns

**arrow** [*FancyArrow*] The created *FancyArrow* object.

#### Other Parameters

**\*\*kwargs** Optional kwargs (inherited from *FancyArrow* patch) control the arrow construction and properties:

#### Constructor arguments

**width: float (default: 0.001)** width of full arrow tail

**length\_includes\_head: bool (default: False)** True if head is to be counted in calculating the length.

**head\_width: float or None (default: 3\*width)** total width of the full arrow head

**head\_length:** float or None (default:  $1.5 * \text{head\_width}$ ) length of arrow head

**shape:** ['full', 'left', 'right'] (default: 'full') draw the left-half, right-half, or full arrow

**overhang:** float (default: 0) fraction that the arrow is swept back (0 overhang means triangular shape). Can be negative or greater than one.

**head\_starts\_at\_zero:** bool (default: False) if True, the head starts being drawn at coordinate 0 instead of ending at coordinate 0.

**Other valid kwargs (inherited from :class:'Patch') are:**

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<i>alpha</i>		float or None
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i>		unknown
<i>capstyle</i>		{'butt', 'round', 'projecting'}
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>color</i>		color
<i>contains</i>		callable
<i>edgecolor</i> or <i>ec</i>		color or None or 'auto'
<i>facecolor</i> or <i>fc</i>		color or None
<i>figure</i>		<i>Figure</i>
<i>fill</i>		bool
<i>gid</i>		str
<i>hatch</i>		{'/', '\\', ' ', '-.', '+', 'x', 'o', 'O', '.', '*'}
<i>in_layout</i>		bool
<i>joinstyle</i>		{'miter', 'round', 'bevel'}
<i>label</i>		object
<i>linestyle</i> or <i>ls</i>		{'-', '--', '-.', ':', ' ', (offset, on-off-seq), ...}
<i>linewidth</i> or <i>lw</i>		float or None
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		None or bool or float or callable
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>transform</i>		<i>Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>zorder</i>		float

## Notes

The resulting arrow is affected by the axes aspect ratio and limits. This may produce an arrow whose head is not square with its stem. To create an arrow whose head is square with its stem, use `annotate()` for example:

```
>>> ax.annotate("", xy=(0.5, 0.5), xytext=(0, 0),
...             arrowprops=dict(arrowstyle="->"))
```

### matplotlib.axes.Axes.inset\_axes

`Axes.inset_axes(self, bounds, *, transform=None, zorder=5, **kwargs)`  
 Add a child inset axes to this existing axes.

#### Parameters

**bounds** `[[x0, y0, width, height]]` Lower-left corner of inset axes, and its width and height.

**transform** `[Transform]` Defaults to `ax.transAxes`, i.e. the units of `rect` are in axes-relative coordinates.

**zorder** `[number]` Defaults to 5 (same as `Axes.legend`). Adjust higher or lower to change whether it is above or below data plotted on the parent axes.

**\*\*kwargs** Other `kwargs` are passed on to the `axes.Axes` child axes.

#### Returns

**Axes** The created `axes.Axes` instance.

**Warning:** This method is experimental as of 3.0, and the API may change.

### Examples

This example makes two inset axes, the first is in axes-relative coordinates, and the second in data-coordinates:

```
fig, ax = plt.subplots()
ax.plot(range(10))
axin1 = ax.inset_axes([0.8, 0.1, 0.15, 0.15])
axin2 = ax.inset_axes(
    [5, 7, 2.3, 2.3], transform=ax.transData)
```

### Examples using matplotlib.axes.Axes.inset\_axes

- `sphinx_glr_gallery_subplots_axes_and_figures_zoom_inset_axes.py`

### matplotlib.axes.Axes.indicate\_inset

`Axes.indicate_inset(self, bounds, inset_ax=None, *, transform=None, facecolor='none', edgecolor='0.5', alpha=0.5, zorder=4.99, **kwargs)`

Add an inset indicator to the axes. This is a rectangle on the plot at the position indicated by `bounds` that optionally has lines that connect the rectangle to an inset axes (`Axes.inset_axes`).

**Parameters**

**bounds** `[[x0, y0, width, height]]` Lower-left corner of rectangle to be marked, and its width and height.

**inset\_ax** `[Axes]` An optional inset axes to draw connecting lines to. Two lines are drawn connecting the indicator box to the inset axes on corners chosen so as to not overlap with the indicator box.

**transform** `[Transform]` Transform for the rectangle co-ordinates. Defaults to `ax.transAxes`, i.e. the units of `rect` are in axes-relative coordinates.

**facecolor** `[Matplotlib color]` Facecolor of the rectangle (default 'none').

**edgecolor** `[Matplotlib color]` Color of the rectangle and color of the connecting lines. Default is '0.5'.

**alpha** `[number]` Transparency of the rectangle and connector lines. Default is 0.5.

**zorder** `[number]` Drawing order of the rectangle and connector lines. Default is 4.99 (just below the default level of inset axes).

**\*\*kwargs** Other *kwargs* are passed on to the rectangle patch.

**Returns**

**rectangle\_patch** `[Patches.Rectangle]` Rectangle artist.

**connector\_lines** `[4-tuple of Patches.ConnectionPatch]` One for each of four connector lines. Two are set with visibility to *False*, but the user can set the visibility to *True* if the automatic choice is not deemed correct.

**Warning:** This method is experimental as of 3.0, and the API may change.

**matplotlib.axes.Axes.indicate\_inset\_zoom**

`Axes.indicate_inset_zoom(self, inset_ax, **kwargs)`

Add an inset indicator rectangle to the axes based on the axis limits for an *inset\_ax* and draw connectors between *inset\_ax* and the rectangle.

**Parameters**

**inset\_ax** `[Axes]` Inset axes to draw connecting lines to. Two lines are drawn connecting the indicator box to the inset axes on corners chosen so as to not overlap with the indicator box.

**\*\*kwargs** Other *kwargs* are passed on to `Axes.inset_rectangle`

**Returns**

**rectangle\_patch** `[Patches.Rectangle]` Rectangle artist.

**connector\_lines** `[4-tuple of Patches.ConnectionPatch]` One for each of four connector lines. Two are set with visibility to *False*, but the user can set the visibility to *True* if the automatic choice is not deemed correct.

**Warning:** This method is experimental as of 3.0, and the API may change.

Examples using `matplotlib.axes.Axes.indicate_inset_zoom`

- `sphx_glr_gallery_subplots_axes_and_figures_zoom_inset_axes.py`

`matplotlib.axes.Axes.secondary_xaxis`

`Axes.secondary_xaxis(self, location, *, functions=None, **kwargs)`

Add a second x-axis to this axes.

For example if we want to have a second scale for the data plotted on the axis.

### Parameters

**location** [string or scalar] The position to put the secondary axis. Strings can be 'top' or 'bottom', for x-oriented axes or 'left' or 'right' for y-oriented axes or a scalar can be a float indicating the relative position on the axes to put the new axes (0 being the bottom (left), and 1.0 being the top (right).)

**functions** [2-tuple of func, or Transform with an inverse] If a 2-tuple of functions, the user specifies the transform function and its inverse. i.e. `functions=(lambda x: 2 / x, lambda x: 2 / x)` would be an reciprocal transform with a factor of 2.

The user can also directly supply a subclass of `transforms.Transform` so long as it has an inverse.

See `/gallery/subplots_axes_and_figures/secondary_axis` for examples of making these conversions.

### Returns

**ax** [`axes._secondary_axes.SecondaryAxis`]

### Other Parameters

**\*\*kwargs** [`Axes` properties.] Other miscellaneous axes parameters.

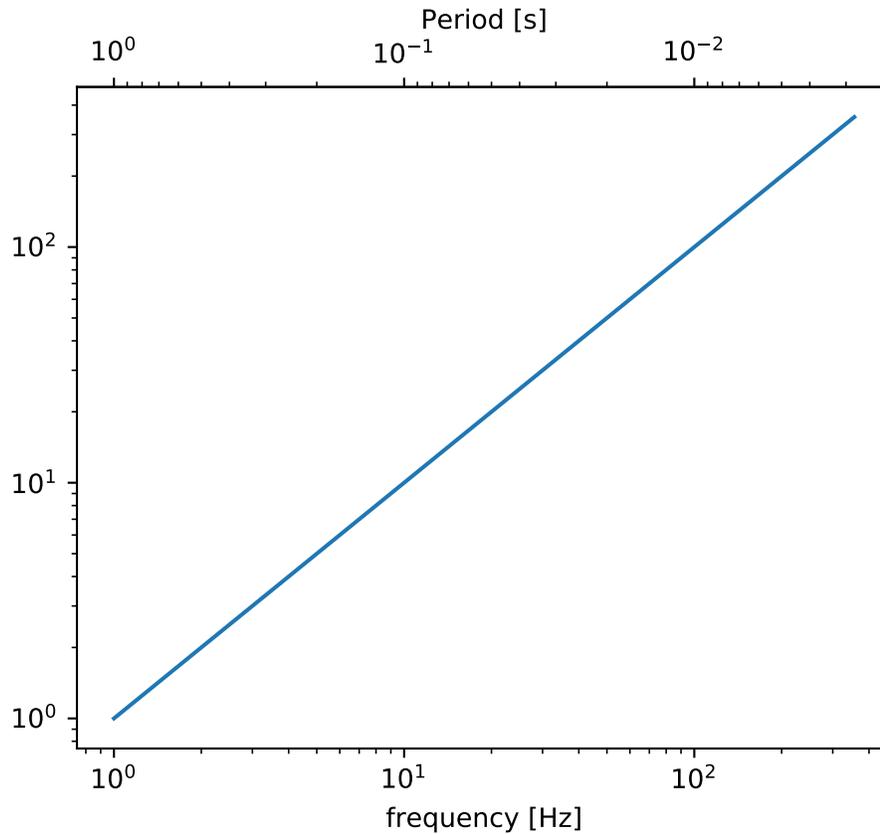
**Warning:** This method is experimental as of 3.1, and the API may change.

### Examples

The main axis shows frequency, and the secondary axis shows period.

Examples using `matplotlib.axes.Axes.secondary_xaxis`

- `sphx_glr_gallery_subplots_axes_and_figures_secondary_axis.py`



### matplotlib.axes.Axes.secondary\_yaxis

`Axes.secondary_yaxis(self, location, *, functions=None, **kwargs)`

Add a second y-axis to this axes.

For example if we want to have a second scale for the data plotted on the axis.

`%( _secax_docstring)s`

#### Examples

Add a secondary axes that converts from radians to degrees

#### Examples using `matplotlib.axes.Axes.secondary_yaxis`

- `sphx_glr_gallery_subplots_axes_and_figures_secondary_axis.py`

#### Fields

`Axes.barbs`

Plot a 2D field of barbs.

`Axes.quiver`

Plot a 2D field of arrows.

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<code>Axes.quiverkey</code>	Add a key to a quiver plot.
<code>Axes.streamplot</code>	Draw streamlines of a vector flow.

**matplotlib.axes.Axes.barbs**

`Axes.barbs(self, *args, data=None, **kw)`

Plot a 2D field of barbs.

Call signature:

```
barbs([X, Y], U, V, [C], **kw)
```

Where  $X, Y$  define the barb locations,  $U, V$  define the barb directions, and  $C$  optionally sets the color.

All arguments may be 1D or 2D.  $U, V, C$  may be masked arrays, but masked  $X, Y$  are not supported at present.

Barbs are traditionally used in meteorology as a way to plot the speed and direction of wind observations, but can technically be used to plot any two dimensional vector quantity. As opposed to arrows, which give vector magnitude by the length of the arrow, the barbs give more quantitative information about the vector magnitude by putting slanted lines or a triangle for various increments in magnitude, as show schematically below:



The largest increment is given by a triangle (or “flag”). After those come full lines (barbs). The smallest increment is a half line. There is only, of course, ever at most 1 half line. If the magnitude is small and only needs a single half-line and no full lines or triangles, the half-line is offset from the end of the barb so that it can be easily distinguished from barbs with a single full line. The magnitude for the barb shown above would nominally be 65, using the standard increments of 50, 10, and 5.

See also [https://en.wikipedia.org/wiki/Wind\\_barb](https://en.wikipedia.org/wiki/Wind_barb).

**Parameters**

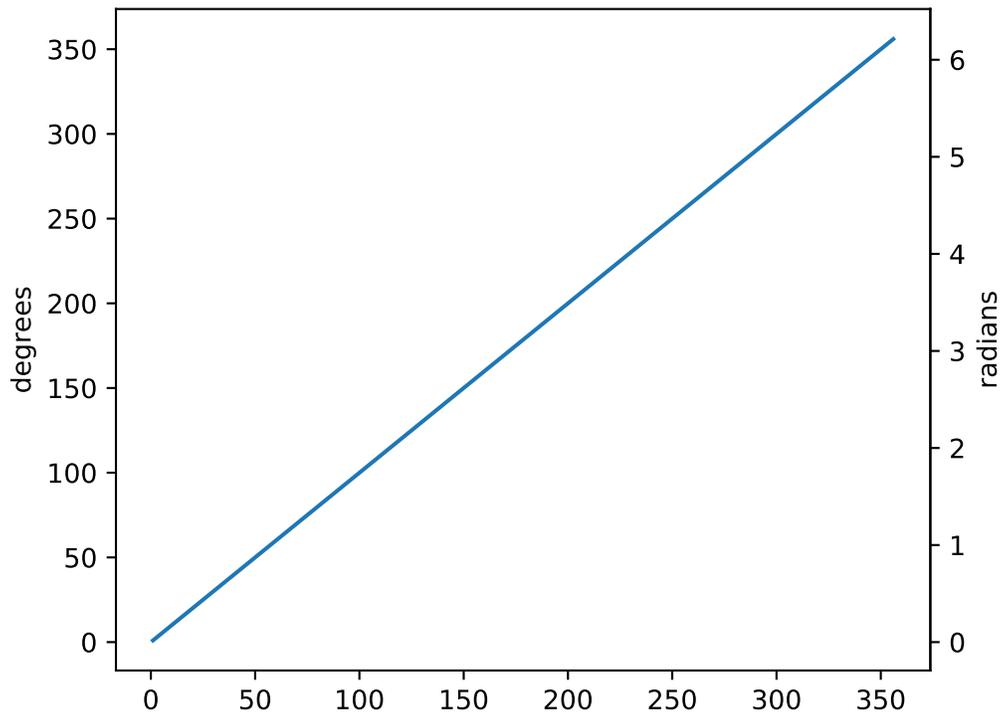
**X, Y** [1D or 2D array-like, optional] The x and y coordinates of the barb locations. See *pivot* for how the barbs are drawn to the x, y positions.

If not given, they will be generated as a uniform integer meshgrid based on the dimensions of  $U$  and  $V$ .

If  $X$  and  $Y$  are 1D but  $U, V$  are 2D,  $X, Y$  are expanded to 2D using  $x, y = \text{np.meshgrid}(X, Y)$ . In this case  $\text{len}(X)$  and  $\text{len}(Y)$  must match the column and row dimensions of  $U$  and  $V$ .

**U, V** [1D or 2D array-like] The x and y components of the barb shaft.

**C** [1D or 2D array-like, optional] Numeric data that defines the barb colors by colormapping via *norm* and *cmap*.



This does not support explicit colors. If you want to set colors directly, use *barbcolor* instead.

**length** [float, default: 7] Length of the barb in points; the other parts of the barb are scaled against this.

**pivot** [{'tip', 'middle'} or float, default: 'tip'] The part of the arrow that is anchored to the *X*, *Y* grid. The barb rotates about this point. This can also be a number, which shifts the start of the barb that many points away from grid point.

**barbcolor** [color or color sequence] Specifies the color of all parts of the barb except for the flags. This parameter is analogous to the *edgecolor* parameter for polygons, which can be used instead. However this parameter will override *facecolor*.

**flagcolor** [color or color sequence] Specifies the color of any flags on the barb. This parameter is analogous to the *facecolor* parameter for polygons, which can be used instead. However, this parameter will override *facecolor*. If this is not set (and *C* has not either) then *flagcolor* will be set to match *barbcolor* so that the barb has a uniform color. If *C* has been set, *flagcolor* has no effect.

**sizes** [dict, optional] A dictionary of coefficients specifying the ratio of a given feature to the length of the barb. Only those values one wishes to override need to be included. These features include:

- 'spacing' - space between features (flags, full/half barbs)

- 'height' - height (distance from shaft to top) of a flag or full barb
- 'width' - width of a flag, twice the width of a full barb
- 'emptybarb' - radius of the circle used for low magnitudes

**fill\_empty** [bool, default: False] Whether the empty barbs (circles) that are drawn should be filled with the flag color. If they are not filled, the center is transparent.

**rounding** [bool, default: True] Whether the vector magnitude should be rounded when allocating barb components. If True, the magnitude is rounded to the nearest multiple of the half-barb increment. If False, the magnitude is simply truncated to the next lowest multiple.

**barb\_increments** [dict, optional] A dictionary of increments specifying values to associate with different parts of the barb. Only those values one wishes to override need to be included.

- 'half' - half barbs (Default is 5)
- 'full' - full barbs (Default is 10)
- 'flag' - flags (default is 50)

**flip\_barb** [bool or array-like of bool, default: False] Whether the lines and flags should point opposite to normal. Normal behavior is for the barbs and lines to point right (comes from wind barbs having these features point towards low pressure in the Northern Hemisphere).

A single value is applied to all barbs. Individual barbs can be flipped by passing a bool array of the same size as *U* and *V*.

**Returns**

**barbs** [Barbs]

**Other Parameters**

**\*\*kwargs** The barbs can further be customized using *PolyCollection* keyword arguments:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and
<i>alpha</i>		float or None
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i> or <i>antialiaseds</i>		bool or sequence of bools
<i>array</i>		ndarray
<i>capstyle</i>		{'butt', 'round', 'projecting'}
<i>clim</i>		a length 2 sequence of floats; may be overridden in methods that have
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>cmap</i>		colormap or registered colormap name
<i>color</i>		color or sequence of rgba tuples
<i>contains</i>		callable
<i>edgecolor</i> or <i>ec</i> or <i>edgecolors</i>		color or sequence of colors or 'face'
<i>facecolor</i> or <i>facecolors</i> or <i>fc</i>		color or sequence of colors
<i>figure</i>		<i>Figure</i>

Continued on next page

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	Property	Description
<i>gid</i>	str	
<i>hatch</i>	{'/', '\', ' ', '-', '+', 'x', 'o', 'O', '.', '*'}	
<i>in_layout</i>	bool	
<i>joinstyle</i>	{'miter', 'round', 'bevel'}	
<i>label</i>	object	
<i>linestyle</i> or dashes or <i>linestyles</i> or <i>ls</i>	{'-', '--', '-.', ':', '', (offset, on-off-seq), ...}	
<i>linewidth</i> or <i>linewidths</i> or <i>lw</i>	float or sequence of floats	
<i>norm</i>	<i>Normalize</i>	
<i>offset_position</i>	{'screen', 'data'}	
<i>offsets</i>	float or sequence of floats	
<i>path_effects</i>	<i>AbstractPathEffect</i>	
<i>picker</i>	None or bool or float or callable	
<i>pickradius</i>	unknown	
<i>rasterized</i>	bool or None	
<i>sketch_params</i>	(scale: float, length: float, randomness: float)	
<i>snap</i>	bool or None	
<i>transform</i>	<i>Transform</i>	
<i>url</i>	str	
<i>urls</i>	List[str] or None	
<i>visible</i>	bool	
<i>zorder</i>	float	

## Notes

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

## Examples using `matplotlib.axes.Axes.barbs`

- `sphx_glr_gallery_images_contours_and_fields_barb_demo.py`

## `matplotlib.axes.Axes.quiver`

`Axes.quiver(self, *args, data=None, **kw)`

Plot a 2D field of arrows.

Call signature:

```
quiver([X, Y], U, V, [C], **kw)
```

Where  $X, Y$  define the arrow locations,  $U, V$  define the arrow directions, and  $C$  optionally sets the color.

### Arrow size

The default settings auto-scales the length of the arrows to a reasonable size. To change this behavior see the *scale* and *scale\_units* parameters.

### Arrow shape

The defaults give a slightly swept-back arrow; to make the head a triangle, make *headaxislength* the same as *headlength*. To make the arrow more pointed, reduce *headwidth* or increase *headlength* and *headaxislength*. To make the head smaller relative to the shaft, scale down all the head parameters. You will probably do best to leave *minshaft* alone.

### Arrow outline

*linewidths* and *edgecolors* can be used to customize the arrow outlines.

### Parameters

**X, Y** [1D or 2D array-like, optional] The x and y coordinates of the arrow locations.

If not given, they will be generated as a uniform integer meshgrid based on the dimensions of  $U$  and  $V$ .

If  $X$  and  $Y$  are 1D but  $U, V$  are 2D,  $X, Y$  are expanded to 2D using  $x, y = \text{np.meshgrid}(X, Y)$ . In this case  $\text{len}(X)$  and  $\text{len}(Y)$  must match the column and row dimensions of  $U$  and  $V$ .

**U, V** [1D or 2D array-like] The x and y direction components of the arrow vectors.

**C** [1D or 2D array-like, optional] Numeric data that defines the arrow colors by colormapping via *norm* and *cmap*.

This does not support explicit colors. If you want to set colors directly, use *color* instead.

**units** [{'width', 'height', 'dots', 'inches', 'x', 'y', 'xy'}, default: 'width'] The arrow dimensions (except for *length*) are measured in multiples of this unit.

The following values are supported:

- 'width', 'height': The width or height of the axis.
- 'dots', 'inches': Pixels or inches based on the figure dpi.
- 'x', 'y', 'xy':  $X, Y$  or  $\sqrt{X^2 + Y^2}$  in data units.

The arrows scale differently depending on the units. For 'x' or 'y', the arrows get larger as one zooms in; for other units, the arrow size is independent of the zoom state. For 'width' or 'height', the arrow size increases with the width and height of the axes, respectively, when the window is resized; for 'dots' or 'inches', resizing does not change the arrows.

**angles** [{'uv', 'xy'} or array-like, optional, default: 'uv'] Method for determining the angle of the arrows.

- `'uv'`: The arrow axis aspect ratio is 1 so that if  $U == V$  the orientation of the arrow on the plot is 45 degrees counter-clockwise from the horizontal axis (positive to the right).

Use this if the arrows symbolize a quantity that is not based on  $X, Y$  data coordinates.

- `'xy'`: Arrows point from  $(x,y)$  to  $(x+u, y+v)$ . Use this for plotting a gradient field, for example.
- Alternatively, arbitrary angles may be specified explicitly as an array of values in degrees, counter-clockwise from the horizontal axis.

In this case  $U, V$  is only used to determine the length of the arrows.

Note: inverting a data axis will correspondingly invert the arrows only with `angles='xy'`.

**scale** [float, optional] Number of data units per arrow length unit, e.g., m/s per plot width; a smaller scale parameter makes the arrow longer. Default is *None*.

If *None*, a simple autoscaling algorithm is used, based on the average vector length and the number of vectors. The arrow length unit is given by the `scale_units` parameter.

**scale\_units** [{'width', 'height', 'dots', 'inches', 'x', 'y', 'xy'}, optional] If the `scale` kwarg is *None*, the arrow length unit. Default is *None*.

e.g. `scale_units` is 'inches', `scale` is 2.0, and  $(u,v) = (1,0)$ , then the vector will be 0.5 inches long.

If `scale_units` is 'width' or 'height', then the vector will be half the width/height of the axes.

If `scale_units` is 'x' then the vector will be 0.5 x-axis units. To plot vectors in the x-y plane, with  $u$  and  $v$  having the same units as  $x$  and  $y$ , use `angles='xy', scale_units='xy', scale=1`.

**width** [float, optional] Shaft width in arrow units; default depends on choice of units, above, and number of vectors; a typical starting value is about 0.005 times the width of the plot.

**headwidth** [float, optional, default: 3] Head width as multiple of shaft width.

**headlength** [float, optional, default: 5] Head length as multiple of shaft width.

**headaxislength** [float, optional, default: 4.5] Head length at shaft intersection.

**minshaft** [float, optional, default: 1] Length below which arrow scales, in units of head length. Do not set this to less than 1, or small arrows will look terrible!

**minlength** [float, optional, default: 1] Minimum length as a multiple of shaft width; if an arrow length is less than this, plot a dot (hexagon) of this diameter instead.

**pivot** [{'tail', 'mid', 'middle', 'tip'}, optional, default: 'tail'] The part of the arrow that is anchored to the  $X, Y$  grid. The arrow rotates about this point.

'mid' is a synonym for 'middle'.

**color** [color or color sequence, optional] Explicit color(s) for the arrows. If *C* has been set, *color* has no effect.

This is a synonym for the *PolyCollection facecolor* parameter.

**Other Parameters**

**\*\*kwargs** [*PolyCollection* properties, optional] All other keyword arguments are passed on to *PolyCollection*:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and
<i>alpha</i>		float or None
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i> or <i>antialiaseds</i>		bool or sequence of bools
<i>array</i>		ndarray
<i>capstyle</i>		{'butt', 'round', 'projecting'}
<i>clim</i>		a length 2 sequence of floats; may be overridden in methods that have
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>cmap</i>		colormap or registered colormap name
<i>color</i>		color or sequence of rgba tuples
<i>contains</i>		callable
<i>edgecolor</i> or <i>ec</i> or <i>edgecolors</i>		color or sequence of colors or 'face'
<i>facecolor</i> or <i>facecolors</i> or <i>fc</i>		color or sequence of colors
<i>figure</i>		<i>Figure</i>
<i>gid</i>		str
<i>hatch</i>		{'/', '\', ' ', '-', '+', 'x', 'o', 'O', '.', '*'}
<i>in_layout</i>		bool
<i>joinstyle</i>		{'miter', 'round', 'bevel'}
<i>label</i>		object
<i>linestyle</i> or <i>dashes</i> or <i>linestyles</i> or <i>ls</i>		{'-', '--', '-.', ':', "", (offset, on-off-seq), ...}
<i>linewidth</i> or <i>linewidths</i> or <i>lw</i>		float or sequence of floats
<i>norm</i>		<i>Normalize</i>
<i>offset_position</i>		{'screen', 'data'}
<i>offsets</i>		float or sequence of floats
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		None or bool or float or callable
<i>pickradius</i>		unknown
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>transform</i>		<i>Transform</i>
<i>url</i>		str
<i>urls</i>		List[str] or None
<i>visible</i>		bool
<i>zorder</i>		float

**See also:**

*quiverkey* Add a key to a quiver plot.

**Examples using `matplotlib.axes.Axes.quiver`**

- sphx\_glr\_gallery\_images\_contours\_and\_fields\_quiver\_demo.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_quiver\_simple\_demo.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_trigradient\_demo.py

**`matplotlib.axes.Axes.quiverkey`**

`Axes.quiverkey(self, Q, X, Y, U, label, **kw)`

Add a key to a quiver plot.

Call signature:

```
quiverkey(Q, X, Y, U, label, **kw)
```

Arguments:

**Q:** The Quiver instance returned by a call to `quiver`.

**X, Y:** The location of the key; additional explanation follows.

**U:** The length of the key

**label:** A string with the length and units of the key

Keyword arguments:

**angle = 0** The angle of the key arrow. Measured in degrees anti-clockwise from the x-axis.

**coordinates = [ 'axes' | 'figure' | 'data' | 'inches' ]** Coordinate system and units for X, Y: 'axes' and 'figure' are normalized coordinate systems with 0,0 in the lower left and 1,1 in the upper right; 'data' are the axes data coordinates (used for the locations of the vectors in the quiver plot itself); 'inches' is position in the figure in inches, with 0,0 at the lower left corner.

**color:** overrides face and edge colors from Q.

**labelpos = [ 'N' | 'S' | 'E' | 'W' ]** Position the label above, below, to the right, to the left of the arrow, respectively.

**labelsep:** Distance in inches between the arrow and the label. Default is 0.1

**labelcolor:** defaults to default *Text* color.

**fontproperties:** A dictionary with keyword arguments accepted by the *FontProperties* initializer: *family, style, variant, size, weight*

Any additional keyword arguments are used to override vector properties taken from Q.

The positioning of the key depends on X, Y, *coordinates*, and *labelpos*. If *labelpos* is 'N' or 'S', X, Y give the position of the middle of the key arrow. If *labelpos* is 'E', X, Y positions the head, and if *labelpos* is 'W', X, Y positions the tail; in either of these two cases, X, Y is somewhere in the middle of the arrow+label key object.

**Examples using `matplotlib.axes.Axes.quiverkey`**

- `sphx_glr_gallery_images_contours_and_fields_quiver_demo.py`
- `sphx_glr_gallery_images_contours_and_fields_quiver_simple_demo.py`

**`matplotlib.axes.Axes.streamplot`**

```
Axes.streamplot(axes, x, y, u, v, density=1, linewidth=None, color=None, cmap=None,
               norm=None, arrowsize=1, arrowstyle='->', minlength=0.1, transform=None,
               zorder=None, start_points=None, maxlength=4.0, integration_direction='both', *, data=None)
```

Draw streamlines of a vector flow.

**Parameters**

**x, y** [1D arrays] An evenly spaced grid.

**u, v** [2D arrays] *x* and *y*-velocities. The number of rows and columns must match the length of *y* and *x*, respectively.

**density** [float or (float, float)] Controls the closeness of streamlines. When `density = 1`, the domain is divided into a 30x30 grid. *density* linearly scales this grid. Each cell in the grid can have, at most, one traversing streamline. For different densities in each direction, use a tuple (`density_x`, `density_y`).

**linewidth** [float or 2D array] The width of the stream lines. With a 2D array the line width can be varied across the grid. The array must have the same shape as *u* and *v*.

**color** [matplotlib color code, or 2D array] The streamline color. If given an array, its values are converted to colors using *cmap* and *norm*. The array must have the same shape as *u* and *v*.

**cmap** [*Colormap*] Colormap used to plot streamlines and arrows. This is only used if *color* is an array.

**norm** [*Normalize*] Normalize object used to scale luminance data to 0, 1. If `None`, stretch (min, max) to (0, 1). This is only used if *color* is an array.

**arrowsize** [float] Scaling factor for the arrow size.

**arrowstyle** [str] Arrow style specification. See *FancyArrowPatch*.

**minlength** [float] Minimum length of streamline in axes coordinates.

**start\_points** [Nx2 array] Coordinates of starting points for the streamlines in data coordinates (the same coordinates as the *x* and *y* arrays).

**zorder** [int] The zorder of the stream lines and arrows. Artists with lower zorder values are drawn first.

**maxlength** [float] Maximum length of streamline in axes coordinates.

**integration\_direction** [{'forward', 'backward', 'both'}] Integrate the streamline in forward, backward or both directions. default is 'both'.

**Returns**

**stream\_container** [StreamplotSet] Container object with attributes

- `lines`: *LineCollection* of streamlines
- `arrows`: *PatchCollection* containing *FancyArrowPatch* objects representing the arrows half-way along stream lines.

This container will probably change in the future to allow changes to the colormap, alpha, etc. for both lines and arrows, but these changes should be backward compatible.

## Notes

---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'start\_points', 'u', 'v', 'x', 'y'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

## Examples using `matplotlib.axes.Axes.streamplot`

- `sphx_glr_gallery_images_contours_and_fields_plot_streamplot.py`

## 17.5.4 Clearing

<code>Axes.cla</code>	Clear the current axes.
<code>Axes.clear</code>	Clear the axes.

### `matplotlib.axes.Axes.cla`

`Axes.cla(self)`  
Clear the current axes.

### Examples using `matplotlib.axes.Axes.cla`

- `sphx_glr_gallery_misc_custom_projection.py`

### `matplotlib.axes.Axes.clear`

`Axes.clear(self)`  
Clear the axes.

## 17.5.5 Appearance

<i>Axes.axis</i>	Convenience method to get or set some axis properties.
<i>Axes.set_axis_off</i>	Turn the x- and y-axis off.
<i>Axes.set_axis_on</i>	Turn the x- and y-axis on.
<i>Axes.set_frame_on</i>	Set whether the axes rectangle patch is drawn.
<i>Axes.get_frame_on</i>	Get whether the axes rectangle patch is drawn.
<i>Axes.set_axisbelow</i>	Set whether axis ticks and gridlines are above or below most artists.
<i>Axes.get_axisbelow</i>	Get whether axis ticks and gridlines are above or below most artists.
<i>Axes.grid</i>	Configure the grid lines.
<i>Axes.get_facecolor</i>	Get the facecolor of the Axes.
<i>Axes.get_fc</i>	Get the facecolor of the Axes.
<i>Axes.set_facecolor</i>	Set the facecolor of the Axes.
<i>Axes.set_fc</i>	Set the facecolor of the Axes.

### matplotlib.axes.Axes.axis

`Axes.axis(self, *args, **kwargs)`

Convenience method to get or set some axis properties.

Call signatures:

```
xmin, xmax, ymin, ymax = axis()
xmin, xmax, ymin, ymax = axis([xmin, xmax, ymin, ymax])
xmin, xmax, ymin, ymax = axis(option)
xmin, xmax, ymin, ymax = axis(**kwargs)
```

#### Parameters

**xmin, xmax, ymin, ymax** [float, optional] The axis limits to be set. Either none or all of the limits must be given. This can also be achieved using

```
ax.set(xlim=(xmin, xmax), ylim=(ymin, ymax))
```

**option** [bool or str] If a bool, turns axis lines and labels on or off. If a string, possible values are:

Value	Description
'on'	Turn on axis lines and labels. Same as <code>True</code> .
'off'	Turn off axis lines and labels. Same as <code>False</code> .
'equal'	Set equal scaling (i.e., make circles circular) by changing axis limits.
'scaled'	Set equal scaling (i.e., make circles circular) by changing dimensions of the plot box.
'tight'	Set limits just large enough to show all data.
'auto'	Automatic scaling (fill plot box with data).
'normal'	Same as 'auto'; deprecated.
'image'	'scaled' with axis limits equal to data limits.
'square'	Square plot; similar to 'scaled', but initially forcing <code>xmax-xmin = ymax-ymin</code> .

**emit** [bool, optional, default `True`] Whether observers are notified of the axis limit change. This option is passed on to `set_xlim` and `set_ylim`.

### Returns

**xmin, xmax, ymin, ymax** [float] The axis limits.

### See also:

`matplotlib.axes.Axes.set_xlim`

`matplotlib.axes.Axes.set_ylim`

### Examples using `matplotlib.axes.Axes.axis`

- `sphx_glr_gallery_lines_bars_and_markers_fill.py`

### `matplotlib.axes.Axes.set_axis_off`

`Axes.set_axis_off(self)`

Turn the x- and y-axis off.

This affects the axis lines, ticks, ticklabels, grid and axis labels.

### Examples using `matplotlib.axes.Axes.set_axis_off`

- `sphx_glr_gallery_images_contours_and_fields_image_transparency_blend.py`
- `sphx_glr_gallery_pie_and_polar_charts_nested_pie.py`
- `sphx_glr_gallery_color_colormap_reference.py`

### matplotlib.axes.Axes.set\_axis\_on

`Axes.set_axis_on(self)`

Turn the x- and y-axis on.

This affects the axis lines, ticks, ticklabels, grid and axis labels.

### matplotlib.axes.Axes.set\_frame\_on

`Axes.set_frame_on(self, b)`

Set whether the axes rectangle patch is drawn.

#### Parameters

**b** [bool]

### matplotlib.axes.Axes.get\_frame\_on

`Axes.get_frame_on(self)`

Get whether the axes rectangle patch is drawn.

### matplotlib.axes.Axes.set\_axisbelow

`Axes.set_axisbelow(self, b)`

Set whether axis ticks and gridlines are above or below most artists.

This controls the zorder of the ticks and gridlines. For more information on the zorder see [/gallery/misc/zorder\\_demo](#).

#### Parameters

**b** [bool or 'line'] Possible values:

- *True* (zorder = 0.5): Ticks and gridlines are below all Artists.
- *'line'* (zorder = 1.5): Ticks and gridlines are above patches (e.g. rectangles, with default zorder = 1) but still below lines and markers (with their default zorder = 2).
- *False* (zorder = 2.5): Ticks and gridlines are above patches and lines / markers.

#### See also:

`get_axisbelow`

### matplotlib.axes.Axes.get\_axisbelow

`Axes.get_axisbelow(self)`

Get whether axis ticks and gridlines are above or below most artists.

#### Returns

**axisbelow** [bool or 'line']

#### See also:

`set_axisbelow`**matplotlib.axes.Axes.grid**`Axes.grid(self, b=None, which='major', axis='both', **kwargs)`

Configure the grid lines.

**Parameters**

**b** [bool or None, optional] Whether to show the grid lines. If any *kwargs* are supplied, it is assumed you want the grid on and *b* will be set to True.

If *b* is *None* and there are no *kwargs*, this toggles the visibility of the lines.

**which** [{'major', 'minor', 'both'}, optional] The grid lines to apply the changes on.

**axis** [{'both', 'x', 'y'}, optional] The axis to apply the changes on.

**\*\*kwargs** [*Line2D* properties] Define the line properties of the grid, e.g.:

```
grid(color='r', linestyle='-', linewidth=2)
```

Valid *kwargs* are

	Property	Description
<code>agg_filter</code>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<code>alpha</code>	float	
<code>animated</code>	bool	
<code>antialiased</code> or <code>aa</code>	bool	
<code>clip_box</code>	<i>Bbox</i>	
<code>clip_on</code>	bool	
<code>clip_path</code>	[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]	
<code>color</code> or <code>c</code>	color	
<code>contains</code>	callable	
<code>dash_capstyle</code>	{'butt', 'round', 'projecting'}	
<code>dash_joinstyle</code>	{'miter', 'round', 'bevel'}	
<code>dashes</code>	sequence of floats (on/off ink in points) or (None, None)	
<code>drawstyle</code> or <code>ds</code>	{'default', 'steps', 'steps-pre', 'steps-mid', 'steps-post'}, default: 'default'	
<code>figure</code>	<i>Figure</i>	
<code>fillstyle</code>	{'full', 'left', 'right', 'bottom', 'top', 'none'}	
<code>gid</code>	str	
<code>in_layout</code>	bool	
<code>label</code>	object	
<code>linestyle</code> or <code>ls</code>	{'-', '--', '-.', ':', '', (offset, on-off-seq), ...}	
<code>linewidth</code> or <code>lw</code>	float	
<code>marker</code>		marker style
<code>markeredgecolor</code> or <code>mec</code>	color	
<code>markeredgewidth</code> or <code>mew</code>	float	
<code>markerfacecolor</code> or <code>mfc</code>	color	
<code>markerfacecoloralt</code> or <code>mfcalt</code>	color	
<code>markersize</code> or <code>ms</code>	float	
<code>markevery</code>	None or int or (int, int) or slice or List[int] or float or (float, float)	

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	Property	Description
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		float or callable[[Artist, Event], Tuple[bool, dict]]
<i>pickradius</i>		float
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>solid_capstyle</i>		{'butt', 'round', 'projecting'}
<i>solid_joinstyle</i>		{'miter', 'round', 'bevel'}
<i>transform</i>		<i>matplotlib.transforms.Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>xdata</i>		1D array
<i>ydata</i>		1D array
<i>zorder</i>		float

### Notes

The axis is drawn as a unit, so the effective *zorder* for drawing the grid is determined by the *zorder* of each axis, not by the *zorder* of the *Line2D* objects comprising the grid. Therefore, to set grid *zorder*, use *set\_axisbelow* or, for more control, call the *set\_zorder* method of each axis.

### matplotlib.axes.Axes.get\_facecolor

`Axes.get_facecolor(self)`  
Get the facecolor of the Axes.

### matplotlib.axes.Axes.get\_fc

`Axes.get_fc(self)`  
Get the facecolor of the Axes.

### matplotlib.axes.Axes.set\_facecolor

`Axes.set_facecolor(self, color)`  
Set the facecolor of the Axes.

### Parameters

**color** [color]

### Examples using matplotlib.axes.Axes.set\_facecolor

- sphx\_glr\_gallery\_color\_color\_demo.py
- sphx\_glr\_gallery\_color\_color\_cycle\_default.py

**matplotlib.axes.Axes.set\_fc**`Axes.set_fc(self, color)`

Set the facecolor of the Axes.

**Parameters****color** [color]**17.5.6 Property cycle**`Axes.set_prop_cycle`

Set the property cycle of the Axes.

**matplotlib.axes.Axes.set\_\_prop\_\_cycle**`Axes.set_prop_cycle(self, *args, **kwargs)`

Set the property cycle of the Axes.

The property cycle controls the style properties such as color, marker and linestyle of future plot commands. The style properties of data already added to the Axes are not modified.

Call signatures:

```
set_prop_cycle(cycler)
set_prop_cycle(label=values[, label2=values2[, ...]])
set_prop_cycle(label, values)
```

Form 1 sets given `Cycler` object.

Form 2 creates a `Cycler` which cycles over one or more properties simultaneously and set it as the property cycle of the axes. If multiple properties are given, their value lists must have the same length. This is just a shortcut for explicitly creating a `cycler` and passing it to the function, i.e. it's short for `set_prop_cycle(cycler(label=values label2=values2, ...))`.

Form 3 creates a `Cycler` for a single property and set it as the property cycle of the axes. This form exists for compatibility with the original `cycler.cycler` interface. Its use is discouraged in favor of the kwarg form, i.e. `set_prop_cycle(label=values)`.

**Parameters**

**cycler** [`Cycler`] Set the given `Cycler`. *None* resets to the cycle defined by the current style.

**label** [str] The property key. Must be a valid *Artist* property. For example, 'color' or 'linestyle'. Aliases are allowed, such as 'c' for 'color' and 'lw' for 'linewidth'.

**values** [iterable] Finite-length iterable of the property values. These values are validated and will raise a `ValueError` if invalid.

**See also:**

`matplotlib.rcsetup.cycler` Convenience function for creating validated cyclers for properties.

`cycler.cycler` The original function for creating unvalidated cyclers.

## Examples

Setting the property cycle for a single property:

```
>>> ax.set_prop_cycle(color=['red', 'green', 'blue'])
```

Setting the property cycle for simultaneously cycling over multiple properties (e.g. red circle, green plus, blue cross):

```
>>> ax.set_prop_cycle(color=['red', 'green', 'blue'],  
...                  marker=['o', '+', 'x'])
```

## Examples using `matplotlib.axes.Axes.set_prop_cycle`

- `sphx_glr_gallery_color_color_cycler.py`
- *Styling with `cycler`*

## 17.5.7 Axis / limits

---

<code>Axes.get_xaxis</code>	Return the XAxis instance.
<code>Axes.get_yaxis</code>	Return the YAxis instance.

---

### `matplotlib.axes.Axes.get_xaxis`

`Axes.get_xaxis(self)`  
Return the XAxis instance.

### `matplotlib.axes.Axes.get_yaxis`

`Axes.get_yaxis(self)`  
Return the YAxis instance.

## Axis Limits and direction

---

<code>Axes.invert_xaxis</code>	Invert the x-axis.
<code>Axes.xaxis_inverted</code>	Return whether the x-axis is inverted.
<code>Axes.invert_yaxis</code>	Invert the y-axis.
<code>Axes.yaxis_inverted</code>	Return whether the y-axis is inverted.
<code>Axes.set_xlim</code>	Set the x-axis view limits.
<code>Axes.get_xlim</code>	Return the x-axis view limits.
<code>Axes.set_ylim</code>	Set the y-axis view limits.
<code>Axes.get_ylim</code>	Return the y-axis view limits.
<code>Axes.update_datalim</code>	Extend the <code>dataLim</code> BBox to include the given points.

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<code>Axes.update_datalim_bounds</code>	Extend the <code>datalim</code> BBox to include the given <code>Bbox</code> .
<code>Axes.set_xbound</code>	Set the lower and upper numerical bounds of the x-axis.
<code>Axes.get_xbound</code>	Return the lower and upper x-axis bounds, in increasing order.
<code>Axes.set_ybound</code>	Set the lower and upper numerical bounds of the y-axis.
<code>Axes.get_ybound</code>	Return the lower and upper y-axis bounds, in increasing order.

**matplotlib.axes.Axes.invert\_xaxis**

`Axes.invert_xaxis(self)`  
Invert the x-axis.

**See also:**

`xaxis_inverted`  
`get_xlim, set_xlim`  
`get_xbound, set_xbound`

**matplotlib.axes.Axes.xaxis\_inverted**

`Axes.xaxis_inverted(self)`  
Return whether the x-axis is inverted.

The axis is inverted if the left value is larger than the right value.

**See also:**

`invert_xaxis`  
`get_xlim, set_xlim`  
`get_xbound, set_xbound`

**matplotlib.axes.Axes.invert\_yaxis**

`Axes.invert_yaxis(self)`  
Invert the y-axis.

**See also:**

`yaxis_inverted`  
`get_ylim, set_ylim`  
`get_ybound, set_ybound`

**matplotlib.axes.Axes.yaxis\_inverted**`Axes.yaxis_inverted(self)`

Return whether the y-axis is inverted.

The axis is inverted if the bottom value is larger than the top value.

**See also:**`invert_yaxis``get_ylim, set_ylim``get_ybound, set_ybound`**matplotlib.axes.Axes.set\_xlim**`Axes.set_xlim(self, left=None, right=None, emit=True, auto=False, *, xmin=None, xmax=None)`

Set the x-axis view limits.

**Parameters**

**left** [scalar, optional] The left xlim in data coordinates. Passing *None* leaves the limit unchanged.

The left and right xlims may be passed as the tuple (*left, right*) as the first positional argument (or as the *left* keyword argument).

**right** [scalar, optional] The right xlim in data coordinates. Passing *None* leaves the limit unchanged.

**emit** [bool, optional] Whether to notify observers of limit change (default: True).

**auto** [bool or None, optional] Whether to turn on autoscaling of the x-axis. True turns on, False turns off (default action), None leaves unchanged.

**xmin, xmax** [scalar, optional] They are equivalent to left and right respectively, and it is an error to pass both *xmin* and *left* or *xmax* and *right*.

**Returns**

**left, right** [(float, float)] The new x-axis limits in data coordinates.

**See also:**`get_xlim``set_xbound, get_xbound``invert_xaxis, xaxis_inverted`**Notes**

The *left* value may be greater than the *right* value, in which case the x-axis values will decrease from left to right.

## Examples

```
>>> set_xlim(left, right)
>>> set_xlim((left, right))
>>> left, right = set_xlim(left, right)
```

One limit may be left unchanged.

```
>>> set_xlim(right=right_lim)
```

Limits may be passed in reverse order to flip the direction of the x-axis. For example, suppose *x* represents the number of years before present. The x-axis limits might be set like the following so 5000 years ago is on the left of the plot and the present is on the right.

```
>>> set_xlim(5000, 0)
```

## Examples using `matplotlib.axes.Axes.set_xlim`

- `sphx_glr_gallery_shapes_and_collections_donut.py`
- `sphx_glr_gallery_misc_custom_projection.py`

## `matplotlib.axes.Axes.get_xlim`

`Axes.get_xlim(self)`

Return the x-axis view limits.

### Returns

**left, right** [(float, float)] The current x-axis limits in data coordinates.

### See also:

`set_xlim`

`set_xbound`, `get_xbound`

`invert_xaxis`, `xaxis_inverted`

### Notes

The x-axis may be inverted, in which case the *left* value will be greater than the *right* value.

## `matplotlib.axes.Axes.set_ylim`

`Axes.set_ylim(self, bottom=None, top=None, emit=True, auto=False, *, ymin=None, ymax=None)`

Set the y-axis view limits.

### Parameters

**bottom** [scalar, optional] The bottom ylim in data coordinates. Passing *None* leaves the limit unchanged.

The bottom and top ylims may be passed as the tuple (*bottom*, *top*) as the first positional argument (or as the *bottom* keyword argument).

**top** [scalar, optional] The top ylim in data coordinates. Passing *None* leaves the limit unchanged.

**emit** [bool, optional] Whether to notify observers of limit change (default: *True*).

**auto** [bool or *None*, optional] Whether to turn on autoscaling of the y-axis. *True* turns on, *False* turns off (default action), *None* leaves unchanged.

**ymin, ymax** [scalar, optional] They are equivalent to *bottom* and *top* respectively, and it is an error to pass both *ymin* and *bottom* or *ymax* and *top*.

### Returns

**bottom, top** [(float, float)] The new y-axis limits in data coordinates.

### See also:

*get\_ylim*

*set\_ybound*, *get\_ybound*

*invert\_yaxis*, *yaxis\_inverted*

### Notes

The *bottom* value may be greater than the *top* value, in which case the y-axis values will decrease from *bottom* to *top*.

### Examples

```
>>> set_ylim(bottom, top)
>>> set_ylim((bottom, top))
>>> bottom, top = set_ylim(bottom, top)
```

One limit may be left unchanged.

```
>>> set_ylim(top=top_lim)
```

Limits may be passed in reverse order to flip the direction of the y-axis. For example, suppose *y* represents depth of the ocean in m. The y-axis limits might be set like the following so 5000 m depth is at the bottom of the plot and the surface, 0 m, is at the top.

```
>>> set_ylim(5000, 0)
```

### Examples using `matplotlib.axes.Axes.set_ylim`

- `sphx_glr_gallery_pyplots_align_ylabel.py`

- sphx\_glr\_gallery\_shapes\_and\_collections\_donut.py
- sphx\_glr\_gallery\_misc\_custom\_projection.py

### matplotlib.axes.Axes.get\_ylim

`Axes.get_ylim(self)`

Return the y-axis view limits.

#### Returns

**bottom, top** [(float, float)] The current y-axis limits in data coordinates.

#### See also:

`set_ylim`

`set_ybound, get_ybound`

`invert_yaxis, yaxis_inverted`

#### Notes

The y-axis may be inverted, in which case the *bottom* value will be greater than the *top* value.

### matplotlib.axes.Axes.update\_datalim

`Axes.update_datalim(self, xys, updatex=True, updatey=True)`

Extend the dataLim BBox to include the given points.

If no data is set currently, the BBox will ignore its limits and set the bound to be the bounds of the xydata (*xys*). Otherwise, it will compute the bounds of the union of its current data and the data in *xys*.

#### Parameters

**xys** [2D array-like] The points to include in the data limits BBox. This can be either a list of (x, y) tuples or a Nx2 array.

**updatex, updatey** [bool, optional, default *True*] Whether to update the x/y limits.

### matplotlib.axes.Axes.update\_datalim\_bounds

`Axes.update_datalim_bounds(self, bounds)`

Extend the dataLim BBox to include the given *Bbox*.

#### Parameters

**bounds** [*Bbox*]

**matplotlib.axes.Axes.set\_xbound**

`Axes.set_xbound(self, lower=None, upper=None)`

Set the lower and upper numerical bounds of the x-axis.

This method will honor axes inversion regardless of parameter order. It will not change the autoscaling setting (`Axes._autoscaleXon`).

**Parameters**

**lower, upper** [float or None] The lower and upper bounds. If *None*, the respective axis bound is not modified.

**See also:**

`get_xbound`

`get_xlim, set_xlim`

`invert_xaxis, xaxis_inverted`

**matplotlib.axes.Axes.get\_xbound**

`Axes.get_xbound(self)`

Return the lower and upper x-axis bounds, in increasing order.

**See also:**

`set_xbound`

`get_xlim, set_xlim`

`invert_xaxis, xaxis_inverted`

**matplotlib.axes.Axes.set\_ybound**

`Axes.set_ybound(self, lower=None, upper=None)`

Set the lower and upper numerical bounds of the y-axis.

This method will honor axes inversion regardless of parameter order. It will not change the autoscaling setting (`Axes._autoscaleYon`).

**Parameters**

**lower, upper** [float or None] The lower and upper bounds. If *None*, the respective axis bound is not modified.

**See also:**

`get_ybound`

`get_ylim, set_ylim`

`invert_yaxis, yaxis_inverted`

**matplotlib.axes.Axes.get\_ybound**`Axes.get_ybound(self)`

Return the lower and upper y-axis bounds, in increasing order.

**See also:**`set_ybound``get_ylim, set_ylim``invert_yaxis, yaxis_inverted`**Axis Labels, title, and legend**

<code>Axes.set_xlabel</code>	Set the label for the x-axis.
<code>Axes.get_xlabel</code>	Get the xlabel text string.
<code>Axes.set_ylabel</code>	Set the label for the y-axis.
<code>Axes.get_ylabel</code>	Get the ylabel text string.
<code>Axes.set_title</code>	Set a title for the axes.
<code>Axes.get_title</code>	Get an axes title.
<code>Axes.legend</code>	Place a legend on the axes.
<code>Axes.get_legend</code>	Return the Legend instance, or None if no legend is defined.
<code>Axes.get_legend_handles_labels</code>	Return handles and labels for legend

**matplotlib.axes.Axes.set\_xlabel**`Axes.set_xlabel(self, xlabel, fontdict=None, labelpad=None, **kwargs)`

Set the label for the x-axis.

**Parameters****xlabel** [str] The label text.**labelpad** [scalar, optional, default: None] Spacing in points from the axes bounding box including ticks and tick labels.**Other Parameters****\*\*kwargs** [*Text* properties] *Text* properties control the appearance of the label.**See also:**`text` for information on how override and the optional args work**Examples using matplotlib.axes.Axes.set\_xlabel**

- sphx\_glr\_gallery\_statistics\_histogram\_features.py
- sphx\_glr\_gallery\_pyplots\_fig\_axes\_labels\_simple.py
- sphx\_glr\_gallery\_pyplots\_text\_commands.py
- sphx\_glr\_gallery\_color\_color\_demo.py

### matplotlib.axes.Axes.get\_xlabel

`Axes.get_xlabel(self)`  
Get the xlabel text string.

### matplotlib.axes.Axes.set\_ylabel

`Axes.set_ylabel(self, ylabel, fontdict=None, labelpad=None, **kwargs)`  
Set the label for the y-axis.

#### Parameters

**ylabel** [str] The label text.

**labelpad** [scalar, optional, default: None] Spacing in points from the axes bounding box including ticks and tick labels.

#### Other Parameters

**\*\*kwargs** [*Text* properties] *Text* properties control the appearance of the label.

#### See also:

`text` for information on how override and the optional args work

### Examples using matplotlib.axes.Axes.set\_ylabel

- sphx\_glr\_gallery\_statistics\_histogram\_features.py
- sphx\_glr\_gallery\_pyplots\_align\_ylabels.py
- sphx\_glr\_gallery\_pyplots\_fig\_axes\_labels\_simple.py
- sphx\_glr\_gallery\_pyplots\_text\_commands.py
- sphx\_glr\_gallery\_color\_color\_demo.py

### matplotlib.axes.Axes.get\_ylabel

`Axes.get_ylabel(self)`  
Get the ylabel text string.

### matplotlib.axes.Axes.set\_title

`Axes.set_title(self, label, fontdict=None, loc='center', pad=None, **kwargs)`  
Set a title for the axes.

Set one of the three available axes titles. The available titles are positioned above the axes in the center, flush with the left edge, and flush with the right edge.

#### Parameters

**label** [str] Text to use for the title

**fontdict** [dict] A dictionary controlling the appearance of the title text, the default fontdict is:

```
{'fontsize': rcParams['axes.titlesize'],
 'fontweight' : rcParams['axes.titleweight'],
 'verticalalignment': 'baseline',
 'horizontalalignment': loc}
```

**loc** [{'center', 'left', 'right'}, str, optional] Which title to set, defaults to 'center'

**pad** [float] The offset of the title from the top of the axes, in points. Default is None to use rcParams['axes.titlepad'].

### Returns

**text** [*Text*] The matplotlib text instance representing the title

### Other Parameters

**\*\*kwargs** [*Text* properties] Other keyword arguments are text properties, see *Text* for a list of valid text properties.

### Examples using matplotlib.axes.Axes.set\_title

- sphx\_glr\_gallery\_statistics\_histogram\_features.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_font\_file.py
- sphx\_glr\_gallery\_pyplots\_align\_ylabels.py
- sphx\_glr\_gallery\_pyplots\_fig\_axes\_labels\_simple.py
- sphx\_glr\_gallery\_pyplots\_text\_commands.py
- sphx\_glr\_gallery\_color\_color\_demo.py
- sphx\_glr\_gallery\_shapes\_and\_collections\_donut.py

### matplotlib.axes.Axes.get\_title

`Axes.get_title(self, loc='center')`

Get an axes title.

Get one of the three available axes titles. The available titles are positioned above the axes in the center, flush with the left edge, and flush with the right edge.

### Parameters

**loc** [{'center', 'left', 'right'}, str, optional] Which title to get, defaults to 'center'.

### Returns

**title** [str] The title text string.

**matplotlib.axes.Axes.legend**

`Axes.legend(self, *args, **kwargs)`  
Place a legend on the axes.

Call signatures:

```
legend()
legend(labels)
legend(handles, labels)
```

The call signatures correspond to three different ways how to use this method.

**1. Automatic detection of elements to be shown in the legend**

The elements to be added to the legend are automatically determined, when you do not pass in any extra arguments.

In this case, the labels are taken from the artist. You can specify them either at artist creation or by calling the `set_label()` method on the artist:

```
line, = ax.plot([1, 2, 3], label='Inline label')
ax.legend()
```

or:

```
line, = ax.plot([1, 2, 3])
line.set_label('Label via method')
ax.legend()
```

Specific lines can be excluded from the automatic legend element selection by defining a label starting with an underscore. This is default for all artists, so calling `Axes.legend` without any arguments and without setting the labels manually will result in no legend being drawn.

**2. Labeling existing plot elements**

To make a legend for lines which already exist on the axes (via plot for instance), simply call this function with an iterable of strings, one for each legend item. For example:

```
ax.plot([1, 2, 3])
ax.legend(['A simple line'])
```

Note: This way of using is discouraged, because the relation between plot elements and labels is only implicit by their order and can easily be mixed up.

**3. Explicitly defining the elements in the legend**

For full control of which artists have a legend entry, it is possible to pass an iterable of legend artists followed by an iterable of legend labels respectively:

```
legend((line1, line2, line3), ('label1', 'label2', 'label3'))
```

**Parameters**

**handles** [sequence of *Artist*, optional] A list of Artists (lines, patches) to be added to the legend. Use this together with *labels*, if you need full control on what is shown in the legend and the automatic mechanism described above is not sufficient.

The length of handles and labels should be the same in this case. If they are not, they are truncated to the smaller length.

**labels** [sequence of strings, optional] A list of labels to show next to the artists. Use this together with *handles*, if you need full control on what is shown in the legend and the automatic mechanism described above is not sufficient.

## Returns

`matplotlib.legend.Legend` instance

## Other Parameters

**loc** [str or pair of floats, default: `rcParams["legend.loc"]`] ('best' for axes, 'upper right' for figures) The location of the legend.

The strings 'upper left', 'upper right', 'lower left', 'lower right' place the legend at the corresponding corner of the axes/figure.

The strings 'upper center', 'lower center', 'center left', 'center right' place the legend at the center of the corresponding edge of the axes/figure.

The string 'center' places the legend at the center of the axes/figure.

The string 'best' places the legend at the location, among the nine locations defined so far, with the minimum overlap with other drawn artists. This option can be quite slow for plots with large amounts of data; your plotting speed may benefit from providing a specific location.

The location can also be a 2-tuple giving the coordinates of the lower-left corner of the legend in axes coordinates (in which case *bbox\_to\_anchor* will be ignored).

For back-compatibility, 'center right' (but no other location) can also be spelled 'right', and each "string" locations can also be given as a numeric value:

Location String	Location Code
'best'	0
'upper right'	1
'upper left'	2
'lower left'	3
'lower right'	4
'right'	5
'center left'	6
'center right'	7
'lower center'	8
'upper center'	9
'center'	10

**bbox\_to\_anchor** [*BboxBase*, 2-tuple, or 4-tuple of floats] Box that is used to position the legend in conjunction with *loc*. Defaults to `axes.bbox` (if called as a method to `Axes.legend`) or `figure.bbox` (if `Figure.legend`). This argument allows arbitrary placement of the legend.

Bbox coordinates are interpreted in the coordinate system given by `bbox_transform`, with the default transform `Axes` or `Figure` coordinates,

depending on which legend is called.

If a 4-tuple or *BboxBase* is given, then it specifies the *bbox* (*x*, *y*, *width*, *height*) that the legend is placed in. To put the legend in the best location in the bottom right quadrant of the axes (or figure):

```
loc='best', bbox_to_anchor=(0.5, 0., 0.5, 0.5)
```

A 2-tuple (*x*, *y*) places the corner of the legend specified by *loc* at *x*, *y*. For example, to put the legend's upper right-hand corner in the center of the axes (or figure) the following keywords can be used:

```
loc='upper right', bbox_to_anchor=(0.5, 0.5)
```

**ncol** [integer] The number of columns that the legend has. Default is 1.

**prop** [None or *matplotlib.font\_manager.FontProperties* or dict] The font properties of the legend. If None (default), the current *matplotlib.rcParams* will be used.

**fontsize** [int or float or {'xx-small', 'x-small', 'small', 'medium', 'large', 'x-large', 'xx-large'}] Controls the font size of the legend. If the value is numeric the size will be the absolute font size in points. String values are relative to the current default font size. This argument is only used if *prop* is not specified.

**numpoints** [None or int] The number of marker points in the legend when creating a legend entry for a *Line2D* (line). Default is None, which will take the value from *rcParams*["*legend.numpoints*"].

**scatterpoints** [None or int] The number of marker points in the legend when creating a legend entry for a *PathCollection* (scatter plot). Default is None, which will take the value from *rcParams*["*legend.scatterpoints*"].

**scatteryoffsets** [iterable of floats] The vertical offset (relative to the font size) for the markers created for a scatter plot legend entry. 0.0 is at the base the legend text, and 1.0 is at the top. To draw all markers at the same height, set to [0.5]. Default is [0.375, 0.5, 0.3125].

**markerscale** [None or int or float] The relative size of legend markers compared with the originally drawn ones. Default is None, which will take the value from *rcParams*["*legend.markerscale*"].

**markerfirst** [bool] If *True*, legend marker is placed to the left of the legend label. If *False*, legend marker is placed to the right of the legend label. Default is *True*.

**frameon** [None or bool] Control whether the legend should be drawn on a patch (frame). Default is None, which will take the value from *rcParams*["*legend.frameon*"].

**fancybox** [None or bool] Control whether round edges should be enabled around the *FancyBboxPatch* which makes up the legend's background. Default is None, which will take the value from *rcParams*["*legend.fancybox*"].

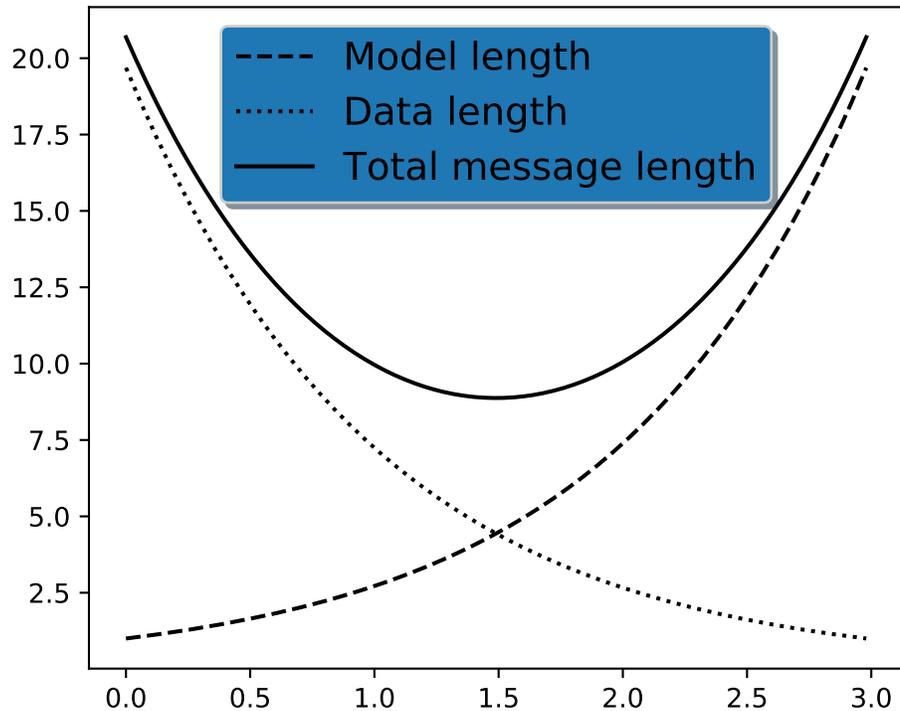
**shadow** [None or bool] Control whether to draw a shadow behind the legend. Default is None, which will take the value from *rcParams*["*legend.shadow*"].

- framealpha** [None or float] Control the alpha transparency of the legend's background. Default is `None`, which will take the value from `rcParams["legend.framealpha"]`. If shadow is activated and *framealpha* is `None`, the default value is ignored.
- facecolor** [None or "inherit" or a color spec] Control the legend's background color. Default is `None`, which will take the value from `rcParams["legend.facecolor"]`. If "inherit", it will take `rcParams["axes.facecolor"]`.
- edgecolor** [None or "inherit" or a color spec] Control the legend's background patch edge color. Default is `None`, which will take the value from `rcParams["legend.edgecolor"]`. If "inherit", it will take `rcParams["axes.edgecolor"]`.
- mode** [{"expand", None}] If mode is set to "expand" the legend will be horizontally expanded to fill the axes area (or `bbox_to_anchor` if defines the legend's size).
- bbox\_transform** [None or `matplotlib.transforms.Transform`] The transform for the bounding box (`bbox_to_anchor`). For a value of `None` (default) the Axes' `transAxes` transform will be used.
- title** [str or None] The legend's title. Default is no title (`None`).
- title\_fontsize: str or None** The fontsize of the legend's title. Default is the default fontsize.
- borderpad** [float or None] The fractional whitespace inside the legend border. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.borderpad"]`.
- labelspacing** [float or None] The vertical space between the legend entries. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.labelspacing"]`.
- handlelength** [float or None] The length of the legend handles. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.handlelength"]`.
- handletextpad** [float or None] The pad between the legend handle and text. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.handletextpad"]`.
- borderaxespad** [float or None] The pad between the axes and legend border. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.borderaxespad"]`.
- columnspacing** [float or None] The spacing between columns. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.columnspacing"]`.
- handler\_map** [dict or None] The custom dictionary mapping instances or types to a legend handler. This `handler_map` updates the default handler map found at `matplotlib.legend.Legend.get_legend_handler_map()`.

### Notes

Not all kinds of artist are supported by the legend command. See *Legend guide* for details.

### Examples



### Examples using `matplotlib.axes.Axes.legend`

- `sphinx_glr_gallery_lines_bars_and_markers_horizontal_barchart_distribution.py`
- `sphinx_glr_gallery_lines_bars_and_markers_scatter_with_legend.py`
- `sphinx_glr_gallery_images_contours_and_fields_contourf_hatching.py`
- `sphinx_glr_gallery_images_contours_and_fields_contourf_log.py`
- `sphinx_glr_gallery_pie_and_polar_charts_pie_and_donut_labels.py`
- `sphinx_glr_gallery_pie_and_polar_charts_polar_legend.py`
- `sphinx_glr_gallery_text_labels_and_annotations_legend.py`
- `sphinx_glr_gallery_pyplots_whats_new_98_4_legend.py`

**matplotlib.axes.Axes.get\_legend**`Axes.get_legend(self)`Return the `Legend` instance, or `None` if no legend is defined.**matplotlib.axes.Axes.get\_legend\_handles\_labels**`Axes.get_legend_handles_labels(self, legend_handler_map=None)`

Return handles and labels for legend

`ax.legend()` is equivalent to

```
h, l = ax.get_legend_handles_labels()
ax.legend(h, l)
```

**Axis scales**

<code>Axes.set_xscale</code>	Set the x-axis scale.
<code>Axes.get_xscale</code>	Return the x-axis scale as string.
<code>Axes.set_yscale</code>	Set the y-axis scale.
<code>Axes.get_yscale</code>	Return the y-axis scale as string.

**matplotlib.axes.Axes.set\_xscale**`Axes.set_xscale(self, value, **kwargs)`

Set the x-axis scale.

**Parameters****value** [{"linear", "log", "symlog", "logit", ...}] The axis scale type to apply.**\*\*kwargs** Different keyword arguments are accepted, depending on the scale. See the respective class keyword arguments:

- `matplotlib.scale.LinearScale`
- `matplotlib.scale.LogScale`
- `matplotlib.scale.SymmetricalLogScale`
- `matplotlib.scale.LogitScale`

**Notes**

By default, Matplotlib supports the above mentioned scales. Additionally, custom scales may be registered using `matplotlib.scale.register_scale`. These scales can then also be used here.

**Examples using matplotlib.axes.Axes.set\_xscale**

- `sphinx_glr_gallery_scales_scales.py`

### matplotlib.axes.Axes.get\_xscale

`Axes.get_xscale(self)`  
Return the x-axis scale as string.

**See also:**

`set_xscale`

### matplotlib.axes.Axes.set\_yscale

`Axes.set_yscale(self, value, **kwargs)`  
Set the y-axis scale.

**Parameters**

**value** [{"linear", "log", "symlog", "logit", ...}] The axis scale type to apply.

**\*\*kwargs** Different keyword arguments are accepted, depending on the scale. See the respective class keyword arguments:

- `matplotlib.scale.LinearScale`
- `matplotlib.scale.LogScale`
- `matplotlib.scale.SymmetricalLogScale`
- `matplotlib.scale.LogitScale`

**Notes**

By default, Matplotlib supports the above mentioned scales. Additionally, custom scales may be registered using `matplotlib.scale.register_scale`. These scales can then also be used here.

### Examples using matplotlib.axes.Axes.set\_yscale

- `sphx_glr_gallery_scales_scales.py`

### matplotlib.axes.Axes.get\_yscale

`Axes.get_yscale(self)`  
Return the y-axis scale as string.

**See also:**

`set_yscale`

### Autoscaling and margins

<code>Axes.use_sticky_edges</code>	When autoscaling, whether to obey all <code>Artist.sticky_edges</code> .
<code>Axes.margins</code>	Set or retrieve autoscaling margins.
<code>Axes.set_xmargin</code>	Set padding of X data limits prior to autoscaling.
<code>Axes.set_ymargin</code>	Set padding of Y data limits prior to autoscaling.
<code>Axes.relim</code>	Recompute the data limits based on current artists.
<code>Axes.autoscale</code>	Autoscale the axis view to the data (toggle).
<code>Axes.autoscale_view</code>	Autoscale the view limits using the data limits.
<code>Axes.set_autoscale_on</code>	Set whether autoscaling is applied on plot commands
<code>Axes.get_autoscale_on</code>	Get whether autoscaling is applied for both axes on plot commands
<code>Axes.set_autoscalex_on</code>	Set whether autoscaling for the x-axis is applied on plot commands
<code>Axes.get_autoscalex_on</code>	Get whether autoscaling for the x-axis is applied on plot commands
<code>Axes.set_autoscaley_on</code>	Set whether autoscaling for the y-axis is applied on plot commands
<code>Axes.get_autoscaley_on</code>	Get whether autoscaling for the y-axis is applied on plot commands

### matplotlib.axes.Axes.use\_sticky\_edges

#### `Axes.use_sticky_edges`

When autoscaling, whether to obey all `Artist.sticky_edges`.

Default is `True`.

Setting this to `False` ensures that the specified margins will be applied, even if the plot includes an image, for example, which would otherwise force a view limit to coincide with its data limit.

The changing this property does not change the plot until `autoscale` or `autoscale_view` is called.

### matplotlib.axes.Axes.margins

#### `Axes.margins(self, *margins, x=None, y=None, tight=True)`

Set or retrieve autoscaling margins.

The padding added to each limit of the axes is the `margin` times the data interval. All input parameters must be floats within the range `[0, 1]`. Passing both positional and keyword arguments is invalid and will raise a `TypeError`. If no arguments (positional or otherwise) are provided, the current margins will remain in place and simply be returned.

Specifying any margin changes only the autoscaling; for example, if `xmargin` is not `None`, then `xmargin` times the X data interval will be added to each end of that interval before it is used in autoscaling.

#### Parameters

**\*margins** [float, optional] If a single positional argument is provided, it specifies both margins of the x-axis and y-axis limits. If two positional arguments are provided, they will be interpreted as *xmargin*, *ymargin*. If setting the margin on a single axis is desired, use the keyword arguments described below.

**x, y** [float, optional] Specific margin values for the x-axis and y-axis, respectively. These cannot be used with positional arguments, but can be used individually to alter on e.g., only the y-axis.

**tight** [bool or None, default is True] The *tight* parameter is passed to *autoscale\_view()*, which is executed after a margin is changed; the default here is *True*, on the assumption that when margins are specified, no additional padding to match tick marks is usually desired. Set *tight* to *None* will preserve the previous setting.

### Returns

**xmargin, ymargin** [float]

### Notes

If a previously used Axes method such as *pcolor()* has set *use\_sticky\_edges* to *True*, only the limits not set by the "sticky artists" will be modified. To force all of the margins to be set, set *use\_sticky\_edges* to *False* before calling *margins()*.

### Examples using `matplotlib.axes.Axes.margins`

- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_axes\_margins.py

### `matplotlib.axes.Axes.set_xmargin`

`Axes.set_xmargin(self, m)`

Set padding of X data limits prior to autoscaling.

*m* times the data interval will be added to each end of that interval before it is used in autoscaling. For example, if your data is in the range [0, 2], a factor of *m* = 0.1 will result in a range [-0.2, 2.2].

Negative values  $-0.5 < m < 0$  will result in clipping of the data range. I.e. for a data range [0, 2], a factor of *m* = -0.1 will result in a range [0.2, 1.8].

### Parameters

**m** [float greater than -0.5]

### `matplotlib.axes.Axes.set_ymargin`

`Axes.set_ymargin(self, m)`

Set padding of Y data limits prior to autoscaling.

*m* times the data interval will be added to each end of that interval before it is used in autoscaling. For example, if your data is in the range [0, 2], a factor of *m* = 0.1 will result in a range [-0.2, 2.2].

Negative values  $-0.5 < m < 0$  will result in clipping of the data range. I.e. for a data range  $[0, 2]$ , a factor of  $m = -0.1$  will result in a range  $[0.2, 1.8]$ .

### Parameters

**m** [float greater than -0.5]

#### matplotlib.axes.Axes.relim

`Axes.relim(self, visible_only=False)`

Recompute the data limits based on current artists.

At present, *Collection* instances are not supported.

### Parameters

**visible\_only** [bool] Whether to exclude invisible artists. Defaults to False.

#### matplotlib.axes.Axes.autoscale

`Axes.autoscale(self, enable=True, axis='both', tight=None)`

Autoscale the axis view to the data (toggle).

Convenience method for simple axis view autoscaling. It turns autoscaling on or off, and then, if autoscaling for either axis is on, it performs the autoscaling on the specified axis or axes.

### Parameters

**enable** [bool or None, optional] True (default) turns autoscaling on, False turns it off. None leaves the autoscaling state unchanged.

**axis** [{'both', 'x', 'y'}, optional] which axis to operate on; default is 'both'

**tight** [bool or None, optional] If True, set view limits to data limits; if False, let the locator and margins expand the view limits; if None, use tight scaling if the only artist is an image, otherwise treat *tight* as False. The *tight* setting is retained for future autoscaling until it is explicitly changed.

#### matplotlib.axes.Axes.autoscale\_view

`Axes.autoscale_view(self, tight=None, scalex=True, scaley=True)`

Autoscale the view limits using the data limits.

You can selectively autoscale only a single axis, e.g., the xaxis by setting *scaley* to *False*. The autoscaling preserves any axis direction reversal that has already been done.

If *tight* is *False*, the axis major locator will be used to expand the view limits if `rcParams['axes.autolimit_mode']` is `'round_numbers'`. Note that any margins that are in effect will be applied first, regardless of whether *tight* is *True* or *False*. Specifying *tight* as *True* or *False* saves the setting as a private attribute of the Axes; specifying it as *None* (the default) applies the previously saved value.

The data limits are not updated automatically when artist data are changed after the artist has been added to an Axes instance. In that case, use `matplotlib.axes.Axes.relim()` prior to calling `autoscale_view`.

Examples using `matplotlib.axes.Axes.autoscale_view`

- `sphx_glr_gallery_shapes_and_collections_collections.py`
- `sphx_glr_gallery_shapes_and_collections_compound_path.py`
- `sphx_glr_gallery_shapes_and_collections_ellipse_collection.py`

`matplotlib.axes.Axes.set_autoscale_on`

`Axes.set_autoscale_on(self, b)`

Set whether autoscaling is applied on plot commands

**Parameters**

**b** [bool]

`matplotlib.axes.Axes.get_autoscale_on`

`Axes.get_autoscale_on(self)`

Get whether autoscaling is applied for both axes on plot commands

`matplotlib.axes.Axes.set_autoscalex_on`

`Axes.set_autoscalex_on(self, b)`

Set whether autoscaling for the x-axis is applied on plot commands

**Parameters**

**b** [bool]

`matplotlib.axes.Axes.get_autoscalex_on`

`Axes.get_autoscalex_on(self)`

Get whether autoscaling for the x-axis is applied on plot commands

`matplotlib.axes.Axes.set_autoscaley_on`

`Axes.set_autoscaley_on(self, b)`

Set whether autoscaling for the y-axis is applied on plot commands

**Parameters**

**b** [bool]

`matplotlib.axes.Axes.get_autoscaley_on`

`Axes.get_autoscaley_on(self)`

Get whether autoscaling for the y-axis is applied on plot commands

## Aspect ratio

<code>Axes.apply_aspect</code>	Adjust the Axes for a specified data aspect ratio.
<code>Axes.set_aspect</code>	Set the aspect of the axis scaling, i.e.
<code>Axes.get_aspect</code>	
<code>Axes.set_adjustable</code>	Define which parameter the Axes will change to achieve a given aspect.
<code>Axes.get_adjustable</code>	

### matplotlib.axes.Axes.apply\_aspect

`Axes.apply_aspect(self, position=None)`

Adjust the Axes for a specified data aspect ratio.

Depending on `get_adjustable` this will modify either the Axes box (position) or the view limits. In the former case, `get_anchor` will affect the position.

#### See also:

`matplotlib.axes.Axes.set_aspect` for a description of aspect ratio handling.

`matplotlib.axes.Axes.set_adjustable` defining the parameter to adjust in order to meet the required aspect.

`matplotlib.axes.Axes.set_anchor` defining the position in case of extra space.

#### Notes

This is called automatically when each Axes is drawn. You may need to call it yourself if you need to update the Axes position and/or view limits before the Figure is drawn.

### matplotlib.axes.Axes.set\_aspect

`Axes.set_aspect(self, aspect, adjustable=None, anchor=None, share=False)`

Set the aspect of the axis scaling, i.e. the ratio of y-unit to x-unit.

#### Parameters

**aspect** [{`'auto'`, `'equal'`} or num] Possible values:

value	description
<code>'auto'</code>	automatic; fill the position rectangle with data
<code>'equal'</code>	same scaling from data to plot units for x and y
num	a circle will be stretched such that the height is num times the width. <code>aspect=1</code> is the same as <code>aspect='equal'</code> .

**adjustable** [None or {`'box'`, `'datalim'`}, optional] If not None, this defines which parameter will be adjusted to meet the required aspect. See `set_adjustable` for further details.

**anchor** [None or str or 2-tuple of float, optional] If not `None`, this defines where the Axes will be drawn if there is extra space due to aspect constraints. The most common way to specify the anchor are abbreviations of cardinal directions:

value	description
'C'	centered
'SW'	lower left corner
'S'	middle of bottom edge
'SE'	lower right corner
etc.	

See `set_anchor` for further details.

**share** [bool, optional] If `True`, apply the settings to all shared Axes. Default is `False`.

**See also:**

`matplotlib.axes.Axes.set_adjustable` defining the parameter to adjust in order to meet the required aspect.

`matplotlib.axes.Axes.set_anchor` defining the position in case of extra space.

**Examples using `matplotlib.axes.Axes.set_aspect`**

- `sphinx_glr_gallery_shapes_and_collections_donut.py`

**`matplotlib.axes.Axes.get_aspect`**

`Axes.get_aspect(self)`

**`matplotlib.axes.Axes.set_adjustable`**

`Axes.set_adjustable(self, adjustable, share=False)`

Define which parameter the Axes will change to achieve a given aspect.

**Parameters**

**adjustable** [{'box', 'datalim'}] If 'box', change the physical dimensions of the Axes. If 'datalim', change the x or y data limits.

**share** [bool, optional] If `True`, apply the settings to all shared Axes. Default is `False`.

**See also:**

`matplotlib.axes.Axes.set_aspect` for a description of aspect handling.

## Notes

Shared Axes (of which twinned Axes are a special case) impose restrictions on how aspect ratios can be imposed. For twinned Axes, use 'datalim'. For Axes that share both x and y, use 'box'. Otherwise, either 'datalim' or 'box' may be used. These limitations are partly a requirement to avoid over-specification, and partly a result of the particular implementation we are currently using, in which the adjustments for aspect ratios are done sequentially and independently on each Axes as it is drawn.

## matplotlib.axes.Axes.get\_adjustable

`Axes.get_adjustable(self)`

## Ticks and tick labels

<code>Axes.set_xticks</code>	Set the x ticks with list of <i>ticks</i>
<code>Axes.get_xticks</code>	Return the x ticks as a list of locations
<code>Axes.set_xticklabels</code>	Set the x-tick labels with list of string labels.
<code>Axes.get_xticklabels</code>	Get the x tick labels as a list of <i>Text</i> instances.
<code>Axes.get_xmajorticklabels</code>	Get the major x tick labels.
<code>Axes.get_xminorticklabels</code>	Get the minor x tick labels.
<code>Axes.get_xgridlines</code>	Get the x grid lines as a list of <i>Line2D</i> instances.
<code>Axes.get_xticklines</code>	Get the x tick lines as a list of <i>Line2D</i> instances.
<code>Axes.xaxis_date</code>	Sets up x-axis ticks and labels that treat the x data as dates.
<code>Axes.set_yticks</code>	Set the y ticks with list of <i>ticks</i>
<code>Axes.get_yticks</code>	Return the y ticks as a list of locations
<code>Axes.set_yticklabels</code>	Set the y-tick labels with list of strings labels.
<code>Axes.get_yticklabels</code>	Get the y tick labels as a list of <i>Text</i> instances.
<code>Axes.get_ymajorticklabels</code>	Get the major y tick labels.
<code>Axes.get_yminorticklabels</code>	Get the minor y tick labels.
<code>Axes.get_ygridlines</code>	Get the y grid lines as a list of <i>Line2D</i> instances.
<code>Axes.get_yticklines</code>	Get the y tick lines as a list of <i>Line2D</i> instances.
<code>Axes.yaxis_date</code>	Sets up y-axis ticks and labels that treat the y data as dates.
<code>Axes.minorticks_off</code>	Remove minor ticks from the axes.
<code>Axes.minorticks_on</code>	Display minor ticks on the axes.
<code>Axes.ticklabel_format</code>	Change the <i>ScalarFormatter</i> used by default for linear axes.
<code>Axes.tick_params</code>	Change the appearance of ticks, tick labels, and gridlines.
<code>Axes.locator_params</code>	Control behavior of major tick locators.

**matplotlib.axes.Axes.set\_xticks**

`Axes.set_xticks(self, ticks, minor=False)`  
Set the x ticks with list of *ticks*

**Parameters**

**ticks** [list] List of x-axis tick locations.

**minor** [bool, optional] If False sets major ticks, if True sets minor ticks.  
Default is False.

**matplotlib.axes.Axes.get\_xticks**

`Axes.get_xticks(self, minor=False)`  
Return the x ticks as a list of locations

**matplotlib.axes.Axes.set\_xticklabels**

`Axes.set_xticklabels(self, labels, fontdict=None, minor=False, **kwargs)`  
Set the x-tick labels with list of string labels.

**Parameters**

**labels** [List[str]] List of string labels.

**fontdict** [dict, optional] A dictionary controlling the appearance of the tick-labels. The default fontdict is:

```
{'fontsize': rcParams['axes.titlesize'],  
 'fontweight': rcParams['axes.titleweight'],  
 'verticalalignment': 'baseline',  
 'horizontalalignment': 'left'}
```

**minor** [bool, optional] Whether to set the minor ticklabels rather than the major ones.

**Returns**

**A list of *Text* instances.**

**Other Parameters**

**\*\*kwargs** [*Text* properties.]

**matplotlib.axes.Axes.get\_xticklabels**

`Axes.get_xticklabels(self, minor=False, which=None)`  
Get the x tick labels as a list of *Text* instances.

**Parameters**

**minor** [bool, optional] If True return the minor ticklabels, else return the major ticklabels.

**which** [None, ('minor', 'major', 'both')] Overrides `minor`.

Selects which ticklabels to return

### Returns

**ret** [list] List of *Text* instances.

#### matplotlib.axes.Axes.get\_xmajorticklabels

`Axes.get_xmajorticklabels(self)`

Get the major x tick labels.

### Returns

**labels** [list] List of *Text* instances

#### matplotlib.axes.Axes.get\_xminorticklabels

`Axes.get_xminorticklabels(self)`

Get the minor x tick labels.

### Returns

**labels** [list] List of *Text* instances

#### matplotlib.axes.Axes.get\_xgridlines

`Axes.get_xgridlines(self)`

Get the x grid lines as a list of *Line2D* instances.

#### matplotlib.axes.Axes.get\_xticklines

`Axes.get_xticklines(self)`

Get the x tick lines as a list of *Line2D* instances.

#### matplotlib.axes.Axes.xaxis\_date

`Axes.xaxis_date(self, tz=None)`

Sets up x-axis ticks and labels that treat the x data as dates.

### Parameters

**tz** [string or *tzinfo* instance, optional] Timezone. Defaults to `rcParams["timezone"]`.

#### matplotlib.axes.Axes.set\_yticks

`Axes.set_yticks(self, ticks, minor=False)`

Set the y ticks with list of *ticks*

### Parameters

**ticks** [list] List of y-axis tick locations

**minor** [bool, optional] If `False` sets major ticks, if `True` sets minor ticks.  
Default is `False`.

#### `matplotlib.axes.Axes.get_yticks`

`Axes.get_yticks(self, minor=False)`  
Return the y ticks as a list of locations

#### `matplotlib.axes.Axes.set_yticklabels`

`Axes.set_yticklabels(self, labels, fontdict=None, minor=False, **kwargs)`  
Set the y-tick labels with list of strings labels.

##### Parameters

**labels** [List[str]] list of string labels

**fontdict** [dict, optional] A dictionary controlling the appearance of the tick-labels. The default `fontdict` is:

```
{'fontsize': rcParams['axes.titlesize'],  
'fontweight': rcParams['axes.titleweight'],  
'verticalalignment': 'baseline',  
'horizontalalignment': 'loc'}
```

**minor** [bool, optional] Whether to set the minor ticklabels rather than the major ones.

##### Returns

A list of *Text* instances.

##### Other Parameters

**\*\*kwargs** [*Text* properties.]

#### `matplotlib.axes.Axes.get_yticklabels`

`Axes.get_yticklabels(self, minor=False, which=None)`  
Get the y tick labels as a list of *Text* instances.

##### Parameters

**minor** [bool] If `True` return the minor ticklabels, else return the major tick-labels

**which** [None, ('minor', 'major', 'both')] Overrides `minor`.

Selects which ticklabels to return

##### Returns

**ret** [list] List of *Text* instances.

**matplotlib.axes.Axes.get\_ymajorticklabels**

`Axes.get_ymajorticklabels(self)`  
Get the major y tick labels.

**Returns**

**labels** [list] List of *Text* instances

**matplotlib.axes.Axes.get\_yminorticklabels**

`Axes.get_yminorticklabels(self)`  
Get the minor y tick labels.

**Returns**

**labels** [list] List of *Text* instances

**matplotlib.axes.Axes.get\_ygridlines**

`Axes.get_ygridlines(self)`  
Get the y grid lines as a list of *Line2D* instances.

**matplotlib.axes.Axes.get\_yticklines**

`Axes.get_yticklines(self)`  
Get the y tick lines as a list of *Line2D* instances.

**matplotlib.axes.Axes.yaxis\_date**

`Axes.yaxis_date(self, tz=None)`  
Sets up y-axis ticks and labels that treat the y data as dates.

**Parameters**

**tz** [string or *tzinfo* instance, optional] Timezone. Defaults to `rcParams["timezone"]`.

**matplotlib.axes.Axes.minorticks\_off**

`Axes.minorticks_off(self)`  
Remove minor ticks from the axes.

**matplotlib.axes.Axes.minorticks\_on**

`Axes.minorticks_on(self)`  
Display minor ticks on the axes.

Displaying minor ticks may reduce performance; you may turn them off using `minorticks_off()` if drawing speed is a problem.

### matplotlib.axes.Axes.ticklabel\_format

`Axes.ticklabel_format(self, *, axis='both', style="", scilimits=None, useOffset=None, useLocale=None, useMathText=None)`

Change the *ScalarFormatter* used by default for linear axes.

Optional keyword arguments:

Key-word	Description
<i>axis</i>	[ 'x'   'y'   'both' ]
<i>style</i>	[ 'sci' (or 'scientific')   'plain' ] plain turns off scientific notation
<i>scilimits</i>	(m, n), pair of integers; if <i>style</i> is 'sci', scientific notation will be used for numbers outside the range $10^m$ to $10^n$ . Use (0,0) to include all numbers. Use (m,m) where $m <> 0$ to fix the order of magnitude to $10^m$ .
<i>useOffset</i>	[ bool   offset ]; if True, the offset will be calculated as needed; if False, no offset will be used; if a numeric offset is specified, it will be used.
<i>useLocale</i>	If True, format the number according to the current locale. This affects things such as the character used for the decimal separator. If False, use C-style (English) formatting. The default setting is controlled by the <code>axes.formatter.use_locale</code> rparam.
<i>useMathText</i>	If True, render the offset and scientific notation in <code>mathtext</code>

Only the major ticks are affected. If the method is called when the *ScalarFormatter* is not the *Formatter* being used, an `AttributeError` will be raised.

### matplotlib.axes.Axes.tick\_params

`Axes.tick_params(self, axis='both', **kwargs)`

Change the appearance of ticks, tick labels, and gridlines.

#### Parameters

**axis** [ {'x', 'y', 'both'}, optional] Which axis to apply the parameters to.

#### Other Parameters

**axis** [ {'x', 'y', 'both'}] Axis on which to operate; default is 'both'.

**reset** [bool] If *True*, set all parameters to defaults before processing other keyword arguments. Default is *False*.

**which** [ {'major', 'minor', 'both'}] Default is 'major'; apply arguments to *which* ticks.

**direction** [ {'in', 'out', 'inout'}] Puts ticks inside the axes, outside the axes, or both.

**length** [float] Tick length in points.

**width** [float] Tick width in points.

**color** [color] Tick color; accepts any mpl color spec.

**pad** [float] Distance in points between tick and label.

**labelsize** [float or str] Tick label font size in points or as a string (e.g., 'large').

**labelcolor** [color] Tick label color; mpl color spec.

**colors** [color] Changes the tick color and the label color to the same value: mpl color spec.

**zorder** [float] Tick and label zorder.

**bottom, top, left, right** [bool] Whether to draw the respective ticks.

**labelbottom, labeltop, labelleft, labelright** [bool] Whether to draw the respective tick labels.

**labelrotation** [float] Tick label rotation

**grid\_color** [color] Changes the gridline color to the given mpl color spec.

**grid\_alpha** [float] Transparency of gridlines: 0 (transparent) to 1 (opaque).

**grid\_linewidth** [float] Width of gridlines in points.

**grid\_linestyle** [string] Any valid *Line2D* line style spec.

### Examples

#### Usage

```
ax.tick_params(direction='out', length=6, width=2, colors='r',
               grid_color='r', grid_alpha=0.5)
```

This will make all major ticks be red, pointing out of the box, and with dimensions 6 points by 2 points. Tick labels will also be red. Gridlines will be red and translucent.

#### Examples using `matplotlib.axes.Axes.tick_params`

- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_two\_scales.py
- sphx\_glr\_gallery\_color\_color\_demo.py

#### `matplotlib.axes.Axes.locator_params`

`Axes.locator_params(self, axis='both', tight=None, **kwargs)`

Control behavior of major tick locators.

Because the locator is involved in autoscaling, `autoscale_view` is called automatically after the parameters are changed.

#### Parameters

**axis** [({'both', 'x', 'y'}, optional)] The axis on which to operate.

**tight** [bool or None, optional] Parameter passed to `autoscale_view`. Default is None, for no change.

#### Other Parameters

**\*\*kwargs** Remaining keyword arguments are passed directly to the `set_params()` method of the locator. Supported keywords depend on the type of the locator. See for example `set_params` for the `ticker.MaxNLocator` used by default for linear axes.

### Examples

When plotting small subplots, one might want to reduce the maximum number of ticks and use tight bounds, for example:

```
ax.locator_params(tight=True, nbins=4)
```

## 17.5.8 Units

<code>Axes.convert_xunits</code>	Convert <i>x</i> using the unit type of the xaxis.
<code>Axes.convert_yunits</code>	Convert <i>y</i> using the unit type of the yaxis.
<code>Axes.have_units</code>	Return <i>True</i> if units are set on the <i>x</i> or <i>y</i> axes.

### matplotlib.axes.Axes.convert\_xunits

`Axes.convert_xunits(self, x)`  
Convert *x* using the unit type of the xaxis.

If the artist is not contained in an `Axes` or if the xaxis does not have units, *x* itself is returned.

### matplotlib.axes.Axes.convert\_yunits

`Axes.convert_yunits(self, y)`  
Convert *y* using the unit type of the yaxis.

If the artist is not contained in an `Axes` or if the yaxis does not have units, *y* itself is returned.

### matplotlib.axes.Axes.have\_units

`Axes.have_units(self)`  
Return *True* if units are set on the *x* or *y* axes.

## 17.5.9 Adding Artists

<code>Axes.add_artist</code>	Add an <i>Artist</i> to the axes, and return the artist.
<code>Axes.add_child_axes</code>	Add an <code>AxesBase</code> to the axes' children; return the child axes.

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Continued on next page

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<code>Axes.add_collection</code>	Add a <i>Collection</i> to the axes' collections; return the collection.
<code>Axes.add_container</code>	Add a <i>Container</i> to the axes' containers; return the container.
<code>Axes.add_image</code>	Add an <i>AxesImage</i> to the axes' images; return the image.
<code>Axes.add_line</code>	Add a <i>Line2D</i> to the axes' lines; return the line.
<code>Axes.add_patch</code>	Add a <i>Patch</i> to the axes' patches; return the patch.
<code>Axes.add_table</code>	Add a <i>Table</i> to the axes' tables; return the table.

**matplotlib.axes.Axes.add\_artist**

`Axes.add_artist(self, a)`

Add an *Artist* to the axes, and return the artist.

Use `add_artist` only for artists for which there is no dedicated "add" method; and if necessary, use a method such as `update_dataLim` to manually update the `dataLim` if the artist is to be included in autoscaling.

If no transform has been specified when creating the artist (e.g. `artist.get_transform() == None`) then the transform is set to `ax.transData`.

**Examples using matplotlib.axes.Axes.add\_artist**

- `sphx_glr_gallery_shapes_and_collections_ellipse_demo.py`

**matplotlib.axes.Axes.add\_child\_axes**

`Axes.add_child_axes(self, ax)`

Add an *AxesBase* to the axes' children; return the child axes.

This is the lowlevel version. See `axes.Axes.inset_axes`.

**matplotlib.axes.Axes.add\_collection**

`Axes.add_collection(self, collection, autolim=True)`

Add a *Collection* to the axes' collections; return the collection.

**Examples using matplotlib.axes.Axes.add\_collection**

- `sphx_glr_gallery_lines_bars_and_markers_span_regions.py`
- `sphx_glr_gallery_shapes_and_collections_artist_reference.py`
- `sphx_glr_gallery_shapes_and_collections_collections.py`
- `sphx_glr_gallery_shapes_and_collections_ellipse_collection.py`

- sphx\_glr\_gallery\_shapes\_and\_collections\_line\_collection.py
- sphx\_glr\_gallery\_shapes\_and\_collections\_patch\_collection.py

#### **matplotlib.axes.Axes.add\_container**

`Axes.add_container(self, container)`

Add a *Container* to the axes' containers; return the container.

#### **matplotlib.axes.Axes.add\_image**

`Axes.add_image(self, image)`

Add an *AxesImage* to the axes' images; return the image.

#### **matplotlib.axes.Axes.add\_line**

`Axes.add_line(self, line)`

Add a *Line2D* to the axes' lines; return the line.

#### **Examples using matplotlib.axes.Axes.add\_line**

- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_line\_with\_text.py
- sphx\_glr\_gallery\_shapes\_and\_collections\_artist\_reference.py

#### **matplotlib.axes.Axes.add\_patch**

`Axes.add_patch(self, p)`

Add a *Patch* to the axes' patches; return the patch.

#### **Examples using matplotlib.axes.Axes.add\_patch**

- sphx\_glr\_gallery\_shapes\_and\_collections\_compound\_path.py
- sphx\_glr\_gallery\_shapes\_and\_collections\_dolphin.py
- sphx\_glr\_gallery\_shapes\_and\_collections\_donut.py
- sphx\_glr\_gallery\_shapes\_and\_collections\_hatch\_demo.py
- sphx\_glr\_gallery\_shapes\_and\_collections\_path\_patch.py
- sphx\_glr\_gallery\_shapes\_and\_collections\_quad\_bezier.py
- sphx\_glr\_gallery\_misc\_histogram\_path.py

#### **matplotlib.axes.Axes.add\_table**

`Axes.add_table(self, tab)`

Add a *Table* to the axes' tables; return the table.

## 17.5.10 Twinning

<code>Axes.twinx</code>	Create a twin Axes sharing the xaxis
<code>Axes.twiny</code>	Create a twin Axes sharing the yaxis
<code>Axes.get_shared_x_axes</code>	Return a reference to the shared axes Grouper object for x axes.
<code>Axes.get_shared_y_axes</code>	Return a reference to the shared axes Grouper object for y axes.

### matplotlib.axes.Axes.twinx

`Axes.twinx(self)`

Create a twin Axes sharing the xaxis

Create a new Axes instance with an invisible x-axis and an independent y-axis positioned opposite to the original one (i.e. at right). The x-axis autoscale setting will be inherited from the original Axes. To ensure that the tick marks of both y-axes align, see *LinearLocator*

#### Returns

**ax\_twin** [Axes] The newly created Axes instance

#### Notes

For those who are 'picking' artists while using `twinx`, pick events are only called for the artists in the top-most axes.

### Examples using matplotlib.axes.Axes.twinx

- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_two\_scales.py
- sphx\_glr\_gallery\_statistics\_barchart\_demo.py

### matplotlib.axes.Axes.twiny

`Axes.twiny(self)`

Create a twin Axes sharing the yaxis

Create a new Axes instance with an invisible y-axis and an independent x-axis positioned opposite to the original one (i.e. at top). The y-axis autoscale setting will be inherited from the original Axes. To ensure that the tick marks of both x-axes align, see *LinearLocator*

#### Returns

**ax\_twin** [Axes] The newly created Axes instance

#### Notes

For those who are 'picking' artists while using `twiny`, pick events are only called for the artists in the top-most axes.

Examples using `matplotlib.axes.Axes.twinx`

- `sphx_glr_gallery_subplots_axes_and_figures_two_scales.py`

`matplotlib.axes.Axes.get_shared_x_axes`

`Axes.get_shared_x_axes(self)`

Return a reference to the shared axes Grouper object for x axes.

`matplotlib.axes.Axes.get_shared_y_axes`

`Axes.get_shared_y_axes(self)`

Return a reference to the shared axes Grouper object for y axes.

### 17.5.11 Axes Position

<code>Axes.get_anchor</code>	Get the anchor location.
<code>Axes.set_anchor</code>	Define the anchor location.
<code>Axes.get_axes_locator</code>	Return the axes_locator.
<code>Axes.set_axes_locator</code>	Set the axes locator.
<code>Axes.reset_position</code>	Reset the active position to the original position.
<code>Axes.get_position</code>	Get a copy of the axes rectangle as a <i>Bbox</i> .
<code>Axes.set_position</code>	Set the axes position.

`matplotlib.axes.Axes.get_anchor`

`Axes.get_anchor(self)`

Get the anchor location.

**See also:**

`matplotlib.axes.Axes.set_anchor` for a description of the anchor.

`matplotlib.axes.Axes.set_aspect` for a description of aspect handling.

`matplotlib.axes.Axes.set_anchor`

`Axes.set_anchor(self, anchor, share=False)`

Define the anchor location.

The actual drawing area (active position) of the Axes may be smaller than the Bbox (original position) when a fixed aspect is required. The anchor defines where the drawing area will be located within the available space.

**Parameters**

**anchor** [2-tuple of floats or {'C', 'SW', 'S', 'SE', ...}] The anchor position may be either:

- a sequence  $(cx, cy)$ .  $cx$  and  $cy$  may range from 0 to 1, where 0 is left or bottom and 1 is right or top.
- a string using cardinal directions as abbreviation:
  - 'C' for centered
  - 'S' (south) for bottom-center
  - 'SW' (south west) for bottom-left
  - etc.

Here is an overview of the possible positions:

'NW'	'N'	'NE'
'W'	'C'	'E'
'SW'	'S'	'SE'

**share** [bool, optional] If True, apply the settings to all shared Axes. Default is False.

**See also:**

`matplotlib.axes.Axes.set_aspect` for a description of aspect handling.

**matplotlib.axes.Axes.get\_axes\_locator**

`Axes.get_axes_locator(self)`  
Return the `axes_locator`.

**matplotlib.axes.Axes.set\_axes\_locator**

`Axes.set_axes_locator(self, locator)`  
Set the axes locator.

**Parameters**

**locator** [Callable[[Axes, Renderer], Bbox]]

**matplotlib.axes.Axes.reset\_position**

`Axes.reset_position(self)`  
Reset the active position to the original position.

This resets the a possible position change due to aspect constraints. For an explanation of the positions see `set_position`.

**matplotlib.axes.Axes.get\_position**

`Axes.get_position(self, original=False)`  
Get a copy of the axes rectangle as a `Bbox`.

**Parameters**

**original** [bool] If True, return the original position. Otherwise return the active position. For an explanation of the positions see *set\_position*.

### Returns

**pos** [*Bbox*]

Examples using `matplotlib.axes.Axes.get_position`

- sphx\_glr\_gallery\_images\_contours\_and\_fields\_contour\_demo.py

`matplotlib.axes.Axes.set_position`

`Axes.set_position(self, pos, which='both')`  
Set the axes position.

Axes have two position attributes. The 'original' position is the position allocated for the Axes. The 'active' position is the position the Axes is actually drawn at. These positions are usually the same unless a fixed aspect is set to the Axes. See *set\_aspect* for details.

### Parameters

**pos** [[left, bottom, width, height] or *Bbox*] The new position of the in *Figure* coordinates.

**which** [{'both', 'active', 'original'}, optional] Determines which position variables to change.

Examples using `matplotlib.axes.Axes.set_position`

- sphx\_glr\_gallery\_images\_contours\_and\_fields\_contour\_demo.py

## 17.5.12 Async/Event based

<code>Axes.stale</code>	Whether the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.
<code>Axes.pchanged</code>	Call all of the registered callbacks.
<code>Axes.add_callback</code>	Add a callback function that will be called whenever one of the <i>Artist's</i> properties changes.
<code>Axes.remove_callback</code>	Remove a callback based on its observer id.

`matplotlib.axes.Axes.stale`

`Axes.stale`

Whether the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

**matplotlib.axes.Axes.pchanged**`Axes.pchanged(self)`

Call all of the registered callbacks.

This function is triggered internally when a property is changed.

**See also:**`add_callback``remove_callback`**matplotlib.axes.Axes.add\_callback**`Axes.add_callback(self, func)`Add a callback function that will be called whenever one of the *Artist's* properties changes.**Parameters****func** [callable] The callback function. It must have the signature:

```
def func(artist: Artist) -> Any
```

where *artist* is the calling *Artist*. Return values may exist but are ignored.**Returns****oid** [int] The observer id associated with the callback. This id can be used for removing the callback with `remove_callback` later.**See also:**`remove_callback`**matplotlib.axes.Axes.remove\_callback**`Axes.remove_callback(self, oid)`

Remove a callback based on its observer id.

**See also:**`add_callback`**17.5.13 Interactive**`Axes.can_pan`Return *True* if this axes supports any pan/zoom button functionality.`Axes.can_zoom`Return *True* if this axes supports the zoom box button functionality.

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<code>Axes.get_navigate</code>	Get whether the axes responds to navigation commands
<code>Axes.set_navigate</code>	Set whether the axes responds to navigation toolbar commands
<code>Axes.get_navigate_mode</code>	Get the navigation toolbar button status: 'PAN', 'ZOOM', or None
<code>Axes.set_navigate_mode</code>	Set the navigation toolbar button status;
<code>Axes.start_pan</code>	Called when a pan operation has started.
<code>Axes.drag_pan</code>	Called when the mouse moves during a pan operation.
<code>Axes.end_pan</code>	Called when a pan operation completes (when the mouse button is up.)
<code>Axes.format_coord</code>	Return a format string formatting the x, y coordinates.
<code>Axes.format_cursor_data</code>	Return a string representation of <i>data</i> .
<code>Axes.format_xdata</code>	Return x formatted as an x-value.
<code>Axes.format_ydata</code>	Return y formatted as an y-value.
<code>Axes.mouseover</code>	
<code>Axes.in_axes</code>	Return <i>True</i> if the given <i>MouseEvent</i> (in display coords) is in the Axes
<code>Axes.pick</code>	Process a pick event.
<code>Axes.pickable</code>	Return whether the artist is pickable.
<code>Axes.get_picker</code>	Return the picking behavior of the artist.
<code>Axes.set_picker</code>	Define the picking behavior of the artist.
<code>Axes.set_contains</code>	Define a custom contains test for the artist.
<code>Axes.get_contains</code>	Return the custom contains function of the artist if set, or <i>None</i> .
<code>Axes.contains</code>	Test whether the artist contains the mouse event.
<code>Axes.contains_point</code>	Return whether <i>point</i> (pair of pixel coordinates) is inside the axes patch.
<code>Axes.get_cursor_data</code>	Return the cursor data for a given event.

**matplotlib.axes.Axes.can\_pan**`Axes.can_pan(self)`Return *True* if this axes supports any pan/zoom button functionality.**matplotlib.axes.Axes.can\_zoom**`Axes.can_zoom(self)`Return *True* if this axes supports the zoom box button functionality.**matplotlib.axes.Axes.get\_navigate**`Axes.get_navigate(self)`

Get whether the axes responds to navigation commands

**matplotlib.axes.Axes.set\_navigate**

`Axes.set_navigate(self, b)`

Set whether the axes responds to navigation toolbar commands

**Parameters**

**b** [bool]

**matplotlib.axes.Axes.get\_navigate\_mode**

`Axes.get_navigate_mode(self)`

Get the navigation toolbar button status: 'PAN', 'ZOOM', or None

**matplotlib.axes.Axes.set\_navigate\_mode**

`Axes.set_navigate_mode(self, b)`

Set the navigation toolbar button status;

<b>Warning:</b> this is not a user-API function.
--

**matplotlib.axes.Axes.start\_pan**

`Axes.start_pan(self, x, y, button)`

Called when a pan operation has started.

*x*, *y* are the mouse coordinates in display coords. *button* is the mouse button number:

- 1: LEFT
- 2: MIDDLE
- 3: RIGHT

---

**Note:** Intended to be overridden by new projection types.

---

**matplotlib.axes.Axes.drag\_pan**

`Axes.drag_pan(self, button, key, x, y)`

Called when the mouse moves during a pan operation.

*button* is the mouse button number:

- 1: LEFT
- 2: MIDDLE
- 3: RIGHT

*key* is a "shift" key

*x*, *y* are the mouse coordinates in display coords.

---

**Note:** Intended to be overridden by new projection types.

---

#### matplotlib.axes.Axes.end\_pan

Axes.*end\_pan*(*self*)

Called when a pan operation completes (when the mouse button is up.)

---

**Note:** Intended to be overridden by new projection types.

---

#### matplotlib.axes.Axes.format\_coord

Axes.*format\_coord*(*self*, *x*, *y*)

Return a format string formatting the *x*, *y* coordinates.

#### Examples using matplotlib.axes.Axes.format\_coord

- sphx\_glr\_gallery\_images\_contours\_and\_fields\_image\_zcoord.py

#### matplotlib.axes.Axes.format\_cursor\_data

Axes.*format\_cursor\_data*(*self*, *data*)

Return a string representation of *data*.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

The default implementation converts ints and floats and arrays of ints and floats into a comma-separated string enclosed in square brackets.

**See also:**

*get\_cursor\_data*

#### matplotlib.axes.Axes.format\_xdata

Axes.*format\_xdata*(*self*, *x*)

Return *x* formatted as an x-value.

This function will use the *fmt\_xdata* attribute if it is not None, else will fall back on the xaxis major formatter.

---

**matplotlib.axes.Axes.format\_ydata**

`Axes.format_ydata(self, y)`  
Return *y* formatted as an y-value.

This function will use the `fmt_ydata` attribute if it is not `None`, else will fall back on the `yaxis` major formatter.

**matplotlib.axes.Axes.mouseover**

`Axes.mouseover`

**matplotlib.axes.Axes.in\_axes**

`Axes.in_axes(self, mouseevent)`  
Return `True` if the given *mouseevent* (in display coords) is in the Axes

**matplotlib.axes.Axes.pick**

`Axes.pick(self, mouseevent)`  
Process a pick event.

Each child artist will fire a pick event if *mouseevent* is over the artist and the artist has picker set.

**See also:**

`set_picker`, `get_picker`, `pickable`

**matplotlib.axes.Axes.pickable**

`Axes.pickable(self)`  
Return whether the artist is pickable.

**See also:**

`set_picker`, `get_picker`, `pick`

**matplotlib.axes.Axes.get\_picker**

`Axes.get_picker(self)`  
Return the picking behavior of the artist.  
The possible values are described in `set_picker`.

**See also:**

`set_picker`, `pickable`, `pick`

**matplotlib.axes.Axes.set\_picker**`Axes.set_picker(self, picker)`

Define the picking behavior of the artist.

**Parameters****picker** [None or bool or float or callable] This can be one of the following:

- *None*: Picking is disabled for this artist (default).
- A boolean: If *True* then picking will be enabled and the artist will fire a pick event if the mouse event is over the artist.
- A float: If *picker* is a number it is interpreted as an epsilon tolerance in points and the artist will fire off an event if it's data is within epsilon of the mouse event. For some artists like lines and patch collections, the artist may provide additional data to the pick event that is generated, e.g., the indices of the data within epsilon of the pick event
- A function: If *picker* is callable, it is a user supplied function which determines whether the artist is hit by the mouse event:

```
hit, props = picker(artist, mouseevent)
```

to determine the hit test. if the mouse event is over the artist, return *hit=True* and *props* is a dictionary of properties you want added to the `PickEvent` attributes.

**matplotlib.axes.Axes.set\_contains**`Axes.set_contains(self, picker)`

Define a custom contains test for the artist.

The provided callable replaces the default *contains* method of the artist.**Parameters****picker** [callable] A custom picker function to evaluate if an event is within the artist. The function must have the signature:

```
def contains(artist: Artist, event: MouseEvent) -> bool, dict
```

that returns:

- a bool indicating if the event is within the artist
- a dict of additional information. The dict should at least return the same information as the default `contains()` implementation of the respective artist, but may provide additional information.

**matplotlib.axes.Axes.get\_contains**`Axes.get_contains(self)`Return the custom contains function of the artist if set, or *None*.**See also:**

`set_contains`

### matplotlib.axes.Axes.contains

`Axes.contains(self, mouseevent)`

Test whether the artist contains the mouse event.

#### Parameters

**mouseevent** [`matplotlib.backend_bases.MouseEvent`]

#### Returns

**contains** [bool] Whether any values are within the radius.

**details** [dict] An artist-specific dictionary of details of the event context, such as which points are contained in the pick radius. See the individual Artist subclasses for details.

#### See also:

`set_contains`, `get_contains`

### matplotlib.axes.Axes.contains\_point

`Axes.contains_point(self, point)`

Return whether *point* (pair of pixel coordinates) is inside the axes patch.

### matplotlib.axes.Axes.get\_cursor\_data

`Axes.get_cursor_data(self, event)`

Return the cursor data for a given event.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

Cursor data can be used by Artists to provide additional context information for a given event. The default implementation just returns *None*.

Subclasses can override the method and return arbitrary data. However, when doing so, they must ensure that `format_cursor_data` can convert the data to a string representation.

The only current use case is displaying the z-value of an `AxesImage` in the status bar of a plot window, while moving the mouse.

#### Parameters

**event** [`matplotlib.backend_bases.MouseEvent`]

#### See also:

`format_cursor_data`

### 17.5.14 Children

<code>Axes.get_children</code>	Return a list of the child <i>Artists</i> of this <i>Artist</i> .
<code>Axes.get_images</code>	return a list of Axes images contained by the Axes
<code>Axes.get_lines</code>	Return a list of lines contained by the Axes
<code>Axes.findobj</code>	Find artist objects.

#### `matplotlib.axes.Axes.get_children`

`Axes.get_children(self)`  
Return a list of the child *Artists* of this *Artist*.

#### `matplotlib.axes.Axes.get_images`

`Axes.get_images(self)`  
return a list of Axes images contained by the Axes

#### `matplotlib.axes.Axes.get_lines`

`Axes.get_lines(self)`  
Return a list of lines contained by the Axes

#### `matplotlib.axes.Axes.findobj`

`Axes.findobj(self, match=None, include_self=True)`  
Find artist objects.  
Recursively find all *Artist* instances contained in the artist.

##### **Parameters**

**match** A filter criterion for the matches. This can be

- *None*: Return all objects contained in artist.
- A function with signature `def match(artist: Artist) -> bool`. The result will only contain artists for which the function returns *True*.
- A class instance: e.g., *Line2D*. The result will only contain artists of this class or its subclasses (*isinstance* check).

**include\_self** [bool] Include *self* in the list to be checked for a match.

##### **Returns**

**artists** [list of *Artist*]

### 17.5.15 Drawing

---

<code>Axes.draw</code>	Draw everything (plot lines, axes, labels)
<code>Axes.draw_artist</code>	This method can only be used after an initial draw which caches the renderer.
<code>Axes.redraw_in_frame</code>	This method can only be used after an initial draw which caches the renderer.
<code>Axes.get_renderer_cache</code>	
<code>Axes.get_rasterization_zorder</code>	Return the zorder value below which artists will be rasterized.
<code>Axes.set_rasterization_zorder</code>	

---

### Parameters

---

<code>Axes.get_window_extent</code>	Return the axes bounding box in display space; <i>args</i> and <i>kwargs</i> are empty.
<code>Axes.get_tightbbox</code>	Return the tight bounding box of the axes, including axis and their decorators (xlabel, title, etc).

---

### `matplotlib.axes.Axes.draw`

`Axes.draw(self, renderer=None, inframe=False)`  
 Draw everything (plot lines, axes, labels)

### `matplotlib.axes.Axes.draw_artist`

`Axes.draw_artist(self, a)`  
 This method can only be used after an initial draw which caches the renderer. It is used to efficiently update Axes data (axis ticks, labels, etc are not updated)

### `matplotlib.axes.Axes.redraw_in_frame`

`Axes.redraw_in_frame(self)`  
 This method can only be used after an initial draw which caches the renderer. It is used to efficiently update Axes data (axis ticks, labels, etc are not updated)

### `matplotlib.axes.Axes.get_renderer_cache`

`Axes.get_renderer_cache(self)`

### `matplotlib.axes.Axes.get_rasterization_zorder`

`Axes.get_rasterization_zorder(self)`  
 Return the zorder value below which artists will be rasterized.

### `matplotlib.axes.Axes.set_rasterization_zorder`

`Axes.set_rasterization_zorder(self, z)`

### Parameters

**z** [float or None] zorder below which artists are rasterized. None means that artists do not get rasterized based on zorder.

#### matplotlib.axes.Axes.get\_window\_extent

`Axes.get_window_extent(self, *args, **kwargs)`

Return the axes bounding box in display space; *args* and *kwargs* are empty.

This bounding box does not include the spines, ticks, ticklables, or other labels. For a bounding box including these elements use `get_tightbbox`.

#### See also:

`matplotlib.axes.Axes.get_tightbbox`

`matplotlib.axis.Axis.get_tightbbox`

`matplotlib.spines.get_window_extent`

#### matplotlib.axes.Axes.get\_tightbbox

`Axes.get_tightbbox(self, renderer, call_axes_locator=True, bbox_extra_artists=None)`

Return the tight bounding box of the axes, including axis and their decorators (xlabel, title, etc).

Artists that have `artist.set_in_layout(False)` are not included in the bbox.

#### Parameters

**renderer** [*RendererBase* instance] renderer that will be used to draw the figures (i.e. `fig.canvas.get_renderer()`)

**bbox\_extra\_artists** [list of *Artist* or None] List of artists to include in the tight bounding box. If None (default), then all artist children of the axes are included in the tight bounding box.

**call\_axes\_locator** [boolean (default True)] If `call_axes_locator` is False, it does not call the `_axes_locator` attribute, which is necessary to get the correct bounding box. `call_axes_locator=False` can be used if the caller is only interested in the relative size of the tightbbox compared to the axes bbox.

#### Returns

**bbox** [*BboxBase*] bounding box in figure pixel coordinates.

#### See also:

`matplotlib.axis.Axes.get_window_extent`

`matplotlib.axis.Axis.get_tightbbox`

`matplotlib.spines.get_window_extent`

## 17.5.16 Bulk property manipulation

<code>Axes.set</code>	A property batch setter.
<code>Axes.update</code>	Update this artist's properties from the dictionary <i>props</i> .
<code>Axes.properties</code>	Return a dictionary of all the properties of the artist.
<code>Axes.update_from</code>	Copy properties from <i>other</i> to <i>self</i> .

**matplotlib.axes.Axes.set**

`Axes.set(self, **kwargs)`

A property batch setter. Pass *kwargs* to set properties.

**Examples using matplotlib.axes.Axes.set**

- sphx\_glr\_gallery\_pie\_and\_polar\_charts\_nested\_pie.py

**matplotlib.axes.Axes.update**

`Axes.update(self, props)`

Update this artist's properties from the dictionary *props*.

**matplotlib.axes.Axes.properties**

`Axes.properties(self)`

Return a dictionary of all the properties of the artist.

**matplotlib.axes.Axes.update\_from**

`Axes.update_from(self, other)`

Copy properties from *other* to *self*.

**17.5.17 General Artist Properties**

<code>Axes.set_agg_filter</code>	Set the agg filter.
<code>Axes.set_alpha</code>	Set the alpha value used for blending - not supported on all backends.
<code>Axes.set_animated</code>	Set the artist's animation state.
<code>Axes.set_clip_box</code>	Set the artist's clip <i>Bbox</i> .
<code>Axes.set_clip_on</code>	Set whether the artist uses clipping.
<code>Axes.set_clip_path</code>	Set the artist's clip path, which may be:
<code>Axes.set_gid</code>	Set the (group) id for the artist.
<code>Axes.set_label</code>	Set a label that will be displayed in the legend.
<code>Axes.set_path_effects</code>	Set the path effects.

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<code>Axes.set_rasterized</code>	Force rasterized (bitmap) drawing in vector backend output.
<code>Axes.set_sketch_params</code>	Sets the sketch parameters.
<code>Axes.set_snap</code>	Set the snapping behavior.
<code>Axes.set_transform</code>	Set the artist transform.
<code>Axes.set_url</code>	Set the url for the artist.
<code>Axes.set_visible</code>	Set the artist's visibility.
<code>Axes.set_zorder</code>	Set the zorder for the artist.
<code>Axes.get_agg_filter</code>	Return filter function to be used for agg filter.
<code>Axes.get_alpha</code>	Return the alpha value used for blending - not supported on all backends
<code>Axes.get_animated</code>	Return the animated state.
<code>Axes.get_clip_box</code>	Return the clipbox.
<code>Axes.get_clip_on</code>	Return whether the artist uses clipping.
<code>Axes.get_clip_path</code>	Return the clip path.
<code>Axes.get_gid</code>	Return the group id.
<code>Axes.get_label</code>	Return the label used for this artist in the legend.
<code>Axes.get_path_effects</code>	
<code>Axes.get_rasterized</code>	Return whether the artist is to be rasterized.
<code>Axes.get_sketch_params</code>	Returns the sketch parameters for the artist.
<code>Axes.get_snap</code>	Returns the snap setting.
<code>Axes.get_transform</code>	Return the <i>Transform</i> instance used by this artist.
<code>Axes.get_url</code>	Return the url.
<code>Axes.get_visible</code>	Return the visibility.
<code>Axes.get_zorder</code>	Return the artist's zorder.
<code>Axes.axes</code>	The <i>Axes</i> instance the artist resides in, or <i>None</i> .
<code>Axes.set_figure</code>	Set the <i>Figure</i> for this <i>Axes</i> .
<code>Axes.get_figure</code>	Return the <i>Figure</i> instance the artist belongs to.

**matplotlib.axes.Axes.set\_agg\_filter**

`Axes.set_agg_filter(self, filter_func)`

Set the agg filter.

**Parameters**

**filter\_func** [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

**matplotlib.axes.Axes.set\_alpha**

`Axes.set_alpha(self, alpha)`

Set the alpha value used for blending - not supported on all backends.

**Parameters**

**alpha** [float]

**matplotlib.axes.Axes.set\_animated**

`Axes.set_animated(self, b)`  
Set the artist's animation state.

**Parameters**

**b** [bool]

**matplotlib.axes.Axes.set\_clip\_box**

`Axes.set_clip_box(self, clipbox)`  
Set the artist's clip *Bbox*.

**Parameters**

**clipbox** [*Bbox*]

**matplotlib.axes.Axes.set\_clip\_on**

`Axes.set_clip_on(self, b)`  
Set whether the artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

**Parameters**

**b** [bool]

**matplotlib.axes.Axes.set\_clip\_path**

`Axes.set_clip_path(self, path, transform=None)`  
Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- None, to remove a previously set clipping path.

For efficiency, if the path happens to be an axis-aligned rectangle, this method will set the clipping box to the corresponding rectangle and set the clipping path to None.

ACCEPTS: [(*Path*, *Transform*) | *Patch* | None]

**matplotlib.axes.Axes.set\_gid**

`Axes.set_gid(self, gid)`  
Set the (group) id for the artist.

**Parameters**

**gid** [str]

**matplotlib.axes.Axes.set\_label**

`Axes.set_label(self, s)`  
Set a label that will be displayed in the legend.

**Parameters**

**s** [object] *s* will be converted to a string by calling `str`.

**matplotlib.axes.Axes.set\_path\_effects**

`Axes.set_path_effects(self, path_effects)`  
Set the path effects.

**Parameters**

**path\_effects** [*AbstractPathEffect*]

**matplotlib.axes.Axes.set\_rasterized**

`Axes.set_rasterized(self, rasterized)`  
Force rasterized (bitmap) drawing in vector backend output.  
Defaults to `None`, which implies the backend's default behavior.

**Parameters**

**rasterized** [bool or `None`]

**matplotlib.axes.Axes.set\_sketch\_params**

`Axes.set_sketch_params(self, scale=None, length=None, randomness=None)`  
Sets the sketch parameters.

**Parameters**

**scale** [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If `scale` is `None`, or not provided, no sketch filter will be provided.

**length** [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

**randomness** [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

**matplotlib.axes.Axes.set\_snap**

`Axes.set_snap(self, snap)`  
Set the snapping behavior.

Snapping aligns positions with the pixel grid, which results in clearer images. For example, if a black line of 1px width was defined at a position in between two pixels, the resulting image would contain the interpolated value of that line in the pixel grid, which would be a grey value on both adjacent pixel positions. In contrast, snapping will move

the line to the nearest integer pixel value, so that the resulting image will really contain a 1px wide black line.

Snapping is currently only supported by the Agg and MacOSX backends.

### Parameters

**snap** [bool or None] Possible values:

- *True*: Snap vertices to the nearest pixel center.
- *False*: Do not modify vertex positions.
- *None*: (auto) If the path contains only rectilinear line segments, round to the nearest pixel center.

### matplotlib.axes.Axes.set\_transform

`Axes.set_transform(self, t)`  
Set the artist transform.

### Parameters

**t** [*Transform*]

### matplotlib.axes.Axes.set\_url

`Axes.set_url(self, url)`  
Set the url for the artist.

### Parameters

**url** [str]

### matplotlib.axes.Axes.set\_visible

`Axes.set_visible(self, b)`  
Set the artist's visibility.

### Parameters

**b** [bool]

### matplotlib.axes.Axes.set\_zorder

`Axes.set_zorder(self, level)`  
Set the zorder for the artist. Artists with lower zorder values are drawn first.

### Parameters

**level** [float]

### matplotlib.axes.Axes.get\_agg\_filter

`Axes.get_agg_filter(self)`  
Return filter function to be used for agg filter.

**matplotlib.axes.Axes.get\_alpha**

`Axes.get_alpha(self)`  
Return the alpha value used for blending - not supported on all backends

**matplotlib.axes.Axes.get\_animated**

`Axes.get_animated(self)`  
Return the animated state.

**matplotlib.axes.Axes.get\_clip\_box**

`Axes.get_clip_box(self)`  
Return the clipbox.

**matplotlib.axes.Axes.get\_clip\_on**

`Axes.get_clip_on(self)`  
Return whether the artist uses clipping.

**matplotlib.axes.Axes.get\_clip\_path**

`Axes.get_clip_path(self)`  
Return the clip path.

**matplotlib.axes.Axes.get\_gid**

`Axes.get_gid(self)`  
Return the group id.

**matplotlib.axes.Axes.get\_label**

`Axes.get_label(self)`  
Return the label used for this artist in the legend.

**matplotlib.axes.Axes.get\_path\_effects**

`Axes.get_path_effects(self)`

**matplotlib.axes.Axes.get\_rasterized**

`Axes.get_rasterized(self)`  
Return whether the artist is to be rasterized.

**matplotlib.axes.Axes.get\_sketch\_params**

`Axes.get_sketch_params(self)`

Returns the sketch parameters for the artist.

**Returns**

**sketch\_params** [tuple or None] A 3-tuple with the following elements:

- *scale*: The amplitude of the wiggle perpendicular to the source line.
- *length*: The length of the wiggle along the line.
- *randomness*: The scale factor by which the length is shrunken or expanded.

Returns *None* if no sketch parameters were set.

**matplotlib.axes.Axes.get\_snap**

`Axes.get_snap(self)`

Returns the snap setting.

See `set_snap` for details.

**matplotlib.axes.Axes.get\_transform**

`Axes.get_transform(self)`

Return the *Transform* instance used by this artist.

**matplotlib.axes.Axes.get\_url**

`Axes.get_url(self)`

Return the url.

**matplotlib.axes.Axes.get\_visible**

`Axes.get_visible(self)`

Return the visibility.

**matplotlib.axes.Axes.get\_zorder**

`Axes.get_zorder(self)`

Return the artist's zorder.

**matplotlib.axes.Axes.axes**

`Axes.axes`

The *Axes* instance the artist resides in, or *None*.

**matplotlib.axes.Axes.set\_figure**

`Axes.set_figure(self, fig)`  
 Set the *Figure* for this *Axes*.

**Parameters**

**fig** [*Figure*]

**matplotlib.axes.Axes.get\_figure**

`Axes.get_figure(self)`  
 Return the *Figure* instance the artist belongs to.

**17.5.18 Artist Methods**

<code>Axes.remove</code>	Remove the artist from the figure if possible.
<code>Axes.is_transform_set</code>	Return whether the Artist has an explicitly set transform.

**matplotlib.axes.Axes.remove**

`Axes.remove(self)`  
 Remove the artist from the figure if possible.

The effect will not be visible until the figure is redrawn, e.g., with *FigureCanvasBase.draw\_idle*. Call *relim* to update the axes limits if desired.

Note: *relim* will not see collections even if the collection was added to the axes with *autolim = True*.

Note: there is no support for removing the artist's legend entry.

**matplotlib.axes.Axes.is\_transform\_set**

`Axes.is_transform_set(self)`  
 Return whether the Artist has an explicitly set transform.

This is *True* after *set\_transform* has been called.

**17.5.19 Projection**

Methods used by *Axis* that must be overridden for non-rectilinear Axes.

<code>Axes.name</code>	
<code>Axes.get_xaxis_transform</code>	Get the transformation used for drawing x-axis labels, ticks and gridlines.
<code>Axes.get_yaxis_transform</code>	Get the transformation used for drawing y-axis labels, ticks and gridlines.
<code>Axes.get_data_ratio</code>	Return the aspect ratio of the raw data.

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<code>Axes.get_data_ratio_log</code>	Return the aspect ratio of the raw data in log scale.
<code>Axes.get_xaxis_text1_transform</code>	<b>Returns</b>
<code>Axes.get_xaxis_text2_transform</code>	<b>Returns</b>
<code>Axes.get_yaxis_text1_transform</code>	<b>Returns</b>
<code>Axes.get_yaxis_text2_transform</code>	<b>Returns</b>

**matplotlib.axes.Axes.name**

```
Axes.name = 'rectilinear'
```

**matplotlib.axes.Axes.get\_xaxis\_transform**

```
Axes.get_xaxis_transform(self, which='grid')
```

Get the transformation used for drawing x-axis labels, ticks and gridlines. The x-direction is in data coordinates and the y-direction is in axis coordinates.

---

**Note:** This transformation is primarily used by the *Axis* class, and is meant to be overridden by new kinds of projections that may need to place axis elements in different locations.

---

**Examples using matplotlib.axes.Axes.get\_xaxis\_transform**

- *Transformations Tutorial*

**matplotlib.axes.Axes.get\_yaxis\_transform**

```
Axes.get_yaxis_transform(self, which='grid')
```

Get the transformation used for drawing y-axis labels, ticks and gridlines. The x-direction is in axis coordinates and the y-direction is in data coordinates.

---

**Note:** This transformation is primarily used by the *Axis* class, and is meant to be overridden by new kinds of projections that may need to place axis elements in different locations.

---

Examples using `matplotlib.axes.Axes.get_yaxis_transform`

- *Transformations Tutorial*

`matplotlib.axes.Axes.get_data_ratio`

`Axes.get_data_ratio(self)`  
Return the aspect ratio of the raw data.

#### Notes

This method is intended to be overridden by new projection types.

`matplotlib.axes.Axes.get_data_ratio_log`

`Axes.get_data_ratio_log(self)`  
Return the aspect ratio of the raw data in log scale.

#### Notes

Will be used when both axis are in log scale.

`matplotlib.axes.Axes.get_xaxis_text1_transform`

`Axes.get_xaxis_text1_transform(self, pad_points)`

#### Returns

**transform** [Transform] The transform used for drawing x-axis labels, which will add *pad\_points* of padding (in points) between the axes and the label. The x-direction is in data coordinates and the y-direction is in axis coordinates

**valign** [{'center', 'top', 'bottom', 'baseline', 'center\_baseline'}] The text vertical alignment.

**halign** [{'center', 'left', 'right'}] The text horizontal alignment.

#### Notes

This transformation is primarily used by the *Axis* class, and is meant to be overridden by new kinds of projections that may need to place axis elements in different locations.

**matplotlib.axes.Axes.get\_xaxis\_text2\_transform**

`Axes.get_xaxis_text2_transform(self, pad_points)`

**Returns**

**transform** [Transform] The transform used for drawing secondary x-axis labels, which will add *pad\_points* of padding (in points) between the axes and the label. The x-direction is in data coordinates and the y-direction is in axis coordinates

**valign** [{'center', 'top', 'bottom', 'baseline', 'center\_baseline'}] The text vertical alignment.

**halign** [{'center', 'left', 'right'}] The text horizontal alignment.

**Notes**

This transformation is primarily used by the *Axes* class, and is meant to be overridden by new kinds of projections that may need to place axis elements in different locations.

**matplotlib.axes.Axes.get\_yaxis\_text1\_transform**

`Axes.get_yaxis_text1_transform(self, pad_points)`

**Returns**

**transform** [Transform] The transform used for drawing y-axis labels, which will add *pad\_points* of padding (in points) between the axes and the label. The x-direction is in axis coordinates and the y-direction is in data coordinates

**valign** [{'center', 'top', 'bottom', 'baseline', 'center\_baseline'}] The text vertical alignment.

**halign** [{'center', 'left', 'right'}] The text horizontal alignment.

**Notes**

This transformation is primarily used by the *Axes* class, and is meant to be overridden by new kinds of projections that may need to place axis elements in different locations.

**matplotlib.axes.Axes.get\_yaxis\_text2\_transform**

`Axes.get_yaxis_text2_transform(self, pad_points)`

**Returns**

**transform** [Transform] The transform used for drawing secondary y-axis labels, which will add *pad\_points* of padding (in points) between the axes and the label. The x-direction is in axis coordinates and the y-direction is in data coordinates

**valign** [{'center', 'top', 'bottom', 'baseline', 'center\_baseline'}] The text vertical alignment.

**halign** [`{'center', 'left', 'right'}`] The text horizontal alignment.

### Notes

This transformation is primarily used by the *Axes* class, and is meant to be overridden by new kinds of projections that may need to place axis elements in different locations.

## 17.5.20 Other

<i>Axes.zorder</i>	
<i>Axes.get_default_bbox_extra_artists</i>	Return a default list of artists that are used for the bounding box calculation.
<i>Axes.get_transformed_clip_path_and_affine</i>	Return the clip path with the non-affine part of its transformation applied, and the remaining affine part of its transformation.
<i>Axes.has_data</i>	Return <i>True</i> if any artists have been added to axes.

### `matplotlib.axes.Axes.zorder`

`Axes.zorder = 0`

### `matplotlib.axes.Axes.get_default_bbox_extra_artists`

`Axes.get_default_bbox_extra_artists(self)`

Return a default list of artists that are used for the bounding box calculation.

Artists are excluded either by not being visible or `artist.set_in_layout(False)`.

### `matplotlib.axes.Axes.get_transformed_clip_path_and_affine`

`Axes.get_transformed_clip_path_and_affine(self)`

Return the clip path with the non-affine part of its transformation applied, and the remaining affine part of its transformation.

### `matplotlib.axes.Axes.has_data`

`Axes.has_data(self)`

Return *True* if any artists have been added to axes.

This should not be used to determine whether the *dataLim* need to be updated, and may not actually be useful for anything.

### 17.5.21 Inheritance



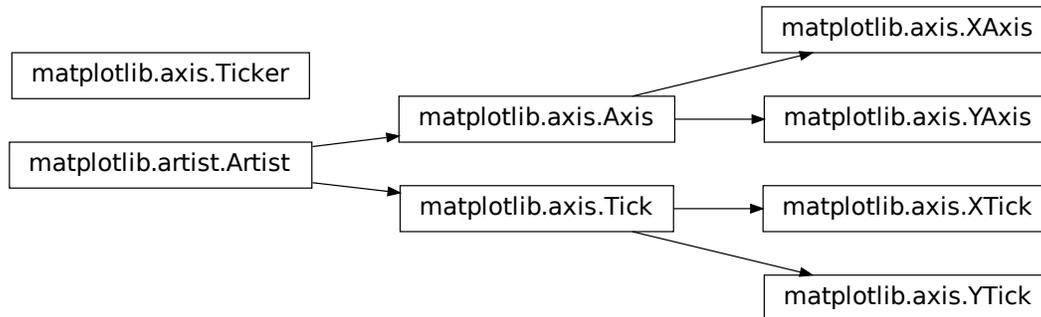
## 17.6 matplotlib.axis

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Classes for the ticks and x and y axis.

## 17.6.1 Inheritance



## 17.6.2 Axis objects

```
class matplotlib.axis.Axis(axes, pickradius=15)
```

Base class for *XAxis* and *YAxis*.

### Attributes

**isDefault\_label** [bool]

**axes** [*matplotlib.axes.Axes*] The *Axes* instance the artist resides in, or *None*.

**major** [*matplotlib.axis.Ticker*] Determines the major tick positions and their label format.

**minor** [*matplotlib.axis.Ticker*] Determines the minor tick positions and their label format.

**callbacks** [*matplotlib.cbook.CallbackRegistry*]

**label** [*Text*] The axis label.

**labelpad** [float] The distance between the axis label and the tick labels. Defaults to `rcParams["axes.labelpad"] = 4`.

**offsetText** [*Text*] A *Text* object containing the data offset of the ticks (if any).

**pickradius** [float] The acceptance radius for containment tests. See also *Axis.contains*.

**majorTicks** [list of *Tick*] The major ticks.

**minorTicks** [list of *Tick*] The minor ticks.

### Parameters

**axes** [*matplotlib.axes.Axes*] The *Axes* to which the created Axis belongs.

**pickradius** [float] The acceptance radius for containment tests. See also *Axis.contains*.

```
class matplotlib.axis.XAxis(axes, pickradius=15)
```

### Parameters

**axes** [*matplotlib.axes.Axes*] The *Axes* to which the created Axis belongs.

**pickradius** [float] The acceptance radius for containment tests. See also *Axis.contains*.

```
class matplotlib.axis.YAxis(axes, pickradius=15)
```

### Parameters

**axes** [*matplotlib.axes.Axes*] The *Axes* to which the created Axis belongs.

**pickradius** [float] The acceptance radius for containment tests. See also *Axis.contains*.

```
class matplotlib.axis.Ticker
```

A container for the objects defining tick position and format.

### Attributes

**locator** [*matplotlib.ticker.Locator* subclass] Determines the positions of the ticks.

**formatter** [*matplotlib.ticker.Formatter* subclass] Determines the format of the tick labels.

<i>Axis.cla</i>	clear the current axis
<i>Axis.get_scale</i>	

---

## matplotlib.axis.Axis.cla

```
Axis.cla(self)
    clear the current axis
```

## matplotlib.axis.Axis.get\_scale

```
Axis.get_scale(self)
```

## Formatters and Locators

<i>Axis.get_major_formatter</i>	Get the formatter of the major ticker
<i>Axis.get_major_locator</i>	Get the locator of the major ticker
<i>Axis.get_minor_formatter</i>	Get the formatter of the minor ticker
<i>Axis.get_minor_locator</i>	Get the locator of the minor ticker
<i>Axis.set_major_formatter</i>	Set the formatter of the major ticker.
<i>Axis.set_major_locator</i>	Set the locator of the major ticker.
<i>Axis.set_minor_formatter</i>	Set the formatter of the minor ticker.
<i>Axis.set_minor_locator</i>	Set the locator of the minor ticker.
<i>Axis.remove_overlapping_locs</i>	If minor ticker locations that overlap with major ticker locations should be trimmed.
<i>Axis.get_remove_overlapping_locs</i>	

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*Axis.set\_remove\_overlapping\_locs*

---

**matplotlib.axis.Axis.get\_major\_formatter**

`Axis.get_major_formatter(self)`  
Get the formatter of the major ticker

**matplotlib.axis.Axis.get\_major\_locator**

`Axis.get_major_locator(self)`  
Get the locator of the major ticker

**matplotlib.axis.Axis.get\_minor\_formatter**

`Axis.get_minor_formatter(self)`  
Get the formatter of the minor ticker

**matplotlib.axis.Axis.get\_minor\_locator**

`Axis.get_minor_locator(self)`  
Get the locator of the minor ticker

**matplotlib.axis.Axis.set\_major\_formatter**

`Axis.set_major_formatter(self, formatter)`  
Set the formatter of the major ticker.

**Parameters**

**formatter** [*Formatter*]

**Examples using matplotlib.axis.Axis.set\_major\_formatter**

- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_timeline.py
- sphx\_glr\_gallery\_pyplots\_dollar\_ticks.py

**matplotlib.axis.Axis.set\_major\_locator**

`Axis.set_major_locator(self, locator)`  
Set the locator of the major ticker.

**Parameters**

**locator** [*Locator*]

**Examples using `matplotlib.axis.Axis.set_major_locator`**

- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_filled\_step.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_timeline.py
- sphx\_glr\_gallery\_scales\_scales.py

**`matplotlib.axis.Axis.set_minor_formatter`**

`Axis.set_minor_formatter(self, formatter)`  
Set the formatter of the minor ticker.

**Parameters**

**formatter** [*Formatter*]

**Examples using `matplotlib.axis.Axis.set_minor_formatter`**

- sphx\_glr\_gallery\_pyplots\_pyplot\_scales.py

**`matplotlib.axis.Axis.set_minor_locator`**

`Axis.set_minor_locator(self, locator)`  
Set the locator of the minor ticker.

**Parameters**

**locator** [*Locator*]

**`matplotlib.axis.Axis.remove_overlapping_locs`**

`Axis.remove_overlapping_locs`  
If minor ticker locations that overlap with major ticker locations should be trimmed.

**`matplotlib.axis.Axis.get_remove_overlapping_locs`**

`Axis.get_remove_overlapping_locs(self)`

**`matplotlib.axis.Axis.set_remove_overlapping_locs`**

`Axis.set_remove_overlapping_locs(self, val)` \_\_\_\_\_  
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**Axis Label**

<code>Axis.set_label_coords</code>	Set the coordinates of the label.
<code>Axis.set_label_position</code>	Set the label position (top or bottom)
<code>Axis.set_label_text</code>	Set the text value of the axis label.
<code>Axis.get_label_position</code>	Return the label position (top or bottom)
<code>Axis.get_label_text</code>	Get the text of the label

**matplotlib.axis.Axis.set\_label\_coords**

`Axis.set_label_coords(self, x, y, transform=None)`

Set the coordinates of the label.

By default, the x coordinate of the y label is determined by the tick label bounding boxes, but this can lead to poor alignment of multiple ylabels if there are multiple axes. Ditto for the y coordinate of the x label.

You can also specify the coordinate system of the label with the transform. If None, the default coordinate system will be the axes coordinate system (0,0) is (left,bottom), (0.5, 0.5) is middle, etc

**Examples using matplotlib.axis.Axis.set\_label\_coords**

- sphx\_glr\_gallery\_pyplots\_align\_ylabels.py

**matplotlib.axis.Axis.set\_label\_position**

`Axis.set_label_position(self, position)`

Set the label position (top or bottom)

**Parameters**

**position** [{'top', 'bottom'}]

**matplotlib.axis.Axis.set\_label\_text**

`Axis.set_label_text(self, label, fontdict=None, **kwargs)`

Set the text value of the axis label.

**Parameters**

**label** [str] Text string.

**fontdict** [dict] Text properties.

**\*\*kwargs** Merged into fontdict.

**matplotlib.axis.Axis.get\_label\_position**

`Axis.get_label_position(self)`  
Return the label position (top or bottom)

**matplotlib.axis.Axis.get\_label\_text**

`Axis.get_label_text(self)`  
Get the text of the label

**Ticks, tick labels and Offset text**

<code>Axis.get_major_ticks</code>	Get the tick instances; grow as necessary.
<code>Axis.get_majorticklabels</code>	Return a list of Text instances for the major ticklabels.
<code>Axis.get_majorticklines</code>	Return the major tick lines as a list of Line2D instances
<code>Axis.get_majorticklocs</code>	Get the array of major tick locations in data coordinates.
<code>Axis.get_minor_ticks</code>	Get the minor tick instances; grow as necessary.
<code>Axis.get_minorticklabels</code>	Return a list of Text instances for the minor ticklabels.
<code>Axis.get_minorticklines</code>	Return the minor tick lines as a list of Line2D instances
<code>Axis.get_minorticklocs</code>	Get the array of minor tick locations in data coordinates.
<code>Axis.get_offset_text</code>	Return the axis offsetText as a Text instance
<code>Axis.get_tick_padding</code>	
<code>Axis.get_ticklabels</code>	Get the tick labels as a list of <i>Text</i> instances.
<code>Axis.get_ticklines</code>	Return the tick lines as a list of Line2D instances
<code>Axis.get_ticklocs</code>	Get the array of tick locations in data coordinates.
<code>Axis.get_gridlines</code>	Return the grid lines as a list of Line2D instance
<code>Axis.grid</code>	Configure the grid lines.
<code>Axis.set_tick_params</code>	Set appearance parameters for ticks, ticklabels, and gridlines.
<code>Axis.axis_date</code>	Sets up axis ticks and labels treating data along this axis as dates.

**matplotlib.axis.Axis.get\_major\_ticks**

`Axis.get_major_ticks(self, numticks=None)`  
Get the tick instances; grow as necessary.

Examples using `matplotlib.axis.Axis.get_major_ticks`

- `sphx_glr_gallery_pyplots_dollar_ticks.py`

**`matplotlib.axis.Axis.get_majorticklabels`**

`Axis.get_majorticklabels(self)`

Return a list of Text instances for the major ticklabels.

**`matplotlib.axis.Axis.get_majorticklines`**

`Axis.get_majorticklines(self)`

Return the major tick lines as a list of Line2D instances

**`matplotlib.axis.Axis.get_majorticklocs`**

`Axis.get_majorticklocs(self)`

Get the array of major tick locations in data coordinates.

**`matplotlib.axis.Axis.get_minor_ticks`**

`Axis.get_minor_ticks(self, numticks=None)`

Get the minor tick instances; grow as necessary.

**`matplotlib.axis.Axis.get_minorticklabels`**

`Axis.get_minorticklabels(self)`

Return a list of Text instances for the minor ticklabels.

**`matplotlib.axis.Axis.get_minorticklines`**

`Axis.get_minorticklines(self)`

Return the minor tick lines as a list of Line2D instances

**`matplotlib.axis.Axis.get_minorticklocs`**

`Axis.get_minorticklocs(self)`

Get the array of minor tick locations in data coordinates.

**`matplotlib.axis.Axis.get_offset_text`**

`Axis.get_offset_text(self)`

Return the axis offsetText as a Text instance

**matplotlib.axis.Axis.get\_tick\_padding**

`Axis.get_tick_padding(self)`

**matplotlib.axis.Axis.get\_ticklabels**

`Axis.get_ticklabels(self, minor=False, which=None)`  
Get the tick labels as a list of *Text* instances.

**Parameters**

**minor** [bool] If True return the minor ticklabels, else return the major ticklabels

**which** [None, ('minor', 'major', 'both')] Overrides *minor*.

Selects which ticklabels to return

**Returns**

**ret** [list] List of *Text* instances.

**Examples using matplotlib.axis.Axis.get\_ticklabels**

- sphx\_glr\_gallery\_pyplots\_fig\_axes\_customize\_simple.py

**matplotlib.axis.Axis.get\_ticklines**

`Axis.get_ticklines(self, minor=False)`  
Return the tick lines as a list of *Line2D* instances

**Examples using matplotlib.axis.Axis.get\_ticklines**

- sphx\_glr\_gallery\_pyplots\_fig\_axes\_customize\_simple.py

**matplotlib.axis.Axis.get\_ticklocs**

`Axis.get_ticklocs(self, minor=False)`  
Get the array of tick locations in data coordinates.

**matplotlib.axis.Axis.get\_gridlines**

`Axis.get_gridlines(self)`  
Return the grid lines as a list of *Line2D* instance

### matplotlib.axis.Axis.grid

`Axis.grid(self, b=None, which='major', **kwargs)`  
 Configure the grid lines.

#### Parameters

**b** [bool or None] Whether to show the grid lines. If any *kwargs* are supplied, it is assumed you want the grid on and *b* will be set to True.

If *b* is *None* and there are no *kwargs*, this toggles the visibility of the lines.

**which** [{'major', 'minor', 'both'}] The grid lines to apply the changes on.

**\*\*kwargs** [*Line2D* properties] Define the line properties of the grid, e.g.:

```
grid(color='r', linestyle='-', linewidth=2)
```

### matplotlib.axis.Axis.set\_tick\_params

`Axis.set_tick_params(self, which='major', reset=False, **kw)`  
 Set appearance parameters for ticks, ticklabels, and gridlines.

For documentation of keyword arguments, see `matplotlib.axes.Axes.tick_params()`.

### matplotlib.axis.Axis.axis\_date

`Axis.axis_date(self, tz=None)`  
 Sets up axis ticks and labels treating data along this axis as dates.

#### Parameters

**tz** [tzinfo or str or None] The timezone used to create date labels.

### Data and view intervals

<code>Axis.get_data_interval</code>	Return the Interval instance for this axis data limits.
<code>Axis.get_view_interval</code>	Return the Interval instance for this axis view limits.
<code>Axis.set_data_interval</code>	Set the axis data limits.
<code>Axis.set_view_interval</code>	Set the axis view limits.

### matplotlib.axis.Axis.get\_data\_interval

`Axis.get_data_interval(self)`  
 Return the Interval instance for this axis data limits.

**matplotlib.axis.Axis.get\_view\_interval**`Axis.get_view_interval(self)`

Return the Interval instance for this axis view limits.

**matplotlib.axis.Axis.set\_data\_interval**`Axis.set_data_interval(self, vmin, vmax, ignore=False)`

Set the axis data limits. This method is for internal use.

If *ignore* is False (the default), this method will never reduce the preexisting data limits, only expand them if *vmin* or *vmax* are not within them. Moreover, the order of *vmin* and *vmax* does not matter; the orientation of the axis will not change.

If *ignore* is True, the data limits will be set exactly to (*vmin*, *vmax*) in that order.

**matplotlib.axis.Axis.set\_view\_interval**`Axis.set_view_interval(self, vmin, vmax, ignore=False)`

Set the axis view limits. This method is for internal use; Matplotlib users should typically use e.g. `set_xlim` and `set_ylim`.

If *ignore* is False (the default), this method will never reduce the preexisting view limits, only expand them if *vmin* or *vmax* are not within them. Moreover, the order of *vmin* and *vmax* does not matter; the orientation of the axis will not change.

If *ignore* is True, the view limits will be set exactly to (*vmin*, *vmax*) in that order.

**Rendering helpers**

<code>Axis.get_minpos</code>	
<code>Axis.get_tick_space</code>	Return the estimated number of ticks that can fit on the axis.
<code>Axis.get_ticklabel_extents</code>	Get the extents of the tick labels on either side of the axes.
<code>Axis.get_tightbbox</code>	Return a bounding box that encloses the axis.

**matplotlib.axis.Axis.get\_minpos**`Axis.get_minpos(self)`**matplotlib.axis.Axis.get\_tick\_space**`Axis.get_tick_space(self)`

Return the estimated number of ticks that can fit on the axis.

**matplotlib.axis.Axis.get\_ticklabel\_extents**

`Axis.get_ticklabel_extents(self, renderer)`  
 Get the extents of the tick labels on either side of the axes.

**matplotlib.axis.Axis.get\_tightbbox**

`Axis.get_tightbbox(self, renderer)`  
 Return a bounding box that encloses the axis. It only accounts tick labels, axis label, and `offsetText`.

**Interactive**

<code>Axis.get_pickradius</code>	Return the depth of the axis used by the picker
<code>Axis.set_pickradius</code>	Set the depth of the axis used by the picker.

**matplotlib.axis.Axis.get\_pickradius**

`Axis.get_pickradius(self)`  
 Return the depth of the axis used by the picker

**matplotlib.axis.Axis.set\_pickradius**

`Axis.set_pickradius(self, pickradius)`  
 Set the depth of the axis used by the picker.

**Parameters**

**pickradius** [float]

**Units**

<code>Axis.convert_units</code>	
<code>Axis.set_units</code>	Set the units for axis.
<code>Axis.get_units</code>	Return the units for axis.
<code>Axis.update_units</code>	introspect <i>data</i> for units converter and update the <code>axis.converter</code> instance if necessary.

**matplotlib.axis.Axis.convert\_units**

`Axis.convert_units(self, x)`

**matplotlib.axis.Axis.set\_units**

`Axis.set_units(self, u)`  
Set the units for axis.

**Parameters**

**u** [units tag]

**matplotlib.axis.Axis.get\_units**

`Axis.get_units(self)`  
Return the units for axis.

**matplotlib.axis.Axis.update\_units**

`Axis.update_units(self, data)`  
introspect *data* for units converter and update the axis.converter instance if necessary.  
Return *True* if *data* is registered for unit conversion.

**Incremental navigation**

<code>Axis.pan</code>	Pan by <i>numsteps</i> (can be positive or negative).
<code>Axis.zoom</code>	Zoom in/out on axis; if <i>direction</i> is >0 zoom in, else zoom out.

**matplotlib.axis.Axis.pan**

`Axis.pan(self, numsteps)`  
Pan by *numsteps* (can be positive or negative).

**matplotlib.axis.Axis.zoom**

`Axis.zoom(self, direction)`  
Zoom in/out on axis; if *direction* is >0 zoom in, else zoom out.

**YAxis Specific**

<code>YAxis.axis_name</code>	
<code>YAxis.get_text_widths</code>	
<code>YAxis.get_ticks_position</code>	Return the ticks position ("left", "right", "default", or "unknown").
<code>YAxis.set_offset_position</code>	

**Parameters**

Continued on next page

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<code>YAxis.set_ticks_position</code>	Set the ticks position (left, right, both, default or none) 'both' sets the ticks to appear on both positions, but does not change the tick labels.
<code>YAxis.tick_left</code>	Move ticks and ticklabels (if present) to the left of the axes.
<code>YAxis.tick_right</code>	Move ticks and ticklabels (if present) to the right of the axes.

**matplotlib.axis.YAxis.axis\_name**

```
YAxis.axis_name = 'y'
```

**matplotlib.axis.YAxis.get\_text\_widths**

```
YAxis.get_text_widths(self, renderer)
```

**matplotlib.axis.YAxis.get\_ticks\_position**

```
YAxis.get_ticks_position(self)
```

Return the ticks position ("left", "right", "default", or "unknown").

**matplotlib.axis.YAxis.set\_offset\_position**

```
YAxis.set_offset_position(self, position)
```

**Parameters**

**position** [ {'left', 'right'} ]

**matplotlib.axis.YAxis.set\_ticks\_position**

```
YAxis.set_ticks_position(self, position)
```

Set the ticks position (left, right, both, default or none) 'both' sets the ticks to appear on both positions, but does not change the tick labels. 'default' resets the tick positions to the default: ticks on both positions, labels at left. 'none' can be used if you don't want any ticks. 'none' and 'both' affect only the ticks, not the labels.

**Parameters**

**position** [ {'left', 'right', 'both', 'default', 'none'} ]

**Examples using matplotlib.axis.YAxis.set\_ticks\_position**

- sphx\_glr\_gallery\_pyplots\_whats\_new\_99\_spines.py

**matplotlib.axis.YAxis.tick\_left**`YAxis.tick_left(self)`

Move ticks and ticklabels (if present) to the left of the axes.

**matplotlib.axis.YAxis.tick\_right**`YAxis.tick_right(self)`

Move ticks and ticklabels (if present) to the right of the axes.

**XAxis Specific**

<code>XAxis.axis_name</code>	
<code>XAxis.get_text_heights</code>	Returns the amount of space one should reserve for text above and below the axes.
<code>XAxis.get_ticks_position</code>	Return the ticks position ("top", "bottom", "default", or "unknown").
<code>XAxis.set_ticks_position</code>	Set the ticks position (top, bottom, both, default or none) both sets the ticks to appear on both positions, but does not change the tick labels.
<code>XAxis.tick_bottom</code>	Move ticks and ticklabels (if present) to the bottom of the axes.
<code>XAxis.tick_top</code>	Move ticks and ticklabels (if present) to the top of the axes.

**matplotlib.axis.XAxis.axis\_name**`XAxis.axis_name = 'x'`**matplotlib.axis.XAxis.get\_text\_heights**`XAxis.get_text_heights(self, renderer)`Returns the amount of space one should reserve for text above and below the axes.  
Returns a tuple (above, below)**matplotlib.axis.XAxis.get\_ticks\_position**`XAxis.get_ticks_position(self)`

Return the ticks position ("top", "bottom", "default", or "unknown").

**matplotlib.axis.XAxis.set\_ticks\_position**`XAxis.set_ticks_position(self, position)`

Set the ticks position (top, bottom, both, default or none) both sets the ticks to appear on both positions, but does not change the tick labels. 'default' resets the tick positions

to the default: ticks on both positions, labels at bottom. 'none' can be used if you don't want any ticks. 'none' and 'both' affect only the ticks, not the labels.

### Parameters

**position** [{'top', 'bottom', 'both', 'default', 'none'}]

Examples using `matplotlib.axis.XAxis.set_ticks_position`

- sphx\_glr\_gallery\_pyplots\_whats\_new\_99\_spines.py

### `matplotlib.axis.XAxis.tick_bottom`

`XAxis.tick_bottom(self)`

Move ticks and ticklabels (if present) to the bottom of the axes.

### `matplotlib.axis.XAxis.tick_top`

`XAxis.tick_top(self)`

Move ticks and ticklabels (if present) to the top of the axes.

### Other

<code>Axis.OFFSETTEXTPAD</code>	
<code>Axis.limit_range_for_scale</code>	
<code>Axis.reset_ticks</code>	Re-initialize the major and minor Tick lists.
<code>Axis.set_default_intervals</code>	Set the default limits for the axis data and view interval if they have not been mutated yet.
<code>Axis.get_smart_bounds</code>	Return whether the axis has smart bounds.
<code>Axis.set_smart_bounds</code>	Set the axis to have smart bounds.

### `matplotlib.axis.Axis.OFFSETTEXTPAD`

`Axis.OFFSETTEXTPAD = 3`

### `matplotlib.axis.Axis.limit_range_for_scale`

`Axis.limit_range_for_scale(self, vmin, vmax)`

### `matplotlib.axis.Axis.reset_ticks`

`Axis.reset_ticks(self)`

Re-initialize the major and minor Tick lists.

Each list starts with a single fresh Tick.

**matplotlib.axis.Axis.set\_default\_intervals**`Axis.set_default_intervals(self)`

Set the default limits for the axis data and view interval if they have not been mutated yet.

**matplotlib.axis.Axis.get\_smart\_bounds**`Axis.get_smart_bounds(self)`

Return whether the axis has smart bounds.

**matplotlib.axis.Axis.set\_smart\_bounds**`Axis.set_smart_bounds(self, value)`

Set the axis to have smart bounds.

**Discouraged**

These methods implicitly use *FixedLocator* and *FixedFormatter*. They can be convenient, but if not used together may de-couple your tick labels from your data.

---

`Axis.set_ticklabels`

Set the text values of the tick labels.

---

`Axis.set_ticks`Set the locations of the tick marks from sequence ticks

---

**matplotlib.axis.Axis.set\_ticklabels**`Axis.set_ticklabels(self, ticklabels, *args, minor=False, **kwargs)`

Set the text values of the tick labels.

**Parameters**

**ticklabels** [sequence of str or of Texts] List of texts for tick labels; must include values for non-visible labels.

**minor** [bool] If True, set minor ticks instead of major ticks.

**\*\*kwargs** Text properties.

**Returns**

**labels** [list of Texts] For each tick, includes `tick.label1` if it is visible, then `tick.label2` if it is visible, in that order.

**matplotlib.axis.Axis.set\_ticks**`Axis.set_ticks(self, ticks, minor=False)`

Set the locations of the tick marks from sequence ticks

**Parameters**

**ticks** [sequence of floats]

**minor** [bool]

Examples using `matplotlib.axis.Axis.set_ticks`

- `sphx_glr_gallery_pyplots_whats_new_99_spines.py`

### 17.6.3 Tick objects

```
class matplotlib.axis.Tick(axes, loc, label, size=None, width=None, color=None,
                           tickdir=None, pad=None, labelsz=None, label-
                           color=None, zorder=None, gridOn=None, tick1On=True,
                           tick2On=True, label1On=True, label2On=False,
                           major=True, labelrotation=0, grid_color=None,
                           grid_linestyle=None, grid_linewidth=None,
                           grid_alpha=None, **kw)
```

Abstract base class for the axis ticks, grid lines and labels.

Ticks mark a position on an Axis. They contain two lines as markers and two labels; one each for the bottom and top positions (in case of an *XAxis*) or for the left and right positions (in case of a *YAxis*).

#### Attributes

**tick1line** [*Line2D*] The left/bottom tick marker.

**tick2line** [*Line2D*] The right/top tick marker.

**gridline** [*Line2D*] The grid line associated with the label position.

**label1** [*Text*] The left/bottom tick label.

**label2** [*Text*] The right/top tick label.

`bbox` is the `Bound2D` bounding box in display coords of the Axes `loc` is the tick location in data coords `size` is the tick size in points

```
class matplotlib.axis.XTick(axes, loc, label, size=None, width=None, color=None,
                             tickdir=None, pad=None, labelsz=None, label-
                             color=None, zorder=None, gridOn=None, tick1On=True,
                             tick2On=True, label1On=True, label2On=False,
                             major=True, labelrotation=0, grid_color=None,
                             grid_linestyle=None, grid_linewidth=None,
                             grid_alpha=None, **kw)
```

Contains all the Artists needed to make an x tick - the tick line, the label text and the grid line

`bbox` is the `Bound2D` bounding box in display coords of the Axes `loc` is the tick location in data coords `size` is the tick size in points

```
class matplotlib.axis.YTick(axes, loc, label, size=None, width=None, color=None,
                             tickdir=None, pad=None, labelsz=None, label-
                             color=None, zorder=None, gridOn=None, tick1On=True,
                             tick2On=True, label1On=True, label2On=False,
                             major=True, labelrotation=0, grid_color=None,
                             grid_linestyle=None, grid_linewidth=None,
                             grid_alpha=None, **kw)
```

Contains all the Artists needed to make a Y tick - the tick line, the label text and the grid line

`bbox` is the Bound2D bounding box in display coords of the Axes `loc` is the tick location in data coords `size` is the tick size in points

<code>Tick.apply_tickdir</code>	Calculate <code>self._pad</code> and <code>self._tickmarkers</code> .
<code>Tick.get_loc</code>	Return the tick location (data coords) as a scalar
<code>Tick.get_pad</code>	Get the value of the tick label pad in points
<code>Tick.get_pad_pixels</code>	
<code>Tick.get_tick_padding</code>	Get the length of the tick outside of the axes.
<code>Tick.get_tickdir</code>	
<code>Tick.get_view_interval</code>	return the view Interval instance for the axis this tick is ticking
<code>Tick.set_label1</code>	Set the label1 text.
<code>Tick.set_label2</code>	Set the label2 text.
<code>Tick.set_pad</code>	Set the tick label pad in points
<code>Tick.update_position</code>	Set the location of tick in data coords with scalar <code>loc</code>

#### **matplotlib.axis.Tick.apply\_tickdir**

`Tick.apply_tickdir(self, tickdir)`  
Calculate `self._pad` and `self._tickmarkers`.

#### **matplotlib.axis.Tick.get\_loc**

`Tick.get_loc(self)`  
Return the tick location (data coords) as a scalar

#### **matplotlib.axis.Tick.get\_pad**

`Tick.get_pad(self)`  
Get the value of the tick label pad in points

#### **matplotlib.axis.Tick.get\_pad\_pixels**

`Tick.get_pad_pixels(self)`

#### **matplotlib.axis.Tick.get\_tick\_padding**

`Tick.get_tick_padding(self)`  
Get the length of the tick outside of the axes.

**matplotlib.axis.Tick.get\_tickdir**

Tick.get\_tickdir(*self*)

**matplotlib.axis.Tick.get\_view\_interval**

Tick.get\_view\_interval(*self*)

return the view Interval instance for the axis this tick is ticking

**matplotlib.axis.Tick.set\_label1**

Tick.set\_label1(*self*, *s*)

Set the label1 text.

**Parameters**

**s** [str]

**matplotlib.axis.Tick.set\_label2**

Tick.set\_label2(*self*, *s*)

Set the label2 text.

**Parameters**

**s** [str]

**matplotlib.axis.Tick.set\_pad**

Tick.set\_pad(*self*, *val*)

Set the tick label pad in points

**Parameters**

**val** [float]

**matplotlib.axis.Tick.update\_position**

Tick.update\_position(*self*, *loc*)

Set the location of tick in data coords with scalar *loc*

## 17.6.4 Common and inherited methods

XTick

---

*XTick.apply\_tickdir*

Calculate self.\_pad and self.tickmarkers.

*XTick.get\_loc*

Return the tick location (data coords) as a scalar

---

Continued on next page

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<code>XTick.get_pad</code>	Get the value of the tick label pad in points
<code>XTick.get_pad_pixels</code>	
<code>XTick.get_tick_padding</code>	Get the length of the tick outside of the axes.
<code>XTick.get_tickdir</code>	
<code>XTick.get_view_interval</code>	return the view Interval instance for the axis this tick is ticking
<code>XTick.set_label1</code>	Set the label1 text.
<code>XTick.set_label2</code>	Set the label2 text.
<code>XTick.set_pad</code>	Set the tick label pad in points
<code>XTick.update_position</code>	Set the location of tick in data coords with scalar <i>loc</i> .

**matplotlib.axis.XTick.apply\_tickdir**

`XTick.apply_tickdir(self, tickdir)`  
Calculate self.\_pad and self.\_tickmarkers.

**matplotlib.axis.XTick.get\_loc**

`XTick.get_loc(self)`  
Return the tick location (data coords) as a scalar

**matplotlib.axis.XTick.get\_pad**

`XTick.get_pad(self)`  
Get the value of the tick label pad in points

**matplotlib.axis.XTick.get\_pad\_pixels**

`XTick.get_pad_pixels(self)`

**matplotlib.axis.XTick.get\_tick\_padding**

`XTick.get_tick_padding(self)`  
Get the length of the tick outside of the axes.

**matplotlib.axis.XTick.get\_tickdir**

`XTick.get_tickdir(self)`

**matplotlib.axis.XTick.get\_view\_interval**

`XTick.get_view_interval(self)`  
return the view Interval instance for the axis this tick is ticking

**matplotlib.axis.XTick.set\_label1**

`XTick.set_label1(self, s)`  
 Set the label1 text.

**Parameters**

**s** [str]

**matplotlib.axis.XTick.set\_label2**

`XTick.set_label2(self, s)`  
 Set the label2 text.

**Parameters**

**s** [str]

**matplotlib.axis.XTick.set\_pad**

`XTick.set_pad(self, val)`  
 Set the tick label pad in points

**Parameters**

**val** [float]

**matplotlib.axis.XTick.update\_position**

`XTick.update_position(self, loc)`  
 Set the location of tick in data coords with scalar *loc*.

**YTick**

<code>YTick.apply_tickdir</code>	Calculate self._pad and self._tickmarkers.
<code>YTick.get_loc</code>	Return the tick location (data coords) as a scalar
<code>YTick.get_pad</code>	Get the value of the tick label pad in points
<code>YTick.get_pad_pixels</code>	
<code>YTick.get_tick_padding</code>	Get the length of the tick outside of the axes.
<code>YTick.get_tickdir</code>	
<code>YTick.get_view_interval</code>	Return the Interval instance for this axis view limits.
<code>YTick.set_label1</code>	Set the label1 text.
<code>YTick.set_label2</code>	Set the label2 text.
<code>YTick.set_pad</code>	Set the tick label pad in points
<code>YTick.update_position</code>	Set the location of tick in data coords with scalar <i>loc</i> .

**matplotlib.axis.YTick.apply\_tickdir**

`YTick.apply_tickdir(self, tickdir)`  
Calculate `self._pad` and `self._tickmarkers`.

**matplotlib.axis.YTick.get\_loc**

`YTick.get_loc(self)`  
Return the tick location (data coords) as a scalar

**matplotlib.axis.YTick.get\_pad**

`YTick.get_pad(self)`  
Get the value of the tick label pad in points

**matplotlib.axis.YTick.get\_pad\_pixels**

`YTick.get_pad_pixels(self)`

**matplotlib.axis.YTick.get\_tick\_padding**

`YTick.get_tick_padding(self)`  
Get the length of the tick outside of the axes.

**matplotlib.axis.YTick.get\_tickdir**

`YTick.get_tickdir(self)`

**matplotlib.axis.YTick.get\_view\_interval**

`YTick.get_view_interval(self)`  
Return the Interval instance for this axis view limits.

**matplotlib.axis.YTick.set\_label1**

`YTick.set_label1(self, s)`  
Set the label1 text.

**Parameters**

**s** [str]

**matplotlib.axis.YTick.set\_label2**

`YTick.set_label2(self, s)`  
 Set the label2 text.

**Parameters**

**s** [str]

**matplotlib.axis.YTick.set\_pad**

`YTick.set_pad(self, val)`  
 Set the tick label pad in points

**Parameters**

**val** [float]

**matplotlib.axis.YTick.update\_position**

`YTick.update_position(self, loc)`  
 Set the location of tick in data coords with scalar *loc*.

**YAxis**

<code>YAxis.OFFSETEXTPAD</code>	
<code>YAxis.axis_date</code>	Sets up axis ticks and labels treating data along this axis as dates.
<code>YAxis.cla</code>	clear the current axis
<code>YAxis.convert_units</code>	
<code>YAxis.get_data_interval</code>	
<code>YAxis.get_gridlines</code>	Return the grid lines as a list of Line2D instance
<code>YAxis.get_label_position</code>	Return the label position (top or bottom)
<code>YAxis.get_label_text</code>	Get the text of the label
<code>YAxis.get_major_formatter</code>	Get the formatter of the major ticker
<code>YAxis.get_major_locator</code>	Get the locator of the major ticker
<code>YAxis.get_major_ticks</code>	Get the tick instances; grow as necessary.
<code>YAxis.get_majorticklabels</code>	Return a list of Text instances for the major ticklabels.
<code>YAxis.get_majorticklines</code>	Return the major tick lines as a list of Line2D instances
<code>YAxis.get_majorticklocs</code>	Get the array of major tick locations in data coordinates.
<code>YAxis.get_minor_formatter</code>	Get the formatter of the minor ticker
<code>YAxis.get_minor_locator</code>	Get the locator of the minor ticker
<code>YAxis.get_minor_ticks</code>	Get the minor tick instances; grow as necessary.
<code>YAxis.get_minorticklabels</code>	Return a list of Text instances for the minor ticklabels.

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Table 127 – continued from previous page

<i>YAxis.get_minorticklines</i>	Return the minor tick lines as a list of <code>Line2D</code> instances
<i>YAxis.get_minorticklocs</i>	Get the array of minor tick locations in data coordinates.
<i>YAxis.get_minpos</i>	
<i>YAxis.get_offset_text</i>	Return the axis <code>offsetText</code> as a <code>Text</code> instance
<i>YAxis.get_pickradius</i>	Return the depth of the axis used by the picker
<i>YAxis.get_scale</i>	
<i>YAxis.get_smart_bounds</i>	Return whether the axis has smart bounds.
<i>YAxis.get_tick_padding</i>	
<i>YAxis.get_tick_space</i>	Return the estimated number of ticks that can fit on the axis.
<i>YAxis.get_ticklabel_extents</i>	Get the extents of the tick labels on either side of the axes.
<i>YAxis.get_ticklabels</i>	Get the tick labels as a list of <code>Text</code> instances.
<i>YAxis.get_ticklines</i>	Return the tick lines as a list of <code>Line2D</code> instances
<i>YAxis.get_ticklocs</i>	Get the array of tick locations in data coordinates.
<i>YAxis.get_tightbbox</i>	Return a bounding box that encloses the axis.
<i>YAxis.get_units</i>	Return the units for axis.
<i>YAxis.get_view_interval</i>	
<i>YAxis.grid</i>	Configure the grid lines.
<i>YAxis.limit_range_for_scale</i>	
<i>YAxis.pan</i>	Pan by <i>numsteps</i> (can be positive or negative).
<i>YAxis.reset_ticks</i>	Re-initialize the major and minor Tick lists.
<i>YAxis.set_data_interval</i>	
<i>YAxis.set_default_intervals</i>	Set the default limits for the axis data and view interval if they have not been mutated yet.
<i>YAxis.set_label_coords</i>	Set the coordinates of the label.
<i>YAxis.set_label_position</i>	Set the label position (left or right)
<i>YAxis.set_label_text</i>	Set the text value of the axis label.
<i>YAxis.set_major_formatter</i>	Set the formatter of the major ticker.
<i>YAxis.set_major_locator</i>	Set the locator of the major ticker.
<i>YAxis.set_minor_formatter</i>	Set the formatter of the minor ticker.
<i>YAxis.set_minor_locator</i>	Set the locator of the minor ticker.
<i>YAxis.set_pickradius</i>	Set the depth of the axis used by the picker.
<i>YAxis.set_smart_bounds</i>	Set the axis to have smart bounds.
<i>YAxis.set_tick_params</i>	Set appearance parameters for ticks, ticklabels, and gridlines.
<i>YAxis.set_ticklabels</i>	Set the text values of the tick labels.
<i>YAxis.set_ticks</i>	Set the locations of the tick marks from sequence ticks
<i>YAxis.set_units</i>	Set the units for axis.
<i>YAxis.set_view_interval</i>	

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Table 127 – continued from previous page

<code>YAxis.update_units</code>	introspect <i>data</i> for units converter and update the <code>axis.converter</code> instance if necessary.
<code>YAxis.zoom</code>	Zoom in/out on axis; if <i>direction</i> is $>0$ zoom in, else zoom out.

**matplotlib.axis.YAxis.OFFSETTEXTPAD**`YAxis.OFFSETTEXTPAD = 3`**matplotlib.axis.YAxis.axis\_date**`YAxis.axis_date(self, tz=None)`

Sets up axis ticks and labels treating data along this axis as dates.

**Parameters****tz** [tzinfo or str or None] The timezone used to create date labels.**matplotlib.axis.YAxis.cla**`YAxis.cla(self)`

clear the current axis

**matplotlib.axis.YAxis.convert\_units**`YAxis.convert_units(self, x)`**matplotlib.axis.YAxis.get\_data\_interval**`YAxis.get_data_interval(self)`**matplotlib.axis.YAxis.get\_gridlines**`YAxis.get_gridlines(self)`

Return the grid lines as a list of Line2D instance

**matplotlib.axis.YAxis.get\_label\_position**`YAxis.get_label_position(self)`

Return the label position (top or bottom)

**matplotlib.axis.YAxis.get\_label\_text**

`YAxis.get_label_text(self)`  
Get the text of the label

**matplotlib.axis.YAxis.get\_major\_formatter**

`YAxis.get_major_formatter(self)`  
Get the formatter of the major ticker

**matplotlib.axis.YAxis.get\_major\_locator**

`YAxis.get_major_locator(self)`  
Get the locator of the major ticker

**matplotlib.axis.YAxis.get\_major\_ticks**

`YAxis.get_major_ticks(self, numticks=None)`  
Get the tick instances; grow as necessary.

**matplotlib.axis.YAxis.get\_majorticklabels**

`YAxis.get_majorticklabels(self)`  
Return a list of Text instances for the major ticklabels.

**matplotlib.axis.YAxis.get\_majorticklines**

`YAxis.get_majorticklines(self)`  
Return the major tick lines as a list of Line2D instances

**matplotlib.axis.YAxis.get\_majorticklocs**

`YAxis.get_majorticklocs(self)`  
Get the array of major tick locations in data coordinates.

**matplotlib.axis.YAxis.get\_minor\_formatter**

`YAxis.get_minor_formatter(self)`  
Get the formatter of the minor ticker

**matplotlib.axis.YAxis.get\_minor\_locator**

`YAxis.get_minor_locator(self)`  
Get the locator of the minor ticker

**matplotlib.axis.YAxis.get\_minor\_ticks**

`YAxis.get_minor_ticks(self, numticks=None)`  
Get the minor tick instances; grow as necessary.

**matplotlib.axis.YAxis.get\_minorticklabels**

`YAxis.get_minorticklabels(self)`  
Return a list of Text instances for the minor ticklabels.

**matplotlib.axis.YAxis.get\_minorticklines**

`YAxis.get_minorticklines(self)`  
Return the minor tick lines as a list of Line2D instances

**matplotlib.axis.YAxis.get\_minorticklocs**

`YAxis.get_minorticklocs(self)`  
Get the array of minor tick locations in data coordinates.

**matplotlib.axis.YAxis.get\_minpos**

`YAxis.get_minpos(self)`

**matplotlib.axis.YAxis.get\_offset\_text**

`YAxis.get_offset_text(self)`  
Return the axis offsetText as a Text instance

**matplotlib.axis.YAxis.get\_pickradius**

`YAxis.get_pickradius(self)`  
Return the depth of the axis used by the picker

**matplotlib.axis.YAxis.get\_scale**

`YAxis.get_scale(self)`

**matplotlib.axis.YAxis.get\_smart\_bounds**

`YAxis.get_smart_bounds(self)`  
Return whether the axis has smart bounds.

**matplotlib.axis.YAxis.get\_tick\_padding**

`YAxis.get_tick_padding(self)`

**matplotlib.axis.YAxis.get\_tick\_space**

`YAxis.get_tick_space(self)`

Return the estimated number of ticks that can fit on the axis.

**matplotlib.axis.YAxis.get\_ticklabel\_extents**

`YAxis.get_ticklabel_extents(self, renderer)`

Get the extents of the tick labels on either side of the axes.

**matplotlib.axis.YAxis.get\_ticklabels**

`YAxis.get_ticklabels(self, minor=False, which=None)`

Get the tick labels as a list of *Text* instances.

**Parameters**

**minor** [bool] If True return the minor ticklabels, else return the major ticklabels

**which** [None, ('minor', 'major', 'both')] Overrides minor.

Selects which ticklabels to return

**Returns**

**ret** [list] List of *Text* instances.

**matplotlib.axis.YAxis.get\_ticklines**

`YAxis.get_ticklines(self, minor=False)`

Return the tick lines as a list of *Line2D* instances

**matplotlib.axis.YAxis.get\_ticklocs**

`YAxis.get_ticklocs(self, minor=False)`

Get the array of tick locations in data coordinates.

**matplotlib.axis.YAxis.get\_tightbbox**

`YAxis.get_tightbbox(self, renderer)`

Return a bounding box that encloses the axis. It only accounts tick labels, axis label, and *offsetText*.

**matplotlib.axis.YAxis.get\_units**

`YAxis.get_units(self)`  
Return the units for axis.

**matplotlib.axis.YAxis.get\_view\_interval**

`YAxis.get_view_interval(self)`

**matplotlib.axis.YAxis.grid**

`YAxis.grid(self, b=None, which='major', **kwargs)`  
Configure the grid lines.

**Parameters**

**b** [bool or None] Whether to show the grid lines. If any *kwargs* are supplied, it is assumed you want the grid on and *b* will be set to True.

If *b* is *None* and there are no *kwargs*, this toggles the visibility of the lines.

**which** [{'major', 'minor', 'both'}] The grid lines to apply the changes on.

**\*\*kwargs** [*Line2D* properties] Define the line properties of the grid, e.g.:

```
grid(color='r', linestyle='-', linewidth=2)
```

**matplotlib.axis.YAxis.limit\_range\_for\_scale**

`YAxis.limit_range_for_scale(self, vmin, vmax)`

**matplotlib.axis.YAxis.pan**

`YAxis.pan(self, numsteps)`  
Pan by *numsteps* (can be positive or negative).

**matplotlib.axis.YAxis.reset\_ticks**

`YAxis.reset_ticks(self)`  
Re-initialize the major and minor Tick lists.  
Each list starts with a single fresh Tick.

**matplotlib.axis.YAxis.set\_data\_interval**

`YAxis.set_data_interval(self, vmin, vmax, ignore=False)`

**matplotlib.axis.YAxis.set\_default\_intervals**`YAxis.set_default_intervals(self)`

Set the default limits for the axis data and view interval if they have not been mutated yet.

**matplotlib.axis.YAxis.set\_label\_coords**`YAxis.set_label_coords(self, x, y, transform=None)`

Set the coordinates of the label.

By default, the x coordinate of the y label is determined by the tick label bounding boxes, but this can lead to poor alignment of multiple ylabels if there are multiple axes. Ditto for the y coordinate of the x label.

You can also specify the coordinate system of the label with the transform. If None, the default coordinate system will be the axes coordinate system (0,0) is (left,bottom), (0.5, 0.5) is middle, etc

**matplotlib.axis.YAxis.set\_label\_position**`YAxis.set_label_position(self, position)`

Set the label position (left or right)

**Parameters**

**position** [ {'left', 'right'} ]

**matplotlib.axis.YAxis.set\_label\_text**`YAxis.set_label_text(self, label, fontdict=None, **kwargs)`

Set the text value of the axis label.

**Parameters**

**label** [str] Text string.

**fontdict** [dict] Text properties.

**\*\*kwargs** Merged into fontdict.

**matplotlib.axis.YAxis.set\_major\_formatter**`YAxis.set_major_formatter(self, formatter)`

Set the formatter of the major ticker.

**Parameters**

**formatter** [*Formatter*]

**matplotlib.axis.YAxis.set\_major\_locator**

`YAxis.set_major_locator(self, locator)`  
Set the locator of the major ticker.

**Parameters**

**locator** [*Locator*]

**matplotlib.axis.YAxis.set\_minor\_formatter**

`YAxis.set_minor_formatter(self, formatter)`  
Set the formatter of the minor ticker.

**Parameters**

**formatter** [*Formatter*]

**matplotlib.axis.YAxis.set\_minor\_locator**

`YAxis.set_minor_locator(self, locator)`  
Set the locator of the minor ticker.

**Parameters**

**locator** [*Locator*]

**matplotlib.axis.YAxis.set\_pickradius**

`YAxis.set_pickradius(self, pickradius)`  
Set the depth of the axis used by the picker.

**Parameters**

**pickradius** [float]

**matplotlib.axis.YAxis.set\_smart\_bounds**

`YAxis.set_smart_bounds(self, value)`  
Set the axis to have smart bounds.

**matplotlib.axis.YAxis.set\_tick\_params**

`YAxis.set_tick_params(self, which='major', reset=False, **kw)`  
Set appearance parameters for ticks, ticklabels, and gridlines.

For documentation of keyword arguments, see `matplotlib.axes.Axes.tick_params()`.

**matplotlib.axis.YAxis.set\_ticklabels**

`YAxis.set_ticklabels(self, ticklabels, *args, minor=False, **kwargs)`

Set the text values of the tick labels.

**Parameters**

**ticklabels** [sequence of str or of Texts] List of texts for tick labels; must include values for non-visible labels.

**minor** [bool] If True, set minor ticks instead of major ticks.

**\*\*kwargs** Text properties.

**Returns**

**labels** [list of Texts] For each tick, includes `tick.label1` if it is visible, then `tick.label2` if it is visible, in that order.

**matplotlib.axis.YAxis.set\_ticks**

`YAxis.set_ticks(self, ticks, minor=False)`

Set the locations of the tick marks from sequence ticks

**Parameters**

**ticks** [sequence of floats]

**minor** [bool]

**matplotlib.axis.YAxis.set\_units**

`YAxis.set_units(self, u)`

Set the units for axis.

**Parameters**

**u** [units tag]

**matplotlib.axis.YAxis.set\_view\_interval**

`YAxis.set_view_interval(self, vmin, vmax, ignore=False)`

**matplotlib.axis.YAxis.update\_units**

`YAxis.update_units(self, data)`

introspect *data* for units converter and update the axis.converter instance if necessary. Return *True* if *data* is registered for unit conversion.

**matplotlib.axis.YAxis.zoom**

`YAxis.zoom(self, direction)`

Zoom in/out on axis; if *direction* is >0 zoom in, else zoom out.

## XAxis

<i>XAxis.OFFSETEXTPAD</i>	
<i>XAxis.axis_date</i>	Sets up axis ticks and labels treating data along this axis as dates.
<i>XAxis.cla</i>	clear the current axis
<i>XAxis.convert_units</i>	
<i>XAxis.get_data_interval</i>	
<i>XAxis.get_gridlines</i>	Return the grid lines as a list of Line2D instance
<i>XAxis.get_label_position</i>	Return the label position (top or bottom)
<i>XAxis.get_label_text</i>	Get the text of the label
<i>XAxis.get_major_formatter</i>	Get the formatter of the major ticker
<i>XAxis.get_major_locator</i>	Get the locator of the major ticker
<i>XAxis.get_major_ticks</i>	Get the tick instances; grow as necessary.
<i>XAxis.get_majorticklabels</i>	Return a list of Text instances for the major ticklabels.
<i>XAxis.get_majorticklines</i>	Return the major tick lines as a list of Line2D instances
<i>XAxis.get_majorticklocs</i>	Get the array of major tick locations in data coordinates.
<i>XAxis.get_minor_formatter</i>	Get the formatter of the minor ticker
<i>XAxis.get_minor_locator</i>	Get the locator of the minor ticker
<i>XAxis.get_minor_ticks</i>	Get the minor tick instances; grow as necessary.
<i>XAxis.get_minorticklabels</i>	Return a list of Text instances for the minor ticklabels.
<i>XAxis.get_minorticklines</i>	Return the minor tick lines as a list of Line2D instances
<i>XAxis.get_minorticklocs</i>	Get the array of minor tick locations in data coordinates.
<i>XAxis.get_minpos</i>	
<i>XAxis.get_offset_text</i>	Return the axis offsetText as a Text instance
<i>XAxis.get_pickradius</i>	Return the depth of the axis used by the picker
<i>XAxis.get_scale</i>	
<i>XAxis.get_smart_bounds</i>	Return whether the axis has smart bounds.
<i>XAxis.get_tick_padding</i>	
<i>XAxis.get_tick_space</i>	Return the estimated number of ticks that can fit on the axis.
<i>XAxis.get_ticklabel_extents</i>	Get the extents of the tick labels on either side of the axes.
<i>XAxis.get_ticklabels</i>	Get the tick labels as a list of Text instances.
<i>XAxis.get_ticklines</i>	Return the tick lines as a list of Line2D instances
<i>XAxis.get_ticklocs</i>	Get the array of tick locations in data coordinates.
<i>XAxis.get_tightbbox</i>	Return a bounding box that encloses the axis.
<i>XAxis.get_units</i>	Return the units for axis.
<i>XAxis.get_view_interval</i>	

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<code>XAxis.grid</code>	Configure the grid lines.
<code>XAxis.limit_range_for_scale</code>	
<code>XAxis.pan</code>	Pan by <i>numsteps</i> (can be positive or negative).
<code>XAxis.reset_ticks</code>	Re-initialize the major and minor Tick lists.
<code>XAxis.set_data_interval</code>	
<code>XAxis.set_default_intervals</code>	Set the default limits for the axis data and view interval if they have not been mutated yet.
<code>XAxis.set_label_coords</code>	Set the coordinates of the label.
<code>XAxis.set_label_position</code>	Set the label position (top or bottom)
<code>XAxis.set_label_text</code>	Set the text value of the axis label.
<code>XAxis.set_major_formatter</code>	Set the formatter of the major ticker.
<code>XAxis.set_major_locator</code>	Set the locator of the major ticker.
<code>XAxis.set_minor_formatter</code>	Set the formatter of the minor ticker.
<code>XAxis.set_minor_locator</code>	Set the locator of the minor ticker.
<code>XAxis.set_pickradius</code>	Set the depth of the axis used by the picker.
<code>XAxis.set_smart_bounds</code>	Set the axis to have smart bounds.
<code>XAxis.set_tick_params</code>	Set appearance parameters for ticks, ticklabels, and gridlines.
<code>XAxis.set_ticklabels</code>	Set the text values of the tick labels.
<code>XAxis.set_ticks</code>	Set the locations of the tick marks from sequence ticks
<code>XAxis.set_units</code>	Set the units for axis.
<code>XAxis.set_view_interval</code>	
<code>XAxis.update_units</code>	introspect <i>data</i> for units converter and update the axis.converter instance if necessary.
<code>XAxis.zoom</code>	Zoom in/out on axis; if <i>direction</i> is >0 zoom in, else zoom out.

**matplotlib.axis.XAxis.OFFSETTEXTPAD**

`XAxis.OFFSETTEXTPAD = 3`

**matplotlib.axis.XAxis.axis\_date**

`XAxis.axis_date(self, tz=None)`

Sets up axis ticks and labels treating data along this axis as dates.

**Parameters**

**tz** [tzinfo or str or None] The timezone used to create date labels.

**matplotlib.axis.XAxis.cla**

`XAxis.cla(self)`

clear the current axis

**matplotlib.axis.XAxis.convert\_units**

`XAxis.convert_units(self, x)`

**matplotlib.axis.XAxis.get\_data\_interval**

`XAxis.get_data_interval(self)`

**matplotlib.axis.XAxis.get\_gridlines**

`XAxis.get_gridlines(self)`  
Return the grid lines as a list of Line2D instance

**matplotlib.axis.XAxis.get\_label\_position**

`XAxis.get_label_position(self)`  
Return the label position (top or bottom)

**matplotlib.axis.XAxis.get\_label\_text**

`XAxis.get_label_text(self)`  
Get the text of the label

**matplotlib.axis.XAxis.get\_major\_formatter**

`XAxis.get_major_formatter(self)`  
Get the formatter of the major ticker

**matplotlib.axis.XAxis.get\_major\_locator**

`XAxis.get_major_locator(self)`  
Get the locator of the major ticker

**matplotlib.axis.XAxis.get\_major\_ticks**

`XAxis.get_major_ticks(self, numticks=None)`  
Get the tick instances; grow as necessary.

**matplotlib.axis.XAxis.get\_majorticklabels**

`XAxis.get_majorticklabels(self)`  
Return a list of Text instances for the major ticklabels.

**matplotlib.axis.XAxis.get\_majorticklines**

`XAxis.get_majorticklines(self)`  
Return the major tick lines as a list of Line2D instances

**matplotlib.axis.XAxis.get\_majorticklocs**

`XAxis.get_majorticklocs(self)`  
Get the array of major tick locations in data coordinates.

**matplotlib.axis.XAxis.get\_minor\_formatter**

`XAxis.get_minor_formatter(self)`  
Get the formatter of the minor ticker

**matplotlib.axis.XAxis.get\_minor\_locator**

`XAxis.get_minor_locator(self)`  
Get the locator of the minor ticker

**matplotlib.axis.XAxis.get\_minor\_ticks**

`XAxis.get_minor_ticks(self, numticks=None)`  
Get the minor tick instances; grow as necessary.

**matplotlib.axis.XAxis.get\_minorticklabels**

`XAxis.get_minorticklabels(self)`  
Return a list of Text instances for the minor ticklabels.

**matplotlib.axis.XAxis.get\_minorticklines**

`XAxis.get_minorticklines(self)`  
Return the minor tick lines as a list of Line2D instances

**matplotlib.axis.XAxis.get\_minorticklocs**

`XAxis.get_minorticklocs(self)`  
Get the array of minor tick locations in data coordinates.

**matplotlib.axis.XAxis.get\_minpos**

`XAxis.get_minpos(self)`

**matplotlib.axis.XAxis.get\_offset\_text**

`XAxis.get_offset_text(self)`  
Return the axis offsetText as a Text instance

**matplotlib.axis.XAxis.get\_pickradius**

`XAxis.get_pickradius(self)`  
Return the depth of the axis used by the picker

**matplotlib.axis.XAxis.get\_scale**

`XAxis.get_scale(self)`

**matplotlib.axis.XAxis.get\_smart\_bounds**

`XAxis.get_smart_bounds(self)`  
Return whether the axis has smart bounds.

**matplotlib.axis.XAxis.get\_tick\_padding**

`XAxis.get_tick_padding(self)`

**matplotlib.axis.XAxis.get\_tick\_space**

`XAxis.get_tick_space(self)`  
Return the estimated number of ticks that can fit on the axis.

**matplotlib.axis.XAxis.get\_ticklabel\_extents**

`XAxis.get_ticklabel_extents(self, renderer)`  
Get the extents of the tick labels on either side of the axes.

**matplotlib.axis.XAxis.get\_ticklabels**

`XAxis.get_ticklabels(self, minor=False, which=None)`  
Get the tick labels as a list of *Text* instances.

**Parameters**

**minor** [bool] If True return the minor ticklabels, else return the major ticklabels

**which** [None, ('minor', 'major', 'both')] Overrides *minor*.

Selects which ticklabels to return

**Returns**

**ret** [list] List of *Text* instances.

#### matplotlib.axis.XAxis.get\_ticklines

`XAxis.get_ticklines(self, minor=False)`  
Return the tick lines as a list of *Line2D* instances

#### matplotlib.axis.XAxis.get\_ticklocs

`XAxis.get_ticklocs(self, minor=False)`  
Get the array of tick locations in data coordinates.

#### matplotlib.axis.XAxis.get\_tightbbox

`XAxis.get_tightbbox(self, renderer)`  
Return a bounding box that encloses the axis. It only accounts tick labels, axis label, and `offsetText`.

#### matplotlib.axis.XAxis.get\_units

`XAxis.get_units(self)`  
Return the units for axis.

#### matplotlib.axis.XAxis.get\_view\_interval

`XAxis.get_view_interval(self)`

#### matplotlib.axis.XAxis.grid

`XAxis.grid(self, b=None, which='major', **kwargs)`  
Configure the grid lines.

##### Parameters

**b** [bool or None] Whether to show the grid lines. If any *kwargs* are supplied, it is assumed you want the grid on and *b* will be set to True.

If *b* is *None* and there are no *kwargs*, this toggles the visibility of the lines.

**which** [{'major', 'minor', 'both'}] The grid lines to apply the changes on.

**\*\*kwargs** [*Line2D* properties] Define the line properties of the grid, e.g.:

```
grid(color='r', linestyle='-', linewidth=2)
```

#### `matplotlib.axis.XAxis.limit_range_for_scale`

`XAxis.limit_range_for_scale(self, vmin, vmax)`

#### `matplotlib.axis.XAxis.pan`

`XAxis.pan(self, numsteps)`  
Pan by *numsteps* (can be positive or negative).

#### `matplotlib.axis.XAxis.reset_ticks`

`XAxis.reset_ticks(self)`  
Re-initialize the major and minor Tick lists.  
Each list starts with a single fresh Tick.

#### `matplotlib.axis.XAxis.set_data_interval`

`XAxis.set_data_interval(self, vmin, vmax, ignore=False)`

#### `matplotlib.axis.XAxis.set_default_intervals`

`XAxis.set_default_intervals(self)`  
Set the default limits for the axis data and view interval if they have not been mutated yet.

#### `matplotlib.axis.XAxis.set_label_coords`

`XAxis.set_label_coords(self, x, y, transform=None)`  
Set the coordinates of the label.

By default, the x coordinate of the y label is determined by the tick label bounding boxes, but this can lead to poor alignment of multiple ylabels if there are multiple axes. Ditto for the y coordinate of the x label.

You can also specify the coordinate system of the label with the transform. If None, the default coordinate system will be the axes coordinate system (0,0) is (left,bottom), (0.5, 0.5) is middle, etc

#### `matplotlib.axis.XAxis.set_label_position`

`XAxis.set_label_position(self, position)`  
Set the label position (top or bottom)

##### **Parameters**

**position** [ {'top', 'bottom'} ]

---

**matplotlib.axis.XAxis.set\_label\_text**

`XAxis.set_label_text(self, label, fontdict=None, **kwargs)`  
Set the text value of the axis label.

**Parameters**

- label** [str] Text string.
- fontdict** [dict] Text properties.
- \*\*kwargs** Merged into fontdict.

**matplotlib.axis.XAxis.set\_major\_formatter**

`XAxis.set_major_formatter(self, formatter)`  
Set the formatter of the major ticker.

**Parameters**

- formatter** [*Formatter*]

**matplotlib.axis.XAxis.set\_major\_locator**

`XAxis.set_major_locator(self, locator)`  
Set the locator of the major ticker.

**Parameters**

- locator** [*Locator*]

**matplotlib.axis.XAxis.set\_minor\_formatter**

`XAxis.set_minor_formatter(self, formatter)`  
Set the formatter of the minor ticker.

**Parameters**

- formatter** [*Formatter*]

**matplotlib.axis.XAxis.set\_minor\_locator**

`XAxis.set_minor_locator(self, locator)`  
Set the locator of the minor ticker.

**Parameters**

- locator** [*Locator*]

### matplotlib.axis.XAxis.set\_pickradius

`XAxis.set_pickradius(self, pickradius)`  
Set the depth of the axis used by the picker.

#### Parameters

**pickradius** [float]

### matplotlib.axis.XAxis.set\_smart\_bounds

`XAxis.set_smart_bounds(self, value)`  
Set the axis to have smart bounds.

### matplotlib.axis.XAxis.set\_tick\_params

`XAxis.set_tick_params(self, which='major', reset=False, **kw)`  
Set appearance parameters for ticks, ticklabels, and gridlines.  
For documentation of keyword arguments, see `matplotlib.axes.Axes.tick_params()`.

### matplotlib.axis.XAxis.set\_ticklabels

`XAxis.set_ticklabels(self, ticklabels, *args, minor=False, **kwargs)`  
Set the text values of the tick labels.

#### Parameters

**ticklabels** [sequence of str or of Texts] List of texts for tick labels; must include values for non-visible labels.

**minor** [bool] If True, set minor ticks instead of major ticks.

**\*\*kwargs** Text properties.

#### Returns

**labels** [list of Texts] For each tick, includes `tick.label1` if it is visible, then `tick.label2` if it is visible, in that order.

### matplotlib.axis.XAxis.set\_ticks

`XAxis.set_ticks(self, ticks, minor=False)`  
Set the locations of the tick marks from sequence ticks

#### Parameters

**ticks** [sequence of floats]

**minor** [bool]

**matplotlib.axis.XAxis.set\_units**

`XAxis.set_units(self, u)`  
Set the units for axis.

**Parameters**

**u** [units tag]

**matplotlib.axis.XAxis.set\_view\_interval**

`XAxis.set_view_interval(self, vmin, vmax, ignore=False)`

**matplotlib.axis.XAxis.update\_units**

`XAxis.update_units(self, data)`  
introspect *data* for units converter and update the axis.converter instance if necessary.  
Return *True* if *data* is registered for unit conversion.

**matplotlib.axis.XAxis.zoom**

`XAxis.zoom(self, direction)`  
Zoom in/out on axis; if *direction* is >0 zoom in, else zoom out.

**Inherited from artist****Ticks**

<code>Tick.add_callback</code>	Add a callback function that will be called whenever one of the <i>Artist's</i> properties changes.
<code>Tick.axes</code>	The <i>Axes</i> instance the artist resides in, or <i>None</i> .
<code>Tick.contains</code>	Test whether the mouse event occurred in the Tick marks.
<code>Tick.convert_xunits</code>	Convert x using the unit type of the xaxis.
<code>Tick.convert_yunits</code>	Convert y using the unit type of the yaxis.
<code>Tick.draw</code>	Draw the Artist using the given renderer.
<code>Tick.findobj</code>	Find artist objects.
<code>Tick.format_cursor_data</code>	Return a string representation of <i>data</i> .
<code>Tick.get_agg_filter</code>	Return filter function to be used for agg filter.
<code>Tick.get_alpha</code>	Return the alpha value used for blending - not supported on all backends
<code>Tick.get_animated</code>	Return the animated state.
<code>Tick.get_children</code>	Return a list of the child <i>Artists</i> of this <i>Artist</i> .

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Table 129 – continued from previous page

<i>Tick.get_clip_box</i>	Return the clipbox.
<i>Tick.get_clip_on</i>	Return whether the artist uses clipping.
<i>Tick.get_clip_path</i>	Return the clip path.
<i>Tick.get_contains</i>	Return the custom contains function of the artist if set, or <i>None</i> .
<i>Tick.get_cursor_data</i>	Return the cursor data for a given event.
<i>Tick.get_figure</i>	Return the <i>Figure</i> instance the artist belongs to.
<i>Tick.get_gid</i>	Return the group id.
<i>Tick.get_label</i>	Return the label used for this artist in the legend.
<i>Tick.get_path_effects</i>	
<i>Tick.get_picker</i>	Return the picking behavior of the artist.
<i>Tick.get_rasterized</i>	Return whether the artist is to be rasterized.
<i>Tick.get_sketch_params</i>	Returns the sketch parameters for the artist.
<i>Tick.get_snap</i>	Returns the snap setting.
<i>Tick.get_transform</i>	Return the <i>Transform</i> instance used by this artist.
<i>Tick.get_transformed_clip_path_and_affine</i>	Return the clip path with the non-affine part of its transformation applied, and the remaining affine part of its transformation.
<i>Tick.get_url</i>	Return the url.
<i>Tick.get_visible</i>	Return the visibility.
<i>Tick.get_window_extent</i>	Get the axes bounding box in display space.
<i>Tick.get_zorder</i>	Return the artist's zorder.
<i>Tick.have_units</i>	Return <i>True</i> if units are set on the x or y axes.
<i>Tick.is_transform_set</i>	Return whether the Artist has an explicitly set transform.
<i>Tick.mouseover</i>	
<i>Tick.pchanged</i>	Call all of the registered callbacks.
<i>Tick.pick</i>	Process a pick event.
<i>Tick.pickable</i>	Return whether the artist is pickable.
<i>Tick.properties</i>	Return a dictionary of all the properties of the artist.
<i>Tick.remove</i>	Remove the artist from the figure if possible.
<i>Tick.remove_callback</i>	Remove a callback based on its observer id.
<i>Tick.set</i>	A property batch setter.
<i>Tick.set_agg_filter</i>	Set the agg filter.
<i>Tick.set_alpha</i>	Set the alpha value used for blending - not supported on all backends.
<i>Tick.set_animated</i>	Set the artist's animation state.
<i>Tick.set_clip_box</i>	Set the artist's clip <i>Bbox</i> .
<i>Tick.set_clip_on</i>	Set whether the artist uses clipping.
<i>Tick.set_clip_path</i>	Set the artist's clip path, which may be:
<i>Tick.set_contains</i>	Define a custom contains test for the artist.
<i>Tick.set_figure</i>	Set the <i>Figure</i> instance the artist belongs to.
<i>Tick.set_gid</i>	Set the (group) id for the artist.
<i>Tick.set_label</i>	Set the label1 text.
<i>Tick.set_path_effects</i>	Set the path effects.
<i>Tick.set_picker</i>	Define the picking behavior of the artist.

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<i>Tick.set_rasterized</i>	Force rasterized (bitmap) drawing in vector backend output.
<i>Tick.set_sketch_params</i>	Sets the sketch parameters.
<i>Tick.set_snap</i>	Set the snapping behavior.
<i>Tick.set_transform</i>	Set the artist transform.
<i>Tick.set_url</i>	Set the url for the artist.
<i>Tick.set_visible</i>	Set the artist's visibility.
<i>Tick.set_zorder</i>	Set the zorder for the artist.
<i>Tick.stale</i>	Whether the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.
<i>Tick.update</i>	Update this artist's properties from the dictionary <i>props</i> .
<i>Tick.update_from</i>	Copy properties from <i>other</i> to <i>self</i> .
<i>Tick.zorder</i>	
<i>XTick.add_callback</i>	Add a callback function that will be called whenever one of the <i>Artist's</i> properties changes.
<i>XTick.axes</i>	The <i>Axes</i> instance the artist resides in, or <i>None</i> .
<i>XTick.contains</i>	Test whether the mouse event occurred in the Tick marks.
<i>XTick.convert_xunits</i>	Convert <i>x</i> using the unit type of the xaxis.
<i>XTick.convert_yunits</i>	Convert <i>y</i> using the unit type of the yaxis.
<i>XTick.draw</i>	Draw the Artist using the given renderer.
<i>XTick.findobj</i>	Find artist objects.
<i>XTick.format_cursor_data</i>	Return a string representation of <i>data</i> .
<i>XTick.get_agg_filter</i>	Return filter function to be used for agg filter.
<i>XTick.get_alpha</i>	Return the alpha value used for blending - not supported on all backends
<i>XTick.get_animated</i>	Return the animated state.
<i>XTick.get_children</i>	Return a list of the child <i>Artists</i> of this <i>Artist</i> .
<i>XTick.get_clip_box</i>	Return the clipbox.
<i>XTick.get_clip_on</i>	Return whether the artist uses clipping.
<i>XTick.get_clip_path</i>	Return the clip path.
<i>XTick.get_contains</i>	Return the custom contains function of the artist if set, or <i>None</i> .
<i>XTick.get_cursor_data</i>	Return the cursor data for a given event.
<i>XTick.get_figure</i>	Return the <i>Figure</i> instance the artist belongs to.
<i>XTick.get_gid</i>	Return the group id.
<i>XTick.get_label</i>	Return the label used for this artist in the legend.
<i>XTick.get_path_effects</i>	
<i>XTick.get_picker</i>	Return the picking behavior of the artist.
<i>XTick.get_rasterized</i>	Return whether the artist is to be rasterized.
<i>XTick.get_sketch_params</i>	Returns the sketch parameters for the artist.
<i>XTick.get_snap</i>	Returns the snap setting.

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<i>XTick.get_transform</i>	Return the <i>Transform</i> instance used by this artist.
<i>XTick.get_transformed_clip_path_and_affine</i>	Return the clip path with the non-affine part of its transformation applied, and the remaining affine part of its transformation.
<i>XTick.get_url</i>	Return the url.
<i>XTick.get_visible</i>	Return the visibility.
<i>XTick.get_window_extent</i>	Get the axes bounding box in display space.
<i>XTick.get_zorder</i>	Return the artist's zorder.
<i>XTick.have_units</i>	Return <i>True</i> if units are set on the x or y axes.
<i>XTick.is_transform_set</i>	Return whether the Artist has an explicitly set transform.
<i>XTick.mouseover</i>	
<i>XTick.pchanged</i>	Call all of the registered callbacks.
<i>XTick.pick</i>	Process a pick event.
<i>XTick.pickable</i>	Return whether the artist is pickable.
<i>XTick.properties</i>	Return a dictionary of all the properties of the artist.
<i>XTick.remove</i>	Remove the artist from the figure if possible.
<i>XTick.remove_callback</i>	Remove a callback based on its observer id.
<i>XTick.set</i>	A property batch setter.
<i>XTick.set_agg_filter</i>	Set the agg filter.
<i>XTick.set_alpha</i>	Set the alpha value used for blending - not supported on all backends.
<i>XTick.set_animated</i>	Set the artist's animation state.
<i>XTick.set_clip_box</i>	Set the artist's clip <i>Bbox</i> .
<i>XTick.set_clip_on</i>	Set whether the artist uses clipping.
<i>XTick.set_clip_path</i>	Set the artist's clip path, which may be:
<i>XTick.set_contains</i>	Define a custom contains test for the artist.
<i>XTick.set_figure</i>	Set the <i>Figure</i> instance the artist belongs to.
<i>XTick.set_gid</i>	Set the (group) id for the artist.
<i>XTick.set_label</i>	Set the label1 text.
<i>XTick.set_path_effects</i>	Set the path effects.
<i>XTick.set_picker</i>	Define the picking behavior of the artist.
<i>XTick.set_rasterized</i>	Force rasterized (bitmap) drawing in vector backend output.
<i>XTick.set_sketch_params</i>	Sets the sketch parameters.
<i>XTick.set_snap</i>	Set the snapping behavior.
<i>XTick.set_transform</i>	Set the artist transform.
<i>XTick.set_url</i>	Set the url for the artist.
<i>XTick.set_visible</i>	Set the artist's visibility.
<i>XTick.set_zorder</i>	Set the zorder for the artist.
<i>XTick.stale</i>	Whether the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.
<i>XTick.update</i>	Update this artist's properties from the dictionary <i>props</i> .
<i>XTick.update_from</i>	Copy properties from <i>other</i> to <i>self</i> .
<i>XTick.zorder</i>	

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<code>YTick.add_callback</code>	Add a callback function that will be called whenever one of the <i>Artist's</i> properties changes.
<code>YTick.axes</code>	The <i>Axes</i> instance the artist resides in, or <i>None</i> .
<code>YTick.contains</code>	Test whether the mouse event occurred in the Tick marks.
<code>YTick.convert_xunits</code>	Convert <i>x</i> using the unit type of the xaxis.
<code>YTick.convert_yunits</code>	Convert <i>y</i> using the unit type of the yaxis.
<code>YTick.draw</code>	Draw the Artist using the given renderer.
<code>YTick.findobjj</code>	Find artist objects.
<code>YTick.format_cursor_data</code>	Return a string representation of <i>data</i> .
<code>YTick.get_agg_filter</code>	Return filter function to be used for agg filter.
<code>YTick.get_alpha</code>	Return the alpha value used for blending - not supported on all backends
<code>YTick.get_animated</code>	Return the animated state.
<code>YTick.get_children</code>	Return a list of the child <i>Artists</i> of this <i>Artist</i> .
<code>YTick.get_clip_box</code>	Return the clipbox.
<code>YTick.get_clip_on</code>	Return whether the artist uses clipping.
<code>YTick.get_clip_path</code>	Return the clip path.
<code>YTick.get_contains</code>	Return the custom contains function of the artist if set, or <i>None</i> .
<code>YTick.get_cursor_data</code>	Return the cursor data for a given event.
<code>YTick.get_figure</code>	Return the <i>Figure</i> instance the artist belongs to.
<code>YTick.get_gid</code>	Return the group id.
<code>YTick.get_label</code>	Return the label used for this artist in the legend.
<code>YTick.get_path_effects</code>	
<code>YTick.get_picker</code>	Return the picking behavior of the artist.
<code>YTick.get_rasterized</code>	Return whether the artist is to be rasterized.
<code>YTick.get_sketch_params</code>	Returns the sketch parameters for the artist.
<code>YTick.get_snap</code>	Returns the snap setting.
<code>YTick.get_transform</code>	Return the <i>Transform</i> instance used by this artist.
<code>YTick.get_transformed_clip_path_and_affine</code>	Return the clip path with the non-affine part of its transformation applied, and the remaining affine part of its transformation.
<code>YTick.get_url</code>	Return the url.
<code>YTick.get_visible</code>	Return the visibility.
<code>YTick.get_window_extent</code>	Get the axes bounding box in display space.
<code>YTick.get_zorder</code>	Return the artist's zorder.
<code>YTick.have_units</code>	Return <i>True</i> if units are set on the <i>x</i> or <i>y</i> axes.
<code>YTick.is_transform_set</code>	Return whether the Artist has an explicitly set transform.
<code>YTick.mouseover</code>	
<code>YTick.pchanged</code>	Call all of the registered callbacks.
<code>YTick.pick</code>	Process a pick event.

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<code>YTick.pickable</code>	Return whether the artist is pickable.
<code>YTick.properties</code>	Return a dictionary of all the properties of the artist.
<code>YTick.remove</code>	Remove the artist from the figure if possible.
<code>YTick.remove_callback</code>	Remove a callback based on its observer id.
<code>YTick.set</code>	A property batch setter.
<code>YTick.set_agg_filter</code>	Set the agg filter.
<code>YTick.set_alpha</code>	Set the alpha value used for blending - not supported on all backends.
<code>YTick.set_animated</code>	Set the artist's animation state.
<code>YTick.set_clip_box</code>	Set the artist's clip <i>Bbox</i> .
<code>YTick.set_clip_on</code>	Set whether the artist uses clipping.
<code>YTick.set_clip_path</code>	Set the artist's clip path, which may be:
<code>YTick.set_contains</code>	Define a custom contains test for the artist.
<code>YTick.set_figure</code>	Set the <i>Figure</i> instance the artist belongs to.
<code>YTick.set_gid</code>	Set the (group) id for the artist.
<code>YTick.set_label</code>	Set the label1 text.
<code>YTick.set_path_effects</code>	Set the path effects.
<code>YTick.set_picker</code>	Define the picking behavior of the artist.
<code>YTick.set_rasterized</code>	Force rasterized (bitmap) drawing in vector backend output.
<code>YTick.set_sketch_params</code>	Sets the sketch parameters.
<code>YTick.set_snap</code>	Set the snapping behavior.
<code>YTick.set_transform</code>	Set the artist transform.
<code>YTick.set_url</code>	Set the url for the artist.
<code>YTick.set_visible</code>	Set the artist's visibility.
<code>YTick.set_zorder</code>	Set the zorder for the artist.
<code>YTick.stale</code>	Whether the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.
<code>YTick.update</code>	Update this artist's properties from the dictionary <i>props</i> .
<code>YTick.update_from</code>	Copy properties from <i>other</i> to <i>self</i> .
<code>YTick.zorder</code>	

**matplotlib.axis.Tick.add\_callback**

`Tick.add_callback(self, func)`

Add a callback function that will be called whenever one of the *Artist's* properties changes.

**Parameters**

**func** [callable] The callback function. It must have the signature:

```
def func(artist: Artist) -> Any
```

where *artist* is the calling *Artist*. Return values may exist but are ignored.

**Returns**

**oid** [int] The observer id associated with the callback. This id can be used for removing the callback with *remove\_callback* later.

**See also:**

`remove_callback`

**matplotlib.axis.Tick.axes**

`Tick.axes`

The *Axes* instance the artist resides in, or *None*.

**matplotlib.axis.Tick.contains**

`Tick.contains(self, mouseevent)`

Test whether the mouse event occurred in the Tick marks.

This function always returns false. It is more useful to test if the axis as a whole contains the mouse rather than the set of tick marks.

**matplotlib.axis.Tick.convert\_xunits**

`Tick.convert_xunits(self, x)`

Convert *x* using the unit type of the xaxis.

If the artist is not in contained in an Axes or if the xaxis does not have units, *x* itself is returned.

**matplotlib.axis.Tick.convert\_yunits**

`Tick.convert_yunits(self, y)`

Convert *y* using the unit type of the yaxis.

If the artist is not in contained in an Axes or if the yaxis does not have units, *y* itself is returned.

**matplotlib.axis.Tick.draw**

`Tick.draw(self, renderer)`

Draw the Artist using the given renderer.

This method will be overridden in the Artist subclasses. Typically, it is implemented to not have any effect if the Artist is not visible (*Artist.get\_visible* is *False*).

**Parameters**

**renderer** [*RendererBase* subclass.]

### matplotlib.axis.Tick.findobj

`Tick.findobj(self, match=None, include_self=True)`  
Find artist objects.

Recursively find all *Artist* instances contained in the artist.

#### Parameters

**match** A filter criterion for the matches. This can be

- *None*: Return all objects contained in artist.
- A function with signature `def match(artist: Artist) -> bool`. The result will only contain artists for which the function returns *True*.
- A class instance: e.g., *Line2D*. The result will only contain artists of this class or its subclasses (instance check).

**include\_self** [bool] Include *self* in the list to be checked for a match.

#### Returns

**artists** [list of *Artist*]

### matplotlib.axis.Tick.format\_cursor\_data

`Tick.format_cursor_data(self, data)`  
Return a string representation of *data*.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

The default implementation converts ints and floats and arrays of ints and floats into a comma-separated string enclosed in square brackets.

#### See also:

`get_cursor_data`

### matplotlib.axis.Tick.get\_agg\_filter

`Tick.get_agg_filter(self)`  
Return filter function to be used for agg filter.

### matplotlib.axis.Tick.get\_alpha

`Tick.get_alpha(self)`  
Return the alpha value used for blending - not supported on all backends

---

**matplotlib.axis.Tick.get\_animated**

`Tick.get_animated(self)`  
Return the animated state.

**matplotlib.axis.Tick.get\_children**

`Tick.get_children(self)`  
Return a list of the child *Artists* of this *Artist*.

**matplotlib.axis.Tick.get\_clip\_box**

`Tick.get_clip_box(self)`  
Return the clipbox.

**matplotlib.axis.Tick.get\_clip\_on**

`Tick.get_clip_on(self)`  
Return whether the artist uses clipping.

**matplotlib.axis.Tick.get\_clip\_path**

`Tick.get_clip_path(self)`  
Return the clip path.

**matplotlib.axis.Tick.get\_contains**

`Tick.get_contains(self)`  
Return the custom contains function of the artist if set, or *None*.

**See also:**

*set\_contains*

**matplotlib.axis.Tick.get\_cursor\_data**

`Tick.get_cursor_data(self, event)`  
Return the cursor data for a given event.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

Cursor data can be used by Artists to provide additional context information for a given event. The default implementation just returns *None*.

Subclasses can override the method and return arbitrary data. However, when doing so, they must ensure that `format_cursor_data` can convert the data to a string representation.

The only current use case is displaying the z-value of an `AxesImage` in the status bar of a plot window, while moving the mouse.

### Parameters

**event** [`matplotlib.backend_bases.MouseEvent`]

### See also:

`format_cursor_data`

### `matplotlib.axis.Tick.get_figure`

`Tick.get_figure(self)`

Return the `Figure` instance the artist belongs to.

### `matplotlib.axis.Tick.get_gid`

`Tick.get_gid(self)`

Return the group id.

### `matplotlib.axis.Tick.get_label`

`Tick.get_label(self)`

Return the label used for this artist in the legend.

### `matplotlib.axis.Tick.get_path_effects`

`Tick.get_path_effects(self)`

### `matplotlib.axis.Tick.get_picker`

`Tick.get_picker(self)`

Return the picking behavior of the artist.

The possible values are described in `set_picker`.

### See also:

`set_picker`, `pickable`, `pick`

### `matplotlib.axis.Tick.get_rasterized`

`Tick.get_rasterized(self)`

Return whether the artist is to be rasterized.

**matplotlib.axis.Tick.get\_sketch\_params**`Tick.get_sketch_params(self)`

Returns the sketch parameters for the artist.

**Returns**

**sketch\_params** [tuple or None] A 3-tuple with the following elements:

- *scale*: The amplitude of the wiggle perpendicular to the source line.
- *length*: The length of the wiggle along the line.
- *randomness*: The scale factor by which the length is shrunken or expanded.

Returns *None* if no sketch parameters were set.

**matplotlib.axis.Tick.get\_snap**`Tick.get_snap(self)`

Returns the snap setting.

See *set\_snap* for details.

**matplotlib.axis.Tick.get\_transform**`Tick.get_transform(self)`

Return the *Transform* instance used by this artist.

**matplotlib.axis.Tick.get\_transformed\_clip\_path\_and\_affine**`Tick.get_transformed_clip_path_and_affine(self)`

Return the clip path with the non-affine part of its transformation applied, and the remaining affine part of its transformation.

**matplotlib.axis.Tick.get\_url**`Tick.get_url(self)`

Return the url.

**matplotlib.axis.Tick.get\_visible**`Tick.get_visible(self)`

Return the visibility.

#### matplotlib.axis.Tick.get\_window\_extent

Tick.get\_window\_extent(*self*, *renderer*)

Get the axes bounding box in display space.

The bounding box' width and height are nonnegative.

Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

#### matplotlib.axis.Tick.get\_zorder

Tick.get\_zorder(*self*)

Return the artist's zorder.

#### matplotlib.axis.Tick.have\_units

Tick.have\_units(*self*)

Return *True* if units are set on the x or y axes.

#### matplotlib.axis.Tick.is\_transform\_set

Tick.is\_transform\_set(*self*)

Return whether the Artist has an explicitly set transform.

This is *True* after *set\_transform* has been called.

#### matplotlib.axis.Tick.mouseover

Tick.mouseover

#### matplotlib.axis.Tick.pchanged

Tick.pchanged(*self*)

Call all of the registered callbacks.

This function is triggered internally when a property is changed.

**See also:**

*add\_callback*

*remove\_callback*

**matplotlib.axis.Tick.pick**

`Tick.pick(self, mouseevent)`

Process a pick event.

Each child artist will fire a pick event if *mouseevent* is over the artist and the artist has picker set.

**See also:**

*set\_picker, get\_picker, pickable*

**matplotlib.axis.Tick.pickable**

`Tick.pickable(self)`

Return whether the artist is pickable.

**See also:**

*set\_picker, get\_picker, pick*

**matplotlib.axis.Tick.properties**

`Tick.properties(self)`

Return a dictionary of all the properties of the artist.

**matplotlib.axis.Tick.remove**

`Tick.remove(self)`

Remove the artist from the figure if possible.

The effect will not be visible until the figure is redrawn, e.g., with *FigureCanvasBase.draw\_idle*. Call *relim* to update the axes limits if desired.

Note: *relim* will not see collections even if the collection was added to the axes with *autolim = True*.

Note: there is no support for removing the artist's legend entry.

**matplotlib.axis.Tick.remove\_callback**

`Tick.remove_callback(self, oid)`

Remove a callback based on its observer id.

**See also:**

*add\_callback*

### matplotlib.axis.Tick.set

Tick.set(*self*, **\*\*kwargs**)

A property batch setter. Pass *kwargs* to set properties.

### matplotlib.axis.Tick.set\_agg\_filter

Tick.set\_agg\_filter(*self*, *filter\_func*)

Set the agg filter.

#### Parameters

**filter\_func** [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

### matplotlib.axis.Tick.set\_alpha

Tick.set\_alpha(*self*, *alpha*)

Set the alpha value used for blending - not supported on all backends.

#### Parameters

**alpha** [float]

### matplotlib.axis.Tick.set\_animated

Tick.set\_animated(*self*, *b*)

Set the artist's animation state.

#### Parameters

**b** [bool]

### matplotlib.axis.Tick.set\_clip\_box

Tick.set\_clip\_box(*self*, *clipbox*)

Set the artist's clip *Bbox*.

#### Parameters

**clipbox** [*Bbox*]

### matplotlib.axis.Tick.set\_clip\_on

Tick.set\_clip\_on(*self*, *b*)

Set whether the artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

#### Parameters

**b** [bool]

**matplotlib.axis.Tick.set\_clip\_path**

`Tick.set_clip_path(self, clippath, transform=None)`

Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- `None`, to remove a previously set clipping path.

For efficiency, if the path happens to be an axis-aligned rectangle, this method will set the clipping box to the corresponding rectangle and set the clipping path to `None`.

ACCEPTS: [(*Path*, *Transform*) | *Patch* | `None`]

**matplotlib.axis.Tick.set\_contains**

`Tick.set_contains(self, picker)`

Define a custom contains test for the artist.

The provided callable replaces the default *contains* method of the artist.

**Parameters**

**picker** [callable] A custom picker function to evaluate if an event is within the artist. The function must have the signature:

```
def contains(artist: Artist, event: MouseEvent) -> bool, dict
```

that returns:

- a `bool` indicating if the event is within the artist
- a `dict` of additional information. The dict should at least return the same information as the default `contains()` implementation of the respective artist, but may provide additional information.

**matplotlib.axis.Tick.set\_figure**

`Tick.set_figure(self, fig)`

Set the *Figure* instance the artist belongs to.

**Parameters**

**fig** [*Figure*]

**matplotlib.axis.Tick.set\_gid**

`Tick.set_gid(self, gid)`

Set the (group) id for the artist.

**Parameters**

**gid** [str]

**matplotlib.axis.Tick.set\_label**

`Tick.set_label(self, s)`  
Set the label text.

**Parameters**

**s** [str]

**matplotlib.axis.Tick.set\_path\_effects**

`Tick.set_path_effects(self, path_effects)`  
Set the path effects.

**Parameters**

**path\_effects** [*AbstractPathEffect*]

**matplotlib.axis.Tick.set\_picker**

`Tick.set_picker(self, picker)`  
Define the picking behavior of the artist.

**Parameters**

**picker** [None or bool or float or callable] This can be one of the following:

- *None*: Picking is disabled for this artist (default).
- A boolean: If *True* then picking will be enabled and the artist will fire a pick event if the mouse event is over the artist.
- A float: If picker is a number it is interpreted as an epsilon tolerance in points and the artist will fire off an event if it's data is within epsilon of the mouse event. For some artists like lines and patch collections, the artist may provide additional data to the pick event that is generated, e.g., the indices of the data within epsilon of the pick event
- A function: If picker is callable, it is a user supplied function which determines whether the artist is hit by the mouse event:

```
hit, props = picker(artist, mouseevent)
```

to determine the hit test. if the mouse event is over the artist, return *hit=True* and props is a dictionary of properties you want added to the PickEvent attributes.

**matplotlib.axis.Tick.set\_rasterized**

`Tick.set_rasterized(self, rasterized)`  
Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

**Parameters**

**rasterized** [bool or None]

**matplotlib.axis.Tick.set\_sketch\_params**

`Tick.set_sketch_params(self, scale=None, length=None, randomness=None)`  
 Sets the sketch parameters.

**Parameters**

**scale** [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If `scale` is `None`, or not provided, no sketch filter will be provided.

**length** [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

**randomness** [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

**matplotlib.axis.Tick.set\_snap**

`Tick.set_snap(self, snap)`  
 Set the snapping behavior.

Snapping aligns positions with the pixel grid, which results in clearer images. For example, if a black line of 1px width was defined at a position in between two pixels, the resulting image would contain the interpolated value of that line in the pixel grid, which would be a grey value on both adjacent pixel positions. In contrast, snapping will move the line to the nearest integer pixel value, so that the resulting image will really contain a 1px wide black line.

Snapping is currently only supported by the Agg and MacOSX backends.

**Parameters**

**snap** [bool or None] Possible values:

- *True*: Snap vertices to the nearest pixel center.
- *False*: Do not modify vertex positions.
- *None*: (auto) If the path contains only rectilinear line segments, round to the nearest pixel center.

**matplotlib.axis.Tick.set\_transform**

`Tick.set_transform(self, t)`  
 Set the artist transform.

**Parameters**

**t** [*Transform*]

**matplotlib.axis.Tick.set\_url**

`Tick.set_url(self, url)`  
 Set the url for the artist.

**Parameters**

**url** [str]

**matplotlib.axis.Tick.set\_visible**

`Tick.set_visible(self, b)`  
Set the artist's visibility.

**Parameters**

**b** [bool]

**matplotlib.axis.Tick.set\_zorder**

`Tick.set_zorder(self, level)`  
Set the zorder for the artist. Artists with lower zorder values are drawn first.

**Parameters**

**level** [float]

**matplotlib.axis.Tick.stale**

`Tick.stale`  
Whether the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

**matplotlib.axis.Tick.update**

`Tick.update(self, props)`  
Update this artist's properties from the dictionary *props*.

**matplotlib.axis.Tick.update\_from**

`Tick.update_from(self, other)`  
Copy properties from *other* to *self*.

**matplotlib.axis.Tick.zorder**

`Tick.zorder = 0`

**matplotlib.axis.XTick.add\_callback**

`XTick.add_callback(self, func)`  
Add a callback function that will be called whenever one of the *Artist's* properties changes.

**Parameters**

**func** [callable] The callback function. It must have the signature:

```
def func(artist: Artist) -> Any
```

where *artist* is the calling *Artist*. Return values may exist but are ignored.

### Returns

**oid** [int] The observer id associated with the callback. This id can be used for removing the callback with *remove\_callback* later.

### See also:

*remove\_callback*

### matplotlib.axis.XTick.axes

`XTick.axes`

The *Axes* instance the artist resides in, or *None*.

### matplotlib.axis.XTick.contains

`XTick.contains(self, mouseevent)`

Test whether the mouse event occurred in the Tick marks.

This function always returns false. It is more useful to test if the axis as a whole contains the mouse rather than the set of tick marks.

### matplotlib.axis.XTick.convert\_xunits

`XTick.convert_xunits(self, x)`

Convert *x* using the unit type of the xaxis.

If the artist is not in contained in an *Axes* or if the xaxis does not have units, *x* itself is returned.

### matplotlib.axis.XTick.convert\_yunits

`XTick.convert_yunits(self, y)`

Convert *y* using the unit type of the yaxis.

If the artist is not in contained in an *Axes* or if the yaxis does not have units, *y* itself is returned.

### matplotlib.axis.XTick.draw

`XTick.draw(self, renderer)`

Draw the Artist using the given renderer.

This method will be overridden in the Artist subclasses. Typically, it is implemented to not have any effect if the Artist is not visible (*Artist.get\_visible* is *False*).

**Parameters****renderer** [*RendererBase* subclass.]**matplotlib.axis.XTick.findobj**`XTick.findobj(self, match=None, include_self=True)`

Find artist objects.

Recursively find all *Artist* instances contained in the artist.**Parameters****match** A filter criterion for the matches. This can be

- *None*: Return all objects contained in artist.
- A function with signature `def match(artist: Artist) -> bool`. The result will only contain artists for which the function returns *True*.
- A class instance: e.g., *Line2D*. The result will only contain artists of this class or its subclasses (instance check).

**include\_self** [bool] Include *self* in the list to be checked for a match.**Returns****artists** [list of *Artist*]**matplotlib.axis.XTick.format\_cursor\_data**`XTick.format_cursor_data(self, data)`Return a string representation of *data*.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

The default implementation converts ints and floats and arrays of ints and floats into a comma-separated string enclosed in square brackets.

**See also:***get\_cursor\_data***matplotlib.axis.XTick.get\_agg\_filter**`XTick.get_agg_filter(self)`

Return filter function to be used for agg filter.

**matplotlib.axis.XTick.get\_alpha**`XTick.get_alpha(self)`

Return the alpha value used for blending - not supported on all backends

---

**matplotlib.axis.XTick.get\_animated**

`XTick.get_animated(self)`  
Return the animated state.

**matplotlib.axis.XTick.get\_children**

`XTick.get_children(self)`  
Return a list of the child *Artists* of this *Artist*.

**matplotlib.axis.XTick.get\_clip\_box**

`XTick.get_clip_box(self)`  
Return the clipbox.

**matplotlib.axis.XTick.get\_clip\_on**

`XTick.get_clip_on(self)`  
Return whether the artist uses clipping.

**matplotlib.axis.XTick.get\_clip\_path**

`XTick.get_clip_path(self)`  
Return the clip path.

**matplotlib.axis.XTick.get\_contains**

`XTick.get_contains(self)`  
Return the custom contains function of the artist if set, or *None*.

**See also:**

`set_contains`

**matplotlib.axis.XTick.get\_cursor\_data**

`XTick.get_cursor_data(self, event)`  
Return the cursor data for a given event.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

Cursor data can be used by Artists to provide additional context information for a given event. The default implementation just returns *None*.

Subclasses can override the method and return arbitrary data. However, when doing so, they must ensure that `format_cursor_data` can convert the data to a string representation.

The only current use case is displaying the z-value of an `AxesImage` in the status bar of a plot window, while moving the mouse.

### Parameters

**event** [`matplotlib.backend_bases.MouseEvent`]

### See also:

`format_cursor_data`

### `matplotlib.axis.XTick.get_figure`

`XTick.get_figure(self)`

Return the `Figure` instance the artist belongs to.

### `matplotlib.axis.XTick.get_gid`

`XTick.get_gid(self)`

Return the group id.

### `matplotlib.axis.XTick.get_label`

`XTick.get_label(self)`

Return the label used for this artist in the legend.

### `matplotlib.axis.XTick.get_path_effects`

`XTick.get_path_effects(self)`

### `matplotlib.axis.XTick.get_picker`

`XTick.get_picker(self)`

Return the picking behavior of the artist.

The possible values are described in `set_picker`.

### See also:

`set_picker`, `pickable`, `pick`

### `matplotlib.axis.XTick.get_rasterized`

`XTick.get_rasterized(self)`

Return whether the artist is to be rasterized.

**matplotlib.axis.XTick.get\_sketch\_params**`XTick.get_sketch_params(self)`

Returns the sketch parameters for the artist.

**Returns**

**sketch\_params** [tuple or None] A 3-tuple with the following elements:

- *scale*: The amplitude of the wiggle perpendicular to the source line.
- *length*: The length of the wiggle along the line.
- *randomness*: The scale factor by which the length is shrunken or expanded.

Returns *None* if no sketch parameters were set.

**matplotlib.axis.XTick.get\_snap**`XTick.get_snap(self)`

Returns the snap setting.

See *set\_snap* for details.

**matplotlib.axis.XTick.get\_transform**`XTick.get_transform(self)`

Return the *Transform* instance used by this artist.

**matplotlib.axis.XTick.get\_transformed\_clip\_path\_and\_affine**`XTick.get_transformed_clip_path_and_affine(self)`

Return the clip path with the non-affine part of its transformation applied, and the remaining affine part of its transformation.

**matplotlib.axis.XTick.get\_url**`XTick.get_url(self)`

Return the url.

**matplotlib.axis.XTick.get\_visible**`XTick.get_visible(self)`

Return the visibility.

#### matplotlib.axis.XTick.get\_window\_extent

`XTick.get_window_extent(self, renderer)`

Get the axes bounding box in display space.

The bounding box' width and height are nonnegative.

Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

#### matplotlib.axis.XTick.get\_zorder

`XTick.get_zorder(self)`

Return the artist's zorder.

#### matplotlib.axis.XTick.have\_units

`XTick.have_units(self)`

Return *True* if units are set on the x or y axes.

#### matplotlib.axis.XTick.is\_transform\_set

`XTick.is_transform_set(self)`

Return whether the Artist has an explicitly set transform.

This is *True* after *set\_transform* has been called.

#### matplotlib.axis.XTick.mouseover

`XTick.mouseover`

#### matplotlib.axis.XTick.pchanged

`XTick.pchanged(self)`

Call all of the registered callbacks.

This function is triggered internally when a property is changed.

**See also:**

*add\_callback*

*remove\_callback*

**matplotlib.axis.XTick.pick**`XTick.pick(self, mouseevent)`

Process a pick event.

Each child artist will fire a pick event if *mouseevent* is over the artist and the artist has picker set.

**See also:**

*set\_picker, get\_picker, pickable*

**matplotlib.axis.XTick.pickable**`XTick.pickable(self)`

Return whether the artist is pickable.

**See also:**

*set\_picker, get\_picker, pick*

**matplotlib.axis.XTick.properties**`XTick.properties(self)`

Return a dictionary of all the properties of the artist.

**matplotlib.axis.XTick.remove**`XTick.remove(self)`

Remove the artist from the figure if possible.

The effect will not be visible until the figure is redrawn, e.g., with *FigureCanvasBase.draw\_idle*. Call *relim* to update the axes limits if desired.

Note: *relim* will not see collections even if the collection was added to the axes with *autolim = True*.

Note: there is no support for removing the artist's legend entry.

**matplotlib.axis.XTick.remove\_callback**`XTick.remove_callback(self, oid)`

Remove a callback based on its observer id.

**See also:**

*add\_callback*

### matplotlib.axis.XTick.set

`XTick.set(self, **kwargs)`

A property batch setter. Pass *kwargs* to set properties.

### matplotlib.axis.XTick.set\_agg\_filter

`XTick.set_agg_filter(self, filter_func)`

Set the agg filter.

#### Parameters

**filter\_func** [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

### matplotlib.axis.XTick.set\_alpha

`XTick.set_alpha(self, alpha)`

Set the alpha value used for blending - not supported on all backends.

#### Parameters

**alpha** [float]

### matplotlib.axis.XTick.set\_animated

`XTick.set_animated(self, b)`

Set the artist's animation state.

#### Parameters

**b** [bool]

### matplotlib.axis.XTick.set\_clip\_box

`XTick.set_clip_box(self, clipbox)`

Set the artist's clip *Bbox*.

#### Parameters

**clipbox** [*Bbox*]

### matplotlib.axis.XTick.set\_clip\_on

`XTick.set_clip_on(self, b)`

Set whether the artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

#### Parameters

**b** [bool]

**matplotlib.axis.XTick.set\_clip\_path**

`XTick.set_clip_path(self, clippath, transform=None)`

Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- `None`, to remove a previously set clipping path.

For efficiency, if the path happens to be an axis-aligned rectangle, this method will set the clipping box to the corresponding rectangle and set the clipping path to `None`.

ACCEPTS: [(*Path*, *Transform*) | *Patch* | `None`]

**matplotlib.axis.XTick.set\_contains**

`XTick.set_contains(self, picker)`

Define a custom contains test for the artist.

The provided callable replaces the default *contains* method of the artist.

**Parameters**

**picker** [callable] A custom picker function to evaluate if an event is within the artist. The function must have the signature:

```
def contains(artist: Artist, event: MouseEvent) -> bool, dict
```

that returns:

- a `bool` indicating if the event is within the artist
- a `dict` of additional information. The dict should at least return the same information as the default `contains()` implementation of the respective artist, but may provide additional information.

**matplotlib.axis.XTick.set\_figure**

`XTick.set_figure(self, fig)`

Set the *Figure* instance the artist belongs to.

**Parameters**

**fig** [*Figure*]

**matplotlib.axis.XTick.set\_gid**

`XTick.set_gid(self, gid)`

Set the (group) id for the artist.

**Parameters**

**gid** [str]

**matplotlib.axis.XTick.set\_label**

`XTick.set_label(self, s)`  
Set the label text.

**Parameters**

**s** [str]

**matplotlib.axis.XTick.set\_path\_effects**

`XTick.set_path_effects(self, path_effects)`  
Set the path effects.

**Parameters**

**path\_effects** [*AbstractPathEffect*]

**matplotlib.axis.XTick.set\_picker**

`XTick.set_picker(self, picker)`  
Define the picking behavior of the artist.

**Parameters**

**picker** [None or bool or float or callable] This can be one of the following:

- *None*: Picking is disabled for this artist (default).
- A boolean: If *True* then picking will be enabled and the artist will fire a pick event if the mouse event is over the artist.
- A float: If picker is a number it is interpreted as an epsilon tolerance in points and the artist will fire off an event if it's data is within epsilon of the mouse event. For some artists like lines and patch collections, the artist may provide additional data to the pick event that is generated, e.g., the indices of the data within epsilon of the pick event
- A function: If picker is callable, it is a user supplied function which determines whether the artist is hit by the mouse event:

```
hit, props = picker(artist, mouseevent)
```

to determine the hit test. if the mouse event is over the artist, return *hit=True* and props is a dictionary of properties you want added to the PickEvent attributes.

**matplotlib.axis.XTick.set\_rasterized**

`XTick.set_rasterized(self, rasterized)`  
Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

**Parameters**

**rasterized** [bool or None]

**matplotlib.axis.XTick.set\_sketch\_params**

`XTick.set_sketch_params(self, scale=None, length=None, randomness=None)`  
 Sets the sketch parameters.

**Parameters**

**scale** [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If `scale` is `None`, or not provided, no sketch filter will be provided.

**length** [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

**randomness** [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

**matplotlib.axis.XTick.set\_snap**

`XTick.set_snap(self, snap)`  
 Set the snapping behavior.

Snapping aligns positions with the pixel grid, which results in clearer images. For example, if a black line of 1px width was defined at a position in between two pixels, the resulting image would contain the interpolated value of that line in the pixel grid, which would be a grey value on both adjacent pixel positions. In contrast, snapping will move the line to the nearest integer pixel value, so that the resulting image will really contain a 1px wide black line.

Snapping is currently only supported by the Agg and MacOSX backends.

**Parameters**

**snap** [bool or None] Possible values:

- *True*: Snap vertices to the nearest pixel center.
- *False*: Do not modify vertex positions.
- *None*: (auto) If the path contains only rectilinear line segments, round to the nearest pixel center.

**matplotlib.axis.XTick.set\_transform**

`XTick.set_transform(self, t)`  
 Set the artist transform.

**Parameters**

**t** [*Transform*]

**matplotlib.axis.XTick.set\_url**

`XTick.set_url(self, url)`  
 Set the url for the artist.

**Parameters**

**url** [str]

**matplotlib.axis.XTick.set\_visible**

`XTick.set_visible(self, b)`  
Set the artist's visibility.

**Parameters**

**b** [bool]

**matplotlib.axis.XTick.set\_zorder**

`XTick.set_zorder(self, level)`  
Set the zorder for the artist. Artists with lower zorder values are drawn first.

**Parameters**

**level** [float]

**matplotlib.axis.XTick.stale**

`XTick.stale`  
Whether the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

**matplotlib.axis.XTick.update**

`XTick.update(self, props)`  
Update this artist's properties from the dictionary *props*.

**matplotlib.axis.XTick.update\_from**

`XTick.update_from(self, other)`  
Copy properties from *other* to *self*.

**matplotlib.axis.XTick.zorder**

`XTick.zorder = 0`

**matplotlib.axis.YTick.add\_callback**

`YTick.add_callback(self, func)`  
Add a callback function that will be called whenever one of the *Artist's* properties changes.

**Parameters**

**func** [callable] The callback function. It must have the signature:

```
def func(artist: Artist) -> Any
```

where *artist* is the calling *Artist*. Return values may exist but are ignored.

### Returns

**oid** [int] The observer id associated with the callback. This id can be used for removing the callback with *remove\_callback* later.

### See also:

*remove\_callback*

### matplotlib.axis.YTick.axes

`YTick.axes`

The *Axes* instance the artist resides in, or *None*.

### matplotlib.axis.YTick.contains

`YTick.contains(self, mouseevent)`

Test whether the mouse event occurred in the Tick marks.

This function always returns false. It is more useful to test if the axis as a whole contains the mouse rather than the set of tick marks.

### matplotlib.axis.YTick.convert\_xunits

`YTick.convert_xunits(self, x)`

Convert *x* using the unit type of the xaxis.

If the artist is not in contained in an *Axes* or if the xaxis does not have units, *x* itself is returned.

### matplotlib.axis.YTick.convert\_yunits

`YTick.convert_yunits(self, y)`

Convert *y* using the unit type of the yaxis.

If the artist is not in contained in an *Axes* or if the yaxis does not have units, *y* itself is returned.

### matplotlib.axis.YTick.draw

`YTick.draw(self, renderer)`

Draw the Artist using the given renderer.

This method will be overridden in the Artist subclasses. Typically, it is implemented to not have any effect if the Artist is not visible (*Artist.get\_visible* is *False*).

**Parameters****renderer** [*RendererBase* subclass.]**matplotlib.axis.YTick.findobj**`YTick.findobj(self, match=None, include_self=True)`

Find artist objects.

Recursively find all *Artist* instances contained in the artist.**Parameters****match** A filter criterion for the matches. This can be

- *None*: Return all objects contained in artist.
- A function with signature `def match(artist: Artist) -> bool`. The result will only contain artists for which the function returns *True*.
- A class instance: e.g., *Line2D*. The result will only contain artists of this class or its subclasses (instance check).

**include\_self** [bool] Include *self* in the list to be checked for a match.**Returns****artists** [list of *Artist*]**matplotlib.axis.YTick.format\_cursor\_data**`YTick.format_cursor_data(self, data)`Return a string representation of *data*.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

The default implementation converts ints and floats and arrays of ints and floats into a comma-separated string enclosed in square brackets.

**See also:***get\_cursor\_data***matplotlib.axis.YTick.get\_agg\_filter**`YTick.get_agg_filter(self)`

Return filter function to be used for agg filter.

**matplotlib.axis.YTick.get\_alpha**`YTick.get_alpha(self)`

Return the alpha value used for blending - not supported on all backends

---

**matplotlib.axis.YTick.get\_animated**

`YTick.get_animated(self)`  
Return the animated state.

**matplotlib.axis.YTick.get\_children**

`YTick.get_children(self)`  
Return a list of the child *Artists* of this *Artist*.

**matplotlib.axis.YTick.get\_clip\_box**

`YTick.get_clip_box(self)`  
Return the clipbox.

**matplotlib.axis.YTick.get\_clip\_on**

`YTick.get_clip_on(self)`  
Return whether the artist uses clipping.

**matplotlib.axis.YTick.get\_clip\_path**

`YTick.get_clip_path(self)`  
Return the clip path.

**matplotlib.axis.YTick.get\_contains**

`YTick.get_contains(self)`  
Return the custom contains function of the artist if set, or *None*.

**See also:**

`set_contains`

**matplotlib.axis.YTick.get\_cursor\_data**

`YTick.get_cursor_data(self, event)`  
Return the cursor data for a given event.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

Cursor data can be used by Artists to provide additional context information for a given event. The default implementation just returns *None*.

Subclasses can override the method and return arbitrary data. However, when doing so, they must ensure that `format_cursor_data` can convert the data to a string representation.

The only current use case is displaying the z-value of an `AxesImage` in the status bar of a plot window, while moving the mouse.

### Parameters

**event** [`matplotlib.backend_bases.MouseEvent`]

### See also:

`format_cursor_data`

### `matplotlib.axis.YTick.get_figure`

`YTick.get_figure(self)`

Return the `Figure` instance the artist belongs to.

### `matplotlib.axis.YTick.get_gid`

`YTick.get_gid(self)`

Return the group id.

### `matplotlib.axis.YTick.get_label`

`YTick.get_label(self)`

Return the label used for this artist in the legend.

### `matplotlib.axis.YTick.get_path_effects`

`YTick.get_path_effects(self)`

### `matplotlib.axis.YTick.get_picker`

`YTick.get_picker(self)`

Return the picking behavior of the artist.

The possible values are described in `set_picker`.

### See also:

`set_picker`, `pickable`, `pick`

### `matplotlib.axis.YTick.get_rasterized`

`YTick.get_rasterized(self)`

Return whether the artist is to be rasterized.

**matplotlib.axis.YTick.get\_sketch\_params**`YTick.get_sketch_params(self)`

Returns the sketch parameters for the artist.

**Returns**

**sketch\_params** [tuple or None] A 3-tuple with the following elements:

- *scale*: The amplitude of the wiggle perpendicular to the source line.
- *length*: The length of the wiggle along the line.
- *randomness*: The scale factor by which the length is shrunken or expanded.

Returns *None* if no sketch parameters were set.

**matplotlib.axis.YTick.get\_snap**`YTick.get_snap(self)`

Returns the snap setting.

See *set\_snap* for details.

**matplotlib.axis.YTick.get\_transform**`YTick.get_transform(self)`

Return the *Transform* instance used by this artist.

**matplotlib.axis.YTick.get\_transformed\_clip\_path\_and\_affine**`YTick.get_transformed_clip_path_and_affine(self)`

Return the clip path with the non-affine part of its transformation applied, and the remaining affine part of its transformation.

**matplotlib.axis.YTick.get\_url**`YTick.get_url(self)`

Return the url.

**matplotlib.axis.YTick.get\_visible**`YTick.get_visible(self)`

Return the visibility.

#### matplotlib.axis.YTick.get\_window\_extent

`YTick.get_window_extent(self, renderer)`

Get the axes bounding box in display space.

The bounding box' width and height are nonnegative.

Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

#### matplotlib.axis.YTick.get\_zorder

`YTick.get_zorder(self)`

Return the artist's zorder.

#### matplotlib.axis.YTick.have\_units

`YTick.have_units(self)`

Return *True* if units are set on the x or y axes.

#### matplotlib.axis.YTick.is\_transform\_set

`YTick.is_transform_set(self)`

Return whether the Artist has an explicitly set transform.

This is *True* after *set\_transform* has been called.

#### matplotlib.axis.YTick.mouseover

`YTick.mouseover`

#### matplotlib.axis.YTick.pchanged

`YTick.pchanged(self)`

Call all of the registered callbacks.

This function is triggered internally when a property is changed.

**See also:**

*add\_callback*

*remove\_callback*

**matplotlib.axis.YTick.pick**`YTick.pick(self, mouseevent)`

Process a pick event.

Each child artist will fire a pick event if *mouseevent* is over the artist and the artist has picker set.

**See also:**

*set\_picker, get\_picker, pickable*

**matplotlib.axis.YTick.pickable**`YTick.pickable(self)`

Return whether the artist is pickable.

**See also:**

*set\_picker, get\_picker, pick*

**matplotlib.axis.YTick.properties**`YTick.properties(self)`

Return a dictionary of all the properties of the artist.

**matplotlib.axis.YTick.remove**`YTick.remove(self)`

Remove the artist from the figure if possible.

The effect will not be visible until the figure is redrawn, e.g., with *FigureCanvasBase.draw\_idle*. Call *relim* to update the axes limits if desired.

Note: *relim* will not see collections even if the collection was added to the axes with *autolim = True*.

Note: there is no support for removing the artist's legend entry.

**matplotlib.axis.YTick.remove\_callback**`YTick.remove_callback(self, oid)`

Remove a callback based on its observer id.

**See also:**

*add\_callback*

### matplotlib.axis.YTick.set

`YTick.set(self, **kwargs)`

A property batch setter. Pass *kwargs* to set properties.

### matplotlib.axis.YTick.set\_agg\_filter

`YTick.set_agg_filter(self, filter_func)`

Set the agg filter.

#### Parameters

**filter\_func** [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

### matplotlib.axis.YTick.set\_alpha

`YTick.set_alpha(self, alpha)`

Set the alpha value used for blending - not supported on all backends.

#### Parameters

**alpha** [float]

### matplotlib.axis.YTick.set\_animated

`YTick.set_animated(self, b)`

Set the artist's animation state.

#### Parameters

**b** [bool]

### matplotlib.axis.YTick.set\_clip\_box

`YTick.set_clip_box(self, clipbox)`

Set the artist's clip *Bbox*.

#### Parameters

**clipbox** [*Bbox*]

### matplotlib.axis.YTick.set\_clip\_on

`YTick.set_clip_on(self, b)`

Set whether the artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

#### Parameters

**b** [bool]

**matplotlib.axis.YTick.set\_clip\_path**

`YTick.set_clip_path(self, clippath, transform=None)`

Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- `None`, to remove a previously set clipping path.

For efficiency, if the path happens to be an axis-aligned rectangle, this method will set the clipping box to the corresponding rectangle and set the clipping path to `None`.

ACCEPTS: [(*Path*, *Transform*) | *Patch* | `None`]

**matplotlib.axis.YTick.set\_contains**

`YTick.set_contains(self, picker)`

Define a custom contains test for the artist.

The provided callable replaces the default *contains* method of the artist.

**Parameters**

**picker** [callable] A custom picker function to evaluate if an event is within the artist. The function must have the signature:

```
def contains(artist: Artist, event: MouseEvent) -> bool, dict
```

that returns:

- a `bool` indicating if the event is within the artist
- a `dict` of additional information. The dict should at least return the same information as the default `contains()` implementation of the respective artist, but may provide additional information.

**matplotlib.axis.YTick.set\_figure**

`YTick.set_figure(self, fig)`

Set the *Figure* instance the artist belongs to.

**Parameters**

**fig** [*Figure*]

**matplotlib.axis.YTick.set\_gid**

`YTick.set_gid(self, gid)`

Set the (group) id for the artist.

**Parameters**

**gid** [str]

**matplotlib.axis.YTick.set\_label**

`YTick.set_label(self, s)`  
Set the label text.

**Parameters**

**s** [str]

**matplotlib.axis.YTick.set\_path\_effects**

`YTick.set_path_effects(self, path_effects)`  
Set the path effects.

**Parameters**

**path\_effects** [*AbstractPathEffect*]

**matplotlib.axis.YTick.set\_picker**

`YTick.set_picker(self, picker)`  
Define the picking behavior of the artist.

**Parameters**

**picker** [None or bool or float or callable] This can be one of the following:

- *None*: Picking is disabled for this artist (default).
- A boolean: If *True* then picking will be enabled and the artist will fire a pick event if the mouse event is over the artist.
- A float: If picker is a number it is interpreted as an epsilon tolerance in points and the artist will fire off an event if it's data is within epsilon of the mouse event. For some artists like lines and patch collections, the artist may provide additional data to the pick event that is generated, e.g., the indices of the data within epsilon of the pick event
- A function: If picker is callable, it is a user supplied function which determines whether the artist is hit by the mouse event:

```
hit, props = picker(artist, mouseevent)
```

to determine the hit test. if the mouse event is over the artist, return *hit=True* and props is a dictionary of properties you want added to the PickEvent attributes.

**matplotlib.axis.YTick.set\_rasterized**

`YTick.set_rasterized(self, rasterized)`  
Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

**Parameters**

**rasterized** [bool or None]

**matplotlib.axis.YTick.set\_sketch\_params**

`YTick.set_sketch_params(self, scale=None, length=None, randomness=None)`  
 Sets the sketch parameters.

**Parameters**

**scale** [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If `scale` is `None`, or not provided, no sketch filter will be provided.

**length** [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

**randomness** [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

**matplotlib.axis.YTick.set\_snap**

`YTick.set_snap(self, snap)`  
 Set the snapping behavior.

Snapping aligns positions with the pixel grid, which results in clearer images. For example, if a black line of 1px width was defined at a position in between two pixels, the resulting image would contain the interpolated value of that line in the pixel grid, which would be a grey value on both adjacent pixel positions. In contrast, snapping will move the line to the nearest integer pixel value, so that the resulting image will really contain a 1px wide black line.

Snapping is currently only supported by the Agg and MacOSX backends.

**Parameters**

**snap** [bool or None] Possible values:

- *True*: Snap vertices to the nearest pixel center.
- *False*: Do not modify vertex positions.
- *None*: (auto) If the path contains only rectilinear line segments, round to the nearest pixel center.

**matplotlib.axis.YTick.set\_transform**

`YTick.set_transform(self, t)`  
 Set the artist transform.

**Parameters**

**t** [*Transform*]

**matplotlib.axis.YTick.set\_url**

`YTick.set_url(self, url)`  
 Set the url for the artist.

**Parameters**

**url** [str]

**matplotlib.axis.YTick.set\_visible**

`YTick.set_visible(self, b)`  
Set the artist's visibility.

**Parameters**

**b** [bool]

**matplotlib.axis.YTick.set\_zorder**

`YTick.set_zorder(self, level)`  
Set the zorder for the artist. Artists with lower zorder values are drawn first.

**Parameters**

**level** [float]

**matplotlib.axis.YTick.stale**

`YTick.stale`  
Whether the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

**matplotlib.axis.YTick.update**

`YTick.update(self, props)`  
Update this artist's properties from the dictionary *props*.

**matplotlib.axis.YTick.update\_from**

`YTick.update_from(self, other)`  
Copy properties from *other* to *self*.

**matplotlib.axis.YTick.zorder**

`YTick.zorder = 0`

**Axis**

*Axis.add\_callback*

Add a callback function that will be called whenever one of the *Artist's* properties changes.

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<i>Axis.axes</i>	The <i>Axes</i> instance the artist resides in, or <i>None</i> .
<i>Axis.contains</i>	Test whether the artist contains the mouse event.
<i>Axis.convert_xunits</i>	Convert <i>x</i> using the unit type of the xaxis.
<i>Axis.convert_yunits</i>	Convert <i>y</i> using the unit type of the yaxis.
<i>Axis.draw</i>	Draw the axis lines, grid lines, tick lines and labels
<i>Axis.findobj</i>	Find artist objects.
<i>Axis.format_cursor_data</i>	Return a string representation of <i>data</i> .
<i>Axis.get_agg_filter</i>	Return filter function to be used for agg filter.
<i>Axis.get_alpha</i>	Return the alpha value used for blending - not supported on all backends
<i>Axis.get_animated</i>	Return the animated state.
<i>Axis.get_children</i>	Return a list of the child <i>Artists</i> of this <i>Artist</i> .
<i>Axis.get_clip_box</i>	Return the clipbox.
<i>Axis.get_clip_on</i>	Return whether the artist uses clipping.
<i>Axis.get_clip_path</i>	Return the clip path.
<i>Axis.get_contains</i>	Return the custom contains function of the artist if set, or <i>None</i> .
<i>Axis.get_cursor_data</i>	Return the cursor data for a given event.
<i>Axis.get_figure</i>	Return the <i>Figure</i> instance the artist belongs to.
<i>Axis.get_gid</i>	Return the group id.
<i>Axis.get_label</i>	Return the axis label as a <i>Text</i> instance
<i>Axis.get_path_effects</i>	
<i>Axis.get_picker</i>	Return the picking behavior of the artist.
<i>Axis.get_rasterized</i>	Return whether the artist is to be rasterized.
<i>Axis.get_sketch_params</i>	Returns the sketch parameters for the artist.
<i>Axis.get_snap</i>	Returns the snap setting.
<i>Axis.get_transform</i>	Return the <i>Transform</i> instance used by this artist.
<i>Axis.get_transformed_clip_path_and_affine</i>	Return the clip path with the non-affine part of its transformation applied, and the remaining affine part of its transformation.
<i>Axis.get_url</i>	Return the url.
<i>Axis.get_visible</i>	Return the visibility.
<i>Axis.get_window_extent</i>	Get the axes bounding box in display space.
<i>Axis.get_zorder</i>	Return the artist's zorder.
<i>Axis.have_units</i>	Return <i>True</i> if units are set on the <i>x</i> or <i>y</i> axes.
<i>Axis.is_transform_set</i>	Return whether the Artist has an explicitly set transform.
<i>Axis.mouseover</i>	
<i>Axis.pchanged</i>	Call all of the registered callbacks.
<i>Axis.pick</i>	Process a pick event.
<i>Axis.pickable</i>	Return whether the artist is pickable.
<i>Axis.properties</i>	Return a dictionary of all the properties of the artist.

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<code>Axis.remove</code>	Remove the artist from the figure if possible.
<code>Axis.remove_callback</code>	Remove a callback based on its observer id.
<code>Axis.set</code>	A property batch setter.
<code>Axis.set_agg_filter</code>	Set the agg filter.
<code>Axis.set_alpha</code>	Set the alpha value used for blending - not supported on all backends.
<code>Axis.set_animated</code>	Set the artist's animation state.
<code>Axis.set_clip_box</code>	Set the artist's clip <i>Bbox</i> .
<code>Axis.set_clip_on</code>	Set whether the artist uses clipping.
<code>Axis.set_clip_path</code>	Set the artist's clip path, which may be:
<code>Axis.set_contains</code>	Define a custom contains test for the artist.
<code>Axis.set_figure</code>	Set the <i>Figure</i> instance the artist belongs to.
<code>Axis.set_gid</code>	Set the (group) id for the artist.
<code>Axis.set_label</code>	Set a label that will be displayed in the legend.
<code>Axis.set_path_effects</code>	Set the path effects.
<code>Axis.set_picker</code>	Define the picking behavior of the artist.
<code>Axis.set_rasterized</code>	Force rasterized (bitmap) drawing in vector backend output.
<code>Axis.set_sketch_params</code>	Sets the sketch parameters.
<code>Axis.set_snap</code>	Set the snapping behavior.
<code>Axis.set_transform</code>	Set the artist transform.
<code>Axis.set_url</code>	Set the url for the artist.
<code>Axis.set_visible</code>	Set the artist's visibility.
<code>Axis.set_zorder</code>	Set the zorder for the artist.
<code>Axis.stale</code>	Whether the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.
<code>Axis.update</code>	Update this artist's properties from the dictionary <i>props</i> .
<code>Axis.update_from</code>	Copy properties from <i>other</i> to <i>self</i> .
<code>Axis.zorder</code>	
<code>XAxis.add_callback</code>	Add a callback function that will be called whenever one of the <i>Artist's</i> properties changes.
<code>XAxis.axes</code>	The <i>Axes</i> instance the artist resides in, or <i>None</i> .
<code>XAxis.contains</code>	Test whether the mouse event occurred in the x axis.
<code>XAxis.convert_xunits</code>	Convert x using the unit type of the xaxis.
<code>XAxis.convert_yunits</code>	Convert y using the unit type of the yaxis.
<code>XAxis.draw</code>	Draw the axis lines, grid lines, tick lines and labels
<code>XAxis.findobj</code>	Find artist objects.
<code>XAxis.format_cursor_data</code>	Return a string representation of <i>data</i> .
<code>XAxis.get_agg_filter</code>	Return filter function to be used for agg filter.
<code>XAxis.get_alpha</code>	Return the alpha value used for blending - not supported on all backends
<code>XAxis.get_animated</code>	Return the animated state.

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<code>XAxis.get_children</code>	Return a list of the child <i>Artists</i> of this <i>Artist</i> .
<code>XAxis.get_clip_box</code>	Return the clipbox.
<code>XAxis.get_clip_on</code>	Return whether the artist uses clipping.
<code>XAxis.get_clip_path</code>	Return the clip path.
<code>XAxis.get_contains</code>	Return the custom contains function of the artist if set, or <i>None</i> .
<code>XAxis.get_cursor_data</code>	Return the cursor data for a given event.
<code>XAxis.get_figure</code>	Return the <i>Figure</i> instance the artist belongs to.
<code>XAxis.get_gid</code>	Return the group id.
<code>XAxis.get_label</code>	Return the axis label as a <i>Text</i> instance
<code>XAxis.get_path_effects</code>	
<code>XAxis.get_picker</code>	Return the picking behavior of the artist.
<code>XAxis.get_rasterized</code>	Return whether the artist is to be rasterized.
<code>XAxis.get_sketch_params</code>	Returns the sketch parameters for the artist.
<code>XAxis.get_snap</code>	Returns the snap setting.
<code>XAxis.get_transform</code>	Return the <i>Transform</i> instance used by this artist.
<code>XAxis.get_transformed_clip_path_and_affine</code>	Return the clip path with the non-affine part of its transformation applied, and the remaining affine part of its transformation.
<code>XAxis.get_url</code>	Return the url.
<code>XAxis.get_visible</code>	Return the visibility.
<code>XAxis.get_window_extent</code>	Get the axes bounding box in display space.
<code>XAxis.get_zorder</code>	Return the artist's zorder.
<code>XAxis.have_units</code>	Return <i>True</i> if units are set on the x or y axes.
<code>XAxis.is_transform_set</code>	Return whether the Artist has an explicitly set transform.
<code>XAxis.mouseover</code>	
<code>XAxis.pchanged</code>	Call all of the registered callbacks.
<code>XAxis.pick</code>	Process a pick event.
<code>XAxis.pickable</code>	Return whether the artist is pickable.
<code>XAxis.properties</code>	Return a dictionary of all the properties of the artist.
<code>XAxis.remove</code>	Remove the artist from the figure if possible.
<code>XAxis.remove_callback</code>	Remove a callback based on its observer id.
<code>XAxis.set</code>	A property batch setter.
<code>XAxis.set_agg_filter</code>	Set the agg filter.
<code>XAxis.set_alpha</code>	Set the alpha value used for blending - not supported on all backends.
<code>XAxis.set_animated</code>	Set the artist's animation state.
<code>XAxis.set_clip_box</code>	Set the artist's clip <i>Bbox</i> .
<code>XAxis.set_clip_on</code>	Set whether the artist uses clipping.
<code>XAxis.set_clip_path</code>	Set the artist's clip path, which may be:
<code>XAxis.set_contains</code>	Define a custom contains test for the artist.
<code>XAxis.set_figure</code>	Set the <i>Figure</i> instance the artist belongs to.
<code>XAxis.set_gid</code>	Set the (group) id for the artist.
<code>XAxis.set_label</code>	Set a label that will be displayed in the legend.

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<code>XAxis.set_path_effects</code>	Set the path effects.
<code>XAxis.set_picker</code>	Define the picking behavior of the artist.
<code>XAxis.set_rasterized</code>	Force rasterized (bitmap) drawing in vector backend output.
<code>XAxis.set_sketch_params</code>	Sets the sketch parameters.
<code>XAxis.set_snap</code>	Set the snapping behavior.
<code>XAxis.set_transform</code>	Set the artist transform.
<code>XAxis.set_url</code>	Set the url for the artist.
<code>XAxis.set_visible</code>	Set the artist's visibility.
<code>XAxis.set_zorder</code>	Set the zorder for the artist.
<code>XAxis.stale</code>	Whether the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.
<code>XAxis.update</code>	Update this artist's properties from the dictionary <i>props</i> .
<code>XAxis.update_from</code>	Copy properties from <i>other</i> to <i>self</i> .
<code>XAxis.zorder</code>	
<code>YAxis.add_callback</code>	Add a callback function that will be called whenever one of the <i>Artist's</i> properties changes.
<code>YAxis.axes</code>	The <i>Axes</i> instance the artist resides in, or <i>None</i> .
<code>YAxis.contains</code>	Test whether the mouse event occurred in the y axis.
<code>YAxis.convert_xunits</code>	Convert x using the unit type of the xaxis.
<code>YAxis.convert_yunits</code>	Convert y using the unit type of the yaxis.
<code>YAxis.draw</code>	Draw the axis lines, grid lines, tick lines and labels
<code>YAxis.findobj</code>	Find artist objects.
<code>YAxis.format_cursor_data</code>	Return a string representation of <i>data</i> .
<code>YAxis.get_agg_filter</code>	Return filter function to be used for agg filter.
<code>YAxis.get_alpha</code>	Return the alpha value used for blending - not supported on all backends
<code>YAxis.get_animated</code>	Return the animated state.
<code>YAxis.get_children</code>	Return a list of the child <i>Artists</i> of this <i>Artist</i> .
<code>YAxis.get_clip_box</code>	Return the clipbox.
<code>YAxis.get_clip_on</code>	Return whether the artist uses clipping.
<code>YAxis.get_clip_path</code>	Return the clip path.
<code>YAxis.get_contains</code>	Return the custom contains function of the artist if set, or <i>None</i> .
<code>YAxis.get_cursor_data</code>	Return the cursor data for a given event.
<code>YAxis.get_figure</code>	Return the <i>Figure</i> instance the artist belongs to.
<code>YAxis.get_gid</code>	Return the group id.
<code>YAxis.get_label</code>	Return the axis label as a Text instance
<code>YAxis.get_path_effects</code>	
<code>YAxis.get_picker</code>	Return the picking behavior of the artist.
<code>YAxis.get_rasterized</code>	Return whether the artist is to be rasterized.
<code>YAxis.get_sketch_params</code>	Returns the sketch parameters for the artist.

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Table 130 – continued from previous page

<code>YAxis.get_snap</code>	Returns the snap setting.
<code>YAxis.get_transform</code>	Return the <i>Transform</i> instance used by this artist.
<code>YAxis.get_transformed_clip_path_and_affine</code>	Return the clip path with the non-affine part of its transformation applied, and the remaining affine part of its transformation.
<code>YAxis.get_url</code>	Return the url.
<code>YAxis.get_visible</code>	Return the visibility.
<code>YAxis.get_window_extent</code>	Get the axes bounding box in display space.
<code>YAxis.get_zorder</code>	Return the artist's zorder.
<code>YAxis.have_units</code>	Return <i>True</i> if units are set on the x or y axes.
<code>YAxis.is_transform_set</code>	Return whether the Artist has an explicitly set transform.
<code>YAxis.mouseover</code>	
<code>YAxis.pchanged</code>	Call all of the registered callbacks.
<code>YAxis.pick</code>	Process a pick event.
<code>YAxis.pickable</code>	Return whether the artist is pickable.
<code>YAxis.properties</code>	Return a dictionary of all the properties of the artist.
<code>YAxis.remove</code>	Remove the artist from the figure if possible.
<code>YAxis.remove_callback</code>	Remove a callback based on its observer id.
<code>YAxis.set</code>	A property batch setter.
<code>YAxis.set_agg_filter</code>	Set the agg filter.
<code>YAxis.set_alpha</code>	Set the alpha value used for blending - not supported on all backends.
<code>YAxis.set_animated</code>	Set the artist's animation state.
<code>YAxis.set_clip_box</code>	Set the artist's clip <i>Bbox</i> .
<code>YAxis.set_clip_on</code>	Set whether the artist uses clipping.
<code>YAxis.set_clip_path</code>	Set the artist's clip path, which may be:
<code>YAxis.set_contains</code>	Define a custom contains test for the artist.
<code>YAxis.set_figure</code>	Set the <i>Figure</i> instance the artist belongs to.
<code>YAxis.set_gid</code>	Set the (group) id for the artist.
<code>YAxis.set_label</code>	Set a label that will be displayed in the legend.
<code>YAxis.set_path_effects</code>	Set the path effects.
<code>YAxis.set_picker</code>	Define the picking behavior of the artist.
<code>YAxis.set_rasterized</code>	Force rasterized (bitmap) drawing in vector backend output.
<code>YAxis.set_sketch_params</code>	Sets the sketch parameters.
<code>YAxis.set_snap</code>	Set the snapping behavior.
<code>YAxis.set_transform</code>	Set the artist transform.
<code>YAxis.set_url</code>	Set the url for the artist.
<code>YAxis.set_visible</code>	Set the artist's visibility.
<code>YAxis.set_zorder</code>	Set the zorder for the artist.
<code>YAxis.stale</code>	Whether the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.
<code>YAxis.update</code>	Update this artist's properties from the dictionary <i>props</i> .
<code>YAxis.update_from</code>	Copy properties from <i>other</i> to <i>self</i> .

Continued on next page

*YAxis.zorder***matplotlib.axis.Axis.add\_callback**`Axis.add_callback(self, func)`

Add a callback function that will be called whenever one of the *Artist*'s properties changes.

**Parameters**

**func** [callable] The callback function. It must have the signature:

```
def func(artist: Artist) -> Any
```

where *artist* is the calling *Artist*. Return values may exist but are ignored.

**Returns**

**oid** [int] The observer id associated with the callback. This id can be used for removing the callback with *remove\_callback* later.

**See also:**

*remove\_callback*

**matplotlib.axis.Axis.axes**`Axis.axes`

The *Axes* instance the artist resides in, or *None*.

**matplotlib.axis.Axis.contains**`Axis.contains(self, mouseevent)`

Test whether the artist contains the mouse event.

**Parameters**

**mouseevent** [*matplotlib.backend\_bases.MouseEvent*]

**Returns**

**contains** [bool] Whether any values are within the radius.

**details** [dict] An artist-specific dictionary of details of the event context, such as which points are contained in the pick radius. See the individual *Artist* subclasses for details.

**See also:**

*set\_contains*, *get\_contains*

**matplotlib.axis.Axis.convert\_xunits**

`Axis.convert_xunits(self, x)`  
 Convert `x` using the unit type of the xaxis.

If the artist is not in contained in an Axes or if the xaxis does not have units, `x` itself is returned.

**matplotlib.axis.Axis.convert\_yunits**

`Axis.convert_yunits(self, y)`  
 Convert `y` using the unit type of the yaxis.

If the artist is not in contained in an Axes or if the yaxis does not have units, `y` itself is returned.

**matplotlib.axis.Axis.draw**

`Axis.draw(self, renderer, *args, **kwargs)`  
 Draw the axis lines, grid lines, tick lines and labels

**matplotlib.axis.Axis.findobj**

`Axis.findobj(self, match=None, include_self=True)`  
 Find artist objects.

Recursively find all *Artist* instances contained in the artist.

**Parameters**

**match** A filter criterion for the matches. This can be

- *None*: Return all objects contained in artist.
- A function with signature `def match(artist: Artist) -> bool`. The result will only contain artists for which the function returns *True*.
- A class instance: e.g., *Line2D*. The result will only contain artists of this class or its subclasses (*isinstance* check).

**include\_self** [bool] Include *self* in the list to be checked for a match.

**Returns**

**artists** [list of *Artist*]

**matplotlib.axis.Axis.format\_cursor\_data**

`Axis.format_cursor_data(self, data)`  
 Return a string representation of *data*.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

The default implementation converts ints and floats and arrays of ints and floats into a comma-separated string enclosed in square brackets.

**See also:**

`get_cursor_data`

**matplotlib.axis.Axis.get\_agg\_filter**

`Axis.get_agg_filter(self)`  
Return filter function to be used for agg filter.

**matplotlib.axis.Axis.get\_alpha**

`Axis.get_alpha(self)`  
Return the alpha value used for blending - not supported on all backends

**matplotlib.axis.Axis.get\_animated**

`Axis.get_animated(self)`  
Return the animated state.

**matplotlib.axis.Axis.get\_children**

`Axis.get_children(self)`  
Return a list of the child *Artists* of this *Artist*.

**matplotlib.axis.Axis.get\_clip\_box**

`Axis.get_clip_box(self)`  
Return the clipbox.

**matplotlib.axis.Axis.get\_clip\_on**

`Axis.get_clip_on(self)`  
Return whether the artist uses clipping.

**matplotlib.axis.Axis.get\_clip\_path**

`Axis.get_clip_path(self)`  
Return the clip path.

### matplotlib.axis.Axis.get\_contains

`Axis.get_contains(self)`

Return the custom contains function of the artist if set, or *None*.

**See also:**

*set\_contains*

### matplotlib.axis.Axis.get\_cursor\_data

`Axis.get_cursor_data(self, event)`

Return the cursor data for a given event.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

Cursor data can be used by Artists to provide additional context information for a given event. The default implementation just returns *None*.

Subclasses can override the method and return arbitrary data. However, when doing so, they must ensure that *format\_cursor\_data* can convert the data to a string representation.

The only current use case is displaying the z-value of an *AxesImage* in the status bar of a plot window, while moving the mouse.

**Parameters**

**event** [*matplotlib.backend\_bases.MouseEvent*]

**See also:**

*format\_cursor\_data*

### matplotlib.axis.Axis.get\_figure

`Axis.get_figure(self)`

Return the *Figure* instance the artist belongs to.

### matplotlib.axis.Axis.get\_gid

`Axis.get_gid(self)`

Return the group id.

### matplotlib.axis.Axis.get\_label

`Axis.get_label(self)`

Return the axis label as a Text instance

### matplotlib.axis.Axis.get\_path\_effects

Axis.get\_path\_effects(*self*)

### matplotlib.axis.Axis.get\_picker

Axis.get\_picker(*self*)

Return the picking behavior of the artist.

The possible values are described in *set\_picker*.

**See also:**

*set\_picker*, *pickable*, *pick*

### matplotlib.axis.Axis.get\_rasterized

Axis.get\_rasterized(*self*)

Return whether the artist is to be rasterized.

### matplotlib.axis.Axis.get\_sketch\_params

Axis.get\_sketch\_params(*self*)

Returns the sketch parameters for the artist.

**Returns**

**sketch\_params** [tuple or None] A 3-tuple with the following elements:

- *scale*: The amplitude of the wiggle perpendicular to the source line.
- *length*: The length of the wiggle along the line.
- *randomness*: The scale factor by which the length is shrunken or expanded.

Returns *None* if no sketch parameters were set.

### matplotlib.axis.Axis.get\_snap

Axis.get\_snap(*self*)

Returns the snap setting.

See *set\_snap* for details.

### matplotlib.axis.Axis.get\_transform

Axis.get\_transform(*self*)

Return the *Transform* instance used by this artist.

**matplotlib.axis.Axis.get\_transformed\_clip\_path\_and\_affine**

`Axis.get_transformed_clip_path_and_affine(self)`

Return the clip path with the non-affine part of its transformation applied, and the remaining affine part of its transformation.

**matplotlib.axis.Axis.get\_url**

`Axis.get_url(self)`

Return the url.

**matplotlib.axis.Axis.get\_visible**

`Axis.get_visible(self)`

Return the visibility.

**matplotlib.axis.Axis.get\_window\_extent**

`Axis.get_window_extent(self, renderer)`

Get the axes bounding box in display space.

The bounding box' width and height are nonnegative.

Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

**matplotlib.axis.Axis.get\_zorder**

`Axis.get_zorder(self)`

Return the artist's zorder.

**matplotlib.axis.Axis.have\_units**

`Axis.have_units(self)`

Return *True* if units are set on the x or y axes.

**matplotlib.axis.Axis.is\_transform\_set**

`Axis.is_transform_set(self)`

Return whether the Artist has an explicitly set transform.

This is *True* after *set\_transform* has been called.

### matplotlib.axis.Axis.mouseover

`Axis.mouseover`

### matplotlib.axis.Axis.pchanged

`Axis.pchanged(self)`

Call all of the registered callbacks.

This function is triggered internally when a property is changed.

**See also:**

`add_callback`

`remove_callback`

### matplotlib.axis.Axis.pick

`Axis.pick(self, mouseevent)`

Process a pick event.

Each child artist will fire a pick event if *mouseevent* is over the artist and the artist has picker set.

**See also:**

`set_picker`, `get_picker`, `pickable`

### matplotlib.axis.Axis.pickable

`Axis.pickable(self)`

Return whether the artist is pickable.

**See also:**

`set_picker`, `get_picker`, `pick`

### matplotlib.axis.Axis.properties

`Axis.properties(self)`

Return a dictionary of all the properties of the artist.

### matplotlib.axis.Axis.remove

`Axis.remove(self)`

Remove the artist from the figure if possible.

The effect will not be visible until the figure is redrawn, e.g., with *FigureCanvasBase.draw\_idle*. Call *relim* to update the axes limits if desired.

Note: *relim* will not see collections even if the collection was added to the axes with *autolim = True*.

Note: there is no support for removing the artist's legend entry.

#### matplotlib.axis.Axis.remove\_callback

`Axis.remove_callback(self, oid)`

Remove a callback based on its observer id.

#### See also:

`add_callback`

#### matplotlib.axis.Axis.set

`Axis.set(self, **kwargs)`

A property batch setter. Pass *kwargs* to set properties.

#### matplotlib.axis.Axis.set\_agg\_filter

`Axis.set_agg_filter(self, filter_func)`

Set the agg filter.

#### Parameters

**filter\_func** [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

#### matplotlib.axis.Axis.set\_alpha

`Axis.set_alpha(self, alpha)`

Set the alpha value used for blending - not supported on all backends.

#### Parameters

**alpha** [float]

#### matplotlib.axis.Axis.set\_animated

`Axis.set_animated(self, b)`

Set the artist's animation state.

#### Parameters

**b** [bool]

**matplotlib.axis.Axis.set\_clip\_box**

`Axis.set_clip_box(self, clipbox)`  
Set the artist's clip *Bbox*.

**Parameters**

**clipbox** [*Bbox*]

**matplotlib.axis.Axis.set\_clip\_on**

`Axis.set_clip_on(self, b)`  
Set whether the artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

**Parameters**

**b** [bool]

**matplotlib.axis.Axis.set\_clip\_path**

`Axis.set_clip_path(self, clippath, transform=None)`  
Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- None, to remove a previously set clipping path.

For efficiency, if the path happens to be an axis-aligned rectangle, this method will set the clipping box to the corresponding rectangle and set the clipping path to None.

ACCEPTS: [(*Path*, *Transform*) | *Patch* | None]

**matplotlib.axis.Axis.set\_contains**

`Axis.set_contains(self, picker)`  
Define a custom contains test for the artist.

The provided callable replaces the default *contains* method of the artist.

**Parameters**

**picker** [callable] A custom picker function to evaluate if an event is within the artist. The function must have the signature:

```
def contains(artist: Artist, event: MouseEvent) -> bool, dict
```

that returns:

- a bool indicating if the event is within the artist

- a dict of additional information. The dict should at least return the same information as the default `contains()` implementation of the respective artist, but may provide additional information.

#### matplotlib.axis.Axis.set\_figure

`Axis.set_figure(self, fig)`  
Set the *Figure* instance the artist belongs to.

##### Parameters

**fig** [*Figure*]

#### matplotlib.axis.Axis.set\_gid

`Axis.set_gid(self, gid)`  
Set the (group) id for the artist.

##### Parameters

**gid** [str]

#### matplotlib.axis.Axis.set\_label

`Axis.set_label(self, s)`  
Set a label that will be displayed in the legend.

##### Parameters

**s** [object] *s* will be converted to a string by calling `str`.

#### matplotlib.axis.Axis.set\_path\_effects

`Axis.set_path_effects(self, path_effects)`  
Set the path effects.

##### Parameters

**path\_effects** [*AbstractPathEffect*]

#### matplotlib.axis.Axis.set\_picker

`Axis.set_picker(self, picker)`  
Define the picking behavior of the artist.

##### Parameters

**picker** [None or bool or float or callable] This can be one of the following:

- *None*: Picking is disabled for this artist (default).
- A boolean: If *True* then picking will be enabled and the artist will fire a pick event if the mouse event is over the artist.

- A float: If picker is a number it is interpreted as an epsilon tolerance in points and the artist will fire off an event if it's data is within epsilon of the mouse event. For some artists like lines and patch collections, the artist may provide additional data to the pick event that is generated, e.g., the indices of the data within epsilon of the pick event
- A function: If picker is callable, it is a user supplied function which determines whether the artist is hit by the mouse event:

```
hit, props = picker(artist, mouseevent)
```

to determine the hit test. if the mouse event is over the artist, return *hit=True* and props is a dictionary of properties you want added to the PickEvent attributes.

### matplotlib.axis.Axis.set\_rasterized

`Axis.set_rasterized(self, rasterized)`

Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

#### Parameters

**rasterized** [bool or None]

### matplotlib.axis.Axis.set\_sketch\_params

`Axis.set_sketch_params(self, scale=None, length=None, randomness=None)`

Sets the sketch parameters.

#### Parameters

**scale** [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

**length** [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

**randomness** [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

### matplotlib.axis.Axis.set\_snap

`Axis.set_snap(self, snap)`

Set the snapping behavior.

Snapping aligns positions with the pixel grid, which results in clearer images. For example, if a black line of 1px width was defined at a position in between two pixels, the resulting image would contain the interpolated value of that line in the pixel grid, which would be a grey value on both adjacent pixel positions. In contrast, snapping will move the line to the nearest integer pixel value, so that the resulting image will really contain a 1px wide black line.

Snapping is currently only supported by the Agg and MacOSX backends.

**Parameters**

**snap** [bool or None] Possible values:

- *True*: Snap vertices to the nearest pixel center.
- *False*: Do not modify vertex positions.
- *None*: (auto) If the path contains only rectilinear line segments, round to the nearest pixel center.

**matplotlib.axis.Axis.set\_transform**

`Axis.set_transform(self, t)`  
Set the artist transform.

**Parameters**

**t** [*Transform*]

**matplotlib.axis.Axis.set\_url**

`Axis.set_url(self, url)`  
Set the url for the artist.

**Parameters**

**url** [str]

**matplotlib.axis.Axis.set\_visible**

`Axis.set_visible(self, b)`  
Set the artist's visibility.

**Parameters**

**b** [bool]

**matplotlib.axis.Axis.set\_zorder**

`Axis.set_zorder(self, level)`  
Set the zorder for the artist. Artists with lower zorder values are drawn first.

**Parameters**

**level** [float]

**matplotlib.axis.Axis.stale**

`Axis.stale`  
Whether the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

### matplotlib.axis.Axis.update

`Axis.update(self, props)`  
Update this artist's properties from the dictionary *props*.

### matplotlib.axis.Axis.update\_from

`Axis.update_from(self, other)`  
Copy properties from *other* to *self*.

### matplotlib.axis.Axis.zorder

`Axis.zorder = 0`

### matplotlib.axis.XAxis.add\_callback

`XAxis.add_callback(self, func)`  
Add a callback function that will be called whenever one of the *Artist's* properties changes.

#### Parameters

**func** [callable] The callback function. It must have the signature:

```
def func(artist: Artist) -> Any
```

where *artist* is the calling *Artist*. Return values may exist but are ignored.

#### Returns

**oid** [int] The observer id associated with the callback. This id can be used for removing the callback with *remove\_callback* later.

#### See also:

*remove\_callback*

### matplotlib.axis.XAxis.axes

`XAxis.axes`  
The *Axes* instance the artist resides in, or *None*.

### matplotlib.axis.XAxis.contains

`XAxis.contains(self, mouseevent)`  
Test whether the mouse event occurred in the x axis.

**matplotlib.axis.XAxis.convert\_xunits**`XAxis.convert_xunits(self, x)`Convert *x* using the unit type of the xaxis.

If the artist is not in contained in an Axes or if the xaxis does not have units, *x* itself is returned.

**matplotlib.axis.XAxis.convert\_yunits**`XAxis.convert_yunits(self, y)`Convert *y* using the unit type of the yaxis.

If the artist is not in contained in an Axes or if the yaxis does not have units, *y* itself is returned.

**matplotlib.axis.XAxis.draw**`XAxis.draw(self, renderer, *args, **kwargs)`

Draw the axis lines, grid lines, tick lines and labels

**matplotlib.axis.XAxis.findobj**`XAxis.findobj(self, match=None, include_self=True)`

Find artist objects.

Recursively find all *Artist* instances contained in the artist.

**Parameters**

**match** A filter criterion for the matches. This can be

- *None*: Return all objects contained in artist.
- A function with signature `def match(artist: Artist) -> bool`. The result will only contain artists for which the function returns *True*.
- A class instance: e.g., *Line2D*. The result will only contain artists of this class or its subclasses (*isinstance* check).

**include\_self** [bool] Include *self* in the list to be checked for a match.

**Returns**

**artists** [list of *Artist*]

**matplotlib.axis.XAxis.format\_cursor\_data**`XAxis.format_cursor_data(self, data)`Return a string representation of *data*.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

The default implementation converts ints and floats and arrays of ints and floats into a comma-separated string enclosed in square brackets.

**See also:**

`get_cursor_data`

**matplotlib.axis.XAxis.get\_agg\_filter**

`XAxis.get_agg_filter(self)`

Return filter function to be used for agg filter.

**matplotlib.axis.XAxis.get\_alpha**

`XAxis.get_alpha(self)`

Return the alpha value used for blending - not supported on all backends

**matplotlib.axis.XAxis.get\_animated**

`XAxis.get_animated(self)`

Return the animated state.

**matplotlib.axis.XAxis.get\_children**

`XAxis.get_children(self)`

Return a list of the child *Artists* of this *Artist*.

**matplotlib.axis.XAxis.get\_clip\_box**

`XAxis.get_clip_box(self)`

Return the clipbox.

**matplotlib.axis.XAxis.get\_clip\_on**

`XAxis.get_clip_on(self)`

Return whether the artist uses clipping.

**matplotlib.axis.XAxis.get\_clip\_path**

`XAxis.get_clip_path(self)`

Return the clip path.

**matplotlib.axis.XAxis.get\_contains**`XAxis.get_contains(self)`Return the custom contains function of the artist if set, or *None*.**See also:**`set_contains`**matplotlib.axis.XAxis.get\_cursor\_data**`XAxis.get_cursor_data(self, event)`

Return the cursor data for a given event.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

Cursor data can be used by Artists to provide additional context information for a given event. The default implementation just returns *None*.

Subclasses can override the method and return arbitrary data. However, when doing so, they must ensure that `format_cursor_data` can convert the data to a string representation.

The only current use case is displaying the z-value of an *AxesImage* in the status bar of a plot window, while moving the mouse.

**Parameters**

**event** [`matplotlib.backend_bases.MouseEvent`]

**See also:**`format_cursor_data`**matplotlib.axis.XAxis.get\_figure**`XAxis.get_figure(self)`Return the *Figure* instance the artist belongs to.**matplotlib.axis.XAxis.get\_gid**`XAxis.get_gid(self)`

Return the group id.

**matplotlib.axis.XAxis.get\_label**`XAxis.get_label(self)`

Return the axis label as a Text instance

### matplotlib.axis.XAxis.get\_path\_effects

XAxis.get\_path\_effects(*self*)

### matplotlib.axis.XAxis.get\_picker

XAxis.get\_picker(*self*)

Return the picking behavior of the artist.

The possible values are described in *set\_picker*.

#### See also:

*set\_picker*, *pickable*, *pick*

### matplotlib.axis.XAxis.get\_rasterized

XAxis.get\_rasterized(*self*)

Return whether the artist is to be rasterized.

### matplotlib.axis.XAxis.get\_sketch\_params

XAxis.get\_sketch\_params(*self*)

Returns the sketch parameters for the artist.

#### Returns

**sketch\_params** [tuple or None] A 3-tuple with the following elements:

- *scale*: The amplitude of the wiggle perpendicular to the source line.
- *length*: The length of the wiggle along the line.
- *randomness*: The scale factor by which the length is shrunken or expanded.

Returns *None* if no sketch parameters were set.

### matplotlib.axis.XAxis.get\_snap

XAxis.get\_snap(*self*)

Returns the snap setting.

See *set\_snap* for details.

### matplotlib.axis.XAxis.get\_transform

XAxis.get\_transform(*self*)

Return the *Transform* instance used by this artist.

**matplotlib.axis.XAxis.get\_transformed\_clip\_path\_and\_affine**

`XAxis.get_transformed_clip_path_and_affine(self)`

Return the clip path with the non-affine part of its transformation applied, and the remaining affine part of its transformation.

**matplotlib.axis.XAxis.get\_url**

`XAxis.get_url(self)`

Return the url.

**matplotlib.axis.XAxis.get\_visible**

`XAxis.get_visible(self)`

Return the visibility.

**matplotlib.axis.XAxis.get\_window\_extent**

`XAxis.get_window_extent(self, renderer)`

Get the axes bounding box in display space.

The bounding box' width and height are nonnegative.

Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

**matplotlib.axis.XAxis.get\_zorder**

`XAxis.get_zorder(self)`

Return the artist's zorder.

**matplotlib.axis.XAxis.have\_units**

`XAxis.have_units(self)`

Return *True* if units are set on the x or y axes.

**matplotlib.axis.XAxis.is\_transform\_set**

`XAxis.is_transform_set(self)`

Return whether the Artist has an explicitly set transform.

This is *True* after *set\_transform* has been called.

### matplotlib.axis.XAxis.mouseover

`XAxis.mouseover`

### matplotlib.axis.XAxis.pchanged

`XAxis.pchanged(self)`

Call all of the registered callbacks.

This function is triggered internally when a property is changed.

**See also:**

`add_callback`

`remove_callback`

### matplotlib.axis.XAxis.pick

`XAxis.pick(self, mouseevent)`

Process a pick event.

Each child artist will fire a pick event if *mouseevent* is over the artist and the artist has picker set.

**See also:**

`set_picker`, `get_picker`, `pickable`

### matplotlib.axis.XAxis.pickable

`XAxis.pickable(self)`

Return whether the artist is pickable.

**See also:**

`set_picker`, `get_picker`, `pick`

### matplotlib.axis.XAxis.properties

`XAxis.properties(self)`

Return a dictionary of all the properties of the artist.

### matplotlib.axis.XAxis.remove

`XAxis.remove(self)`

Remove the artist from the figure if possible.

The effect will not be visible until the figure is redrawn, e.g., with *FigureCanvasBase.draw\_idle*. Call *relim* to update the axes limits if desired.

Note: *relim* will not see collections even if the collection was added to the axes with *autolim = True*.

Note: there is no support for removing the artist's legend entry.

#### `matplotlib.axis.XAxis.remove_callback`

`XAxis.remove_callback(self, oid)`

Remove a callback based on its observer id.

**See also:**

`add_callback`

#### `matplotlib.axis.XAxis.set`

`XAxis.set(self, **kwargs)`

A property batch setter. Pass *kwargs* to set properties.

#### `matplotlib.axis.XAxis.set_agg_filter`

`XAxis.set_agg_filter(self, filter_func)`

Set the agg filter.

**Parameters**

**filter\_func** [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

#### `matplotlib.axis.XAxis.set_alpha`

`XAxis.set_alpha(self, alpha)`

Set the alpha value used for blending - not supported on all backends.

**Parameters**

**alpha** [float]

#### `matplotlib.axis.XAxis.set_animated`

`XAxis.set_animated(self, b)`

Set the artist's animation state.

**Parameters**

**b** [bool]

**matplotlib.axis.XAxis.set\_clip\_box**

`XAxis.set_clip_box(self, clipbox)`  
Set the artist's clip *Bbox*.

**Parameters**

**clipbox** [*Bbox*]

**matplotlib.axis.XAxis.set\_clip\_on**

`XAxis.set_clip_on(self, b)`  
Set whether the artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

**Parameters**

**b** [bool]

**matplotlib.axis.XAxis.set\_clip\_path**

`XAxis.set_clip_path(self, clippath, transform=None)`  
Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- None, to remove a previously set clipping path.

For efficiency, if the path happens to be an axis-aligned rectangle, this method will set the clipping box to the corresponding rectangle and set the clipping path to None.

ACCEPTS: [(*Path*, *Transform*) | *Patch* | None]

**matplotlib.axis.XAxis.set\_contains**

`XAxis.set_contains(self, picker)`  
Define a custom contains test for the artist.

The provided callable replaces the default *contains* method of the artist.

**Parameters**

**picker** [callable] A custom picker function to evaluate if an event is within the artist. The function must have the signature:

```
def contains(artist: Artist, event: MouseEvent) -> bool, dict
```

that returns:

- a bool indicating if the event is within the artist

- a dict of additional information. The dict should at least return the same information as the default `contains()` implementation of the respective artist, but may provide additional information.

#### `matplotlib.axis.XAxis.set_figure`

`XAxis.set_figure(self, fig)`

Set the *Figure* instance the artist belongs to.

##### Parameters

**fig** [*Figure*]

#### `matplotlib.axis.XAxis.set_gid`

`XAxis.set_gid(self, gid)`

Set the (group) id for the artist.

##### Parameters

**gid** [str]

#### `matplotlib.axis.XAxis.set_label`

`XAxis.set_label(self, s)`

Set a label that will be displayed in the legend.

##### Parameters

**s** [object] *s* will be converted to a string by calling `str`.

#### `matplotlib.axis.XAxis.set_path_effects`

`XAxis.set_path_effects(self, path_effects)`

Set the path effects.

##### Parameters

**path\_effects** [*AbstractPathEffect*]

#### `matplotlib.axis.XAxis.set_picker`

`XAxis.set_picker(self, picker)`

Define the picking behavior of the artist.

##### Parameters

**picker** [None or bool or float or callable] This can be one of the following:

- *None*: Picking is disabled for this artist (default).
- A boolean: If *True* then picking will be enabled and the artist will fire a pick event if the mouse event is over the artist.

- A float: If picker is a number it is interpreted as an epsilon tolerance in points and the artist will fire off an event if it's data is within epsilon of the mouse event. For some artists like lines and patch collections, the artist may provide additional data to the pick event that is generated, e.g., the indices of the data within epsilon of the pick event
- A function: If picker is callable, it is a user supplied function which determines whether the artist is hit by the mouse event:

```
hit, props = picker(artist, mouseevent)
```

to determine the hit test. if the mouse event is over the artist, return *hit=True* and props is a dictionary of properties you want added to the PickEvent attributes.

### matplotlib.axis.XAxis.set\_rasterized

`XAxis.set_rasterized(self, rasterized)`

Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

#### Parameters

**rasterized** [bool or None]

### matplotlib.axis.XAxis.set\_sketch\_params

`XAxis.set_sketch_params(self, scale=None, length=None, randomness=None)`

Sets the sketch parameters.

#### Parameters

**scale** [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

**length** [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

**randomness** [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

### matplotlib.axis.XAxis.set\_snap

`XAxis.set_snap(self, snap)`

Set the snapping behavior.

Snapping aligns positions with the pixel grid, which results in clearer images. For example, if a black line of 1px width was defined at a position in between two pixels, the resulting image would contain the interpolated value of that line in the pixel grid, which would be a grey value on both adjacent pixel positions. In contrast, snapping will move the line to the nearest integer pixel value, so that the resulting image will really contain a 1px wide black line.

Snapping is currently only supported by the Agg and MacOSX backends.

**Parameters**

**snap** [bool or None] Possible values:

- *True*: Snap vertices to the nearest pixel center.
- *False*: Do not modify vertex positions.
- *None*: (auto) If the path contains only rectilinear line segments, round to the nearest pixel center.

**matplotlib.axis.XAxis.set\_transform**

`XAxis.set_transform(self, t)`  
Set the artist transform.

**Parameters**

**t** [*Transform*]

**matplotlib.axis.XAxis.set\_url**

`XAxis.set_url(self, url)`  
Set the url for the artist.

**Parameters**

**url** [str]

**matplotlib.axis.XAxis.set\_visible**

`XAxis.set_visible(self, b)`  
Set the artist's visibility.

**Parameters**

**b** [bool]

**matplotlib.axis.XAxis.set\_zorder**

`XAxis.set_zorder(self, level)`  
Set the zorder for the artist. Artists with lower zorder values are drawn first.

**Parameters**

**level** [float]

**matplotlib.axis.XAxis.stale**

`XAxis.stale`  
Whether the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

### matplotlib.axis.XAxis.update

`XAxis.update(self, props)`  
Update this artist's properties from the dictionary *props*.

### matplotlib.axis.XAxis.update\_from

`XAxis.update_from(self, other)`  
Copy properties from *other* to *self*.

### matplotlib.axis.XAxis.zorder

`XAxis.zorder = 0`

### matplotlib.axis.YAxis.add\_callback

`YAxis.add_callback(self, func)`  
Add a callback function that will be called whenever one of the *Artist's* properties changes.

#### Parameters

**func** [callable] The callback function. It must have the signature:

```
def func(artist: Artist) -> Any
```

where *artist* is the calling *Artist*. Return values may exist but are ignored.

#### Returns

**oid** [int] The observer id associated with the callback. This id can be used for removing the callback with *remove\_callback* later.

#### See also:

*remove\_callback*

### matplotlib.axis.YAxis.axes

`YAxis.axes`  
The *Axes* instance the artist resides in, or *None*.

### matplotlib.axis.YAxis.contains

`YAxis.contains(self, mouseevent)`  
Test whether the mouse event occurred in the y axis.  
Returns *True* | *False*

**matplotlib.axis.YAxis.convert\_xunits**

`YAxis.convert_xunits(self, x)`

Convert *x* using the unit type of the xaxis.

If the artist is not in contained in an Axes or if the xaxis does not have units, *x* itself is returned.

**matplotlib.axis.YAxis.convert\_yunits**

`YAxis.convert_yunits(self, y)`

Convert *y* using the unit type of the yaxis.

If the artist is not in contained in an Axes or if the yaxis does not have units, *y* itself is returned.

**matplotlib.axis.YAxis.draw**

`YAxis.draw(self, renderer, *args, **kwargs)`

Draw the axis lines, grid lines, tick lines and labels

**matplotlib.axis.YAxis.findobj**

`YAxis.findobj(self, match=None, include_self=True)`

Find artist objects.

Recursively find all *Artist* instances contained in the artist.

**Parameters**

**match** A filter criterion for the matches. This can be

- *None*: Return all objects contained in artist.
- A function with signature `def match(artist: Artist) -> bool`. The result will only contain artists for which the function returns *True*.
- A class instance: e.g., *Line2D*. The result will only contain artists of this class or its subclasses (*isinstance* check).

**include\_self** [bool] Include *self* in the list to be checked for a match.

**Returns**

**artists** [list of *Artist*]

**matplotlib.axis.YAxis.format\_cursor\_data**

`YAxis.format_cursor_data(self, data)`

Return a string representation of *data*.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

The default implementation converts ints and floats and arrays of ints and floats into a comma-separated string enclosed in square brackets.

**See also:**

`get_cursor_data`

**matplotlib.axis.YAxis.get\_agg\_filter**

`YAxis.get_agg_filter(self)`

Return filter function to be used for agg filter.

**matplotlib.axis.YAxis.get\_alpha**

`YAxis.get_alpha(self)`

Return the alpha value used for blending - not supported on all backends

**matplotlib.axis.YAxis.get\_animated**

`YAxis.get_animated(self)`

Return the animated state.

**matplotlib.axis.YAxis.get\_children**

`YAxis.get_children(self)`

Return a list of the child *Artists* of this *Artist*.

**matplotlib.axis.YAxis.get\_clip\_box**

`YAxis.get_clip_box(self)`

Return the clipbox.

**matplotlib.axis.YAxis.get\_clip\_on**

`YAxis.get_clip_on(self)`

Return whether the artist uses clipping.

**matplotlib.axis.YAxis.get\_clip\_path**

`YAxis.get_clip_path(self)`

Return the clip path.

**matplotlib.axis.YAxis.get\_contains**`YAxis.get_contains(self)`Return the custom contains function of the artist if set, or *None*.**See also:**`set_contains`**matplotlib.axis.YAxis.get\_cursor\_data**`YAxis.get_cursor_data(self, event)`

Return the cursor data for a given event.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

Cursor data can be used by Artists to provide additional context information for a given event. The default implementation just returns *None*.

Subclasses can override the method and return arbitrary data. However, when doing so, they must ensure that `format_cursor_data` can convert the data to a string representation.

The only current use case is displaying the z-value of an *AxesImage* in the status bar of a plot window, while moving the mouse.

**Parameters**

**event** [`matplotlib.backend_bases.MouseEvent`]

**See also:**`format_cursor_data`**matplotlib.axis.YAxis.get\_figure**`YAxis.get_figure(self)`Return the *Figure* instance the artist belongs to.**matplotlib.axis.YAxis.get\_gid**`YAxis.get_gid(self)`

Return the group id.

**matplotlib.axis.YAxis.get\_label**`YAxis.get_label(self)`

Return the axis label as a Text instance

#### matplotlib.axis.YAxis.get\_path\_effects

YAxis.get\_path\_effects(*self*)

#### matplotlib.axis.YAxis.get\_picker

YAxis.get\_picker(*self*)

Return the picking behavior of the artist.

The possible values are described in *set\_picker*.

**See also:**

*set\_picker*, *pickable*, *pick*

#### matplotlib.axis.YAxis.get\_rasterized

YAxis.get\_rasterized(*self*)

Return whether the artist is to be rasterized.

#### matplotlib.axis.YAxis.get\_sketch\_params

YAxis.get\_sketch\_params(*self*)

Returns the sketch parameters for the artist.

**Returns**

**sketch\_params** [tuple or None] A 3-tuple with the following elements:

- *scale*: The amplitude of the wiggle perpendicular to the source line.
- *length*: The length of the wiggle along the line.
- *randomness*: The scale factor by which the length is shrunken or expanded.

Returns *None* if no sketch parameters were set.

#### matplotlib.axis.YAxis.get\_snap

YAxis.get\_snap(*self*)

Returns the snap setting.

See *set\_snap* for details.

#### matplotlib.axis.YAxis.get\_transform

YAxis.get\_transform(*self*)

Return the *Transform* instance used by this artist.

**matplotlib.axis.YAxis.get\_transformed\_clip\_path\_and\_affine**

`YAxis.get_transformed_clip_path_and_affine(self)`

Return the clip path with the non-affine part of its transformation applied, and the remaining affine part of its transformation.

**matplotlib.axis.YAxis.get\_url**

`YAxis.get_url(self)`

Return the url.

**matplotlib.axis.YAxis.get\_visible**

`YAxis.get_visible(self)`

Return the visibility.

**matplotlib.axis.YAxis.get\_window\_extent**

`YAxis.get_window_extent(self, renderer)`

Get the axes bounding box in display space.

The bounding box' width and height are nonnegative.

Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

**matplotlib.axis.YAxis.get\_zorder**

`YAxis.get_zorder(self)`

Return the artist's zorder.

**matplotlib.axis.YAxis.have\_units**

`YAxis.have_units(self)`

Return *True* if units are set on the x or y axes.

**matplotlib.axis.YAxis.is\_transform\_set**

`YAxis.is_transform_set(self)`

Return whether the Artist has an explicitly set transform.

This is *True* after *set\_transform* has been called.

### matplotlib.axis.YAxis.mouseover

`YAxis.mouseover`

### matplotlib.axis.YAxis.pchanged

`YAxis.pchanged(self)`

Call all of the registered callbacks.

This function is triggered internally when a property is changed.

**See also:**

`add_callback`

`remove_callback`

### matplotlib.axis.YAxis.pick

`YAxis.pick(self, mouseevent)`

Process a pick event.

Each child artist will fire a pick event if *mouseevent* is over the artist and the artist has picker set.

**See also:**

`set_picker`, `get_picker`, `pickable`

### matplotlib.axis.YAxis.pickable

`YAxis.pickable(self)`

Return whether the artist is pickable.

**See also:**

`set_picker`, `get_picker`, `pick`

### matplotlib.axis.YAxis.properties

`YAxis.properties(self)`

Return a dictionary of all the properties of the artist.

### matplotlib.axis.YAxis.remove

`YAxis.remove(self)`

Remove the artist from the figure if possible.

The effect will not be visible until the figure is redrawn, e.g., with *FigureCanvasBase.draw\_idle*. Call *relim* to update the axes limits if desired.

Note: *relim* will not see collections even if the collection was added to the axes with *autolim = True*.

Note: there is no support for removing the artist's legend entry.

#### matplotlib.axis.YAxis.remove\_callback

`YAxis.remove_callback(self, oid)`

Remove a callback based on its observer id.

#### See also:

`add_callback`

#### matplotlib.axis.YAxis.set

`YAxis.set(self, **kwargs)`

A property batch setter. Pass *kwargs* to set properties.

#### matplotlib.axis.YAxis.set\_agg\_filter

`YAxis.set_agg_filter(self, filter_func)`

Set the agg filter.

#### Parameters

**filter\_func** [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

#### matplotlib.axis.YAxis.set\_alpha

`YAxis.set_alpha(self, alpha)`

Set the alpha value used for blending - not supported on all backends.

#### Parameters

**alpha** [float]

#### matplotlib.axis.YAxis.set\_animated

`YAxis.set_animated(self, b)`

Set the artist's animation state.

#### Parameters

**b** [bool]

**matplotlib.axis.YAxis.set\_clip\_box**

`YAxis.set_clip_box(self, clipbox)`  
Set the artist's clip *Bbox*.

**Parameters**

**clipbox** [*Bbox*]

**matplotlib.axis.YAxis.set\_clip\_on**

`YAxis.set_clip_on(self, b)`  
Set whether the artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

**Parameters**

**b** [bool]

**matplotlib.axis.YAxis.set\_clip\_path**

`YAxis.set_clip_path(self, clippath, transform=None)`  
Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- None, to remove a previously set clipping path.

For efficiency, if the path happens to be an axis-aligned rectangle, this method will set the clipping box to the corresponding rectangle and set the clipping path to None.

ACCEPTS: [(*Path*, *Transform*) | *Patch* | None]

**matplotlib.axis.YAxis.set\_contains**

`YAxis.set_contains(self, picker)`  
Define a custom contains test for the artist.

The provided callable replaces the default *contains* method of the artist.

**Parameters**

**picker** [callable] A custom picker function to evaluate if an event is within the artist. The function must have the signature:

```
def contains(artist: Artist, event: MouseEvent) -> bool, dict
```

that returns:

- a bool indicating if the event is within the artist

- a dict of additional information. The dict should at least return the same information as the default `contains()` implementation of the respective artist, but may provide additional information.

#### matplotlib.axis.YAxis.set\_figure

`YAxis.set_figure(self, fig)`

Set the *Figure* instance the artist belongs to.

##### Parameters

**fig** [*Figure*]

#### matplotlib.axis.YAxis.set\_gid

`YAxis.set_gid(self, gid)`

Set the (group) id for the artist.

##### Parameters

**gid** [str]

#### matplotlib.axis.YAxis.set\_label

`YAxis.set_label(self, s)`

Set a label that will be displayed in the legend.

##### Parameters

**s** [object] *s* will be converted to a string by calling `str`.

#### matplotlib.axis.YAxis.set\_path\_effects

`YAxis.set_path_effects(self, path_effects)`

Set the path effects.

##### Parameters

**path\_effects** [*AbstractPathEffect*]

#### matplotlib.axis.YAxis.set\_picker

`YAxis.set_picker(self, picker)`

Define the picking behavior of the artist.

##### Parameters

**picker** [None or bool or float or callable] This can be one of the following:

- *None*: Picking is disabled for this artist (default).
- A boolean: If *True* then picking will be enabled and the artist will fire a pick event if the mouse event is over the artist.

- A float: If picker is a number it is interpreted as an epsilon tolerance in points and the artist will fire off an event if it's data is within epsilon of the mouse event. For some artists like lines and patch collections, the artist may provide additional data to the pick event that is generated, e.g., the indices of the data within epsilon of the pick event
- A function: If picker is callable, it is a user supplied function which determines whether the artist is hit by the mouse event:

```
hit, props = picker(artist, mouseevent)
```

to determine the hit test. if the mouse event is over the artist, return *hit=True* and props is a dictionary of properties you want added to the PickEvent attributes.

### matplotlib.axis.YAxis.set\_rasterized

`YAxis.set_rasterized(self, rasterized)`

Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

#### Parameters

**rasterized** [bool or None]

### matplotlib.axis.YAxis.set\_sketch\_params

`YAxis.set_sketch_params(self, scale=None, length=None, randomness=None)`

Sets the sketch parameters.

#### Parameters

**scale** [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

**length** [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

**randomness** [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

### matplotlib.axis.YAxis.set\_snap

`YAxis.set_snap(self, snap)`

Set the snapping behavior.

Snapping aligns positions with the pixel grid, which results in clearer images. For example, if a black line of 1px width was defined at a position in between two pixels, the resulting image would contain the interpolated value of that line in the pixel grid, which would be a grey value on both adjacent pixel positions. In contrast, snapping will move the line to the nearest integer pixel value, so that the resulting image will really contain a 1px wide black line.

Snapping is currently only supported by the Agg and MacOSX backends.

**Parameters**

**snap** [bool or None] Possible values:

- *True*: Snap vertices to the nearest pixel center.
- *False*: Do not modify vertex positions.
- *None*: (auto) If the path contains only rectilinear line segments, round to the nearest pixel center.

**matplotlib.axis.YAxis.set\_transform**

`YAxis.set_transform(self, t)`  
Set the artist transform.

**Parameters**

**t** [*Transform*]

**matplotlib.axis.YAxis.set\_url**

`YAxis.set_url(self, url)`  
Set the url for the artist.

**Parameters**

**url** [str]

**matplotlib.axis.YAxis.set\_visible**

`YAxis.set_visible(self, b)`  
Set the artist's visibility.

**Parameters**

**b** [bool]

**matplotlib.axis.YAxis.set\_zorder**

`YAxis.set_zorder(self, level)`  
Set the zorder for the artist. Artists with lower zorder values are drawn first.

**Parameters**

**level** [float]

**matplotlib.axis.YAxis.stale**

`YAxis.stale`  
Whether the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

**matplotlib.axis.YAxis.update**`YAxis.update(self, props)`Update this artist's properties from the dictionary *props*.**matplotlib.axis.YAxis.update\_from**`YAxis.update_from(self, other)`Copy properties from *other* to *self*.**matplotlib.axis.YAxis.zorder**`YAxis.zorder = 0`

## 17.7 matplotlib.backend\_bases

Abstract base classes define the primitives that renderers and graphics contexts must implement to serve as a matplotlib backend

*RendererBase* An abstract base class to handle drawing/rendering operations.

*FigureCanvasBase* The abstraction layer that separates the *matplotlib.figure.Figure* from the backend specific details like a user interface drawing area

*GraphicsContextBase* An abstract base class that provides color, line styles, etc...

*Event* The base class for all of the matplotlib event handling. Derived classes such as *KeyEvent* and *MouseEvent* store the meta data like keys and buttons pressed, x and y locations in pixel and *Axes* coordinates.

*ShowBase* The base class for the Show class of each interactive backend; the 'show' callable is then set to `Show.__call__`, inherited from *ShowBase*.

*ToolContainerBase* The base class for the Toolbar class of each interactive backend.

*StatusbarBase* The base class for the messaging area.

```
class matplotlib.backend_bases.CloseEvent(name, canvas, guiEvent=None)
```

Bases: *matplotlib.backend\_bases.Event*

An event triggered by a figure being closed.

```
class matplotlib.backend_bases.DrawEvent(name, canvas, renderer)
```

Bases: *matplotlib.backend\_bases.Event*

An event triggered by a draw operation on the canvas

In most backends callbacks subscribed to this callback will be fired after the rendering is complete but before the screen is updated. Any extra artists drawn to the canvas's renderer will be reflected without an explicit call to `blit`.

**Warning:** Calling `canvas.draw` and `canvas.blit` in these callbacks may not be safe with all backends and may cause infinite recursion.

In addition to the *Event* attributes, the following event attributes are defined:

### Attributes

**renderer** [*RendererBase*] the renderer for the draw event

```
class matplotlib.backend_bases.Event(name, canvas, guiEvent=None)
```

Bases: `object`

A matplotlib event. Attach additional attributes as defined in *FigureCanvasBase.mpl\_connect()*. The following attributes are defined and shown with their default values

### Attributes

**name** [str] the event name

**canvas** [*FigureCanvasBase*] the backend-specific canvas instance generating the event

**guiEvent** the GUI event that triggered the matplotlib event

```
class matplotlib.backend_bases.FigureCanvasBase(figure)
```

Bases: `object`

The canvas the figure renders into.

Public attributes

### Attributes

**figure** [*matplotlib.figure.Figure*] A high-level figure instance

```
blit(self, bbox=None)
```

Blit the canvas in *bbox* (default entire canvas).

```
button_press_event(self, x, y, button, dblclick=False, guiEvent=None)
```

Backend derived classes should call this function on any mouse button press. *x,y* are the canvas coords: 0,0 is lower, left. *button* and *key* are as defined in *MouseEvent*.

This method will call all functions connected to the 'button\_press\_event' with a *MouseEvent* instance.

```
button_release_event(self, x, y, button, guiEvent=None)
```

Backend derived classes should call this function on any mouse button release.

This method will call all functions connected to the 'button\_release\_event' with a *MouseEvent* instance.

### Parameters

**x** [scalar] the canvas coordinates where 0=left

**y** [scalar] the canvas coordinates where 0=bottom

**guiEvent** the native UI event that generated the mpl event

```
close_event(self, guiEvent=None)
```

Pass a *CloseEvent* to all functions connected to `close_event`.

```
draw(self, *args, **kwargs)
```

Render the *Figure*.

```
draw_cursor(self, event)
```

Draw a cursor in the event.axes if *inaxes* is not None. Use native GUI drawing for efficiency if possible

`draw_event(self, renderer)`

Pass a *DrawEvent* to all functions connected to `draw_event`.

`draw_idle(self, *args, **kwargs)`

Request a widget redraw once control returns to the GUI event loop.

Even if multiple calls to *draw\_idle* occur before control returns to the GUI event loop, the figure will only be rendered once.

### Notes

Backends may choose to override the method and implement their own strategy to prevent multiple renderings.

`enter_notify_event(self, guiEvent=None, xy=None)`

Backend derived classes should call this function when entering canvas

### Parameters

**guiEvent** the native UI event that generated the mpl event

**xy** [(float, float)] the coordinate location of the pointer when the canvas is entered

```
events = ['resize_event', 'draw_event', 'key_press_event', 'key_release_event', 'button_press_event'
```

```
filetypes = {'eps': 'Encapsulated Postscript', 'jpeg': 'Joint Photographic Experts Group', 'jpg':
```

```
fixed_dpi = None
```

`flush_events(self)`

Flush the GUI events for the figure.

Interactive backends need to reimplement this method.

`get_default_filename(self)`

Return a string, which includes extension, suitable for use as a default filename.

`classmethod get_default_filetype()`

Get the default savefig file format as specified in rcParam `savefig.format`. Returned string excludes period. Overridden in backends that only support a single file type.

`classmethod get_supported_filetypes()`

Return dict of savefig file formats supported by this backend

`classmethod get_supported_filetypes_grouped()`

Return a dict of savefig file formats supported by this backend, where the keys are a file type name, such as 'Joint Photographic Experts Group', and the values are a list of filename extensions used for that filetype, such as ['jpg', 'jpeg'].

`get_width_height(self)`

Return the figure width and height in points or pixels (depending on the backend), truncated to integers

`get_window_title(self)`

Get the title text of the window containing the figure. Return None if there is no window (e.g., a PS backend).

`grab_mouse(self, ax)`

Set the child axes which are currently grabbing the mouse events. Usually called by the widgets themselves. It is an error to call this if the mouse is already grabbed by another axes.

`inaxes(self, xy)`

Check if a point is in an axes.

#### Parameters

**xy** [tuple or list] (x,y) coordinates. x position - pixels from left of canvas.  
y position - pixels from bottom of canvas.

#### Returns

**axes: topmost axes containing the point, or None if no axes.**

`is_saving(self)`

Returns whether the renderer is in the process of saving to a file, rather than rendering for an on-screen buffer.

`key_press_event(self, key, guiEvent=None)`

Pass a *KeyEvent* to all functions connected to `key_press_event`.

`key_release_event(self, key, guiEvent=None)`

Pass a *KeyEvent* to all functions connected to `key_release_event`.

`leave_notify_event(self, guiEvent=None)`

Backend derived classes should call this function when leaving canvas

#### Parameters

**guiEvent** the native UI event that generated the mpl event

`motion_notify_event(self, x, y, guiEvent=None)`

Backend derived classes should call this function on any motion-notify-event.

This method will call all functions connected to the 'motion\_notify\_event' with a *MouseEvent* instance.

#### Parameters

**x** [scalar] the canvas coordinates where 0=left

**y** [scalar] the canvas coordinates where 0=bottom

**guiEvent** the native UI event that generated the mpl event

`mpl_connect(self, s, func)`

Connect event with string *s* to *func*. The signature of *func* is:

```
def func(event)
```

where event is a *matplotlib.backend\_bases.Event*. The following events are recognized

- 'button\_press\_event'
- 'button\_release\_event'
- 'draw\_event'
- 'key\_press\_event'
- 'key\_release\_event'
- 'motion\_notify\_event'
- 'pick\_event'
- 'resize\_event'

- 'scroll\_event'
- 'figure\_enter\_event',
- 'figure\_leave\_event',
- 'axes\_enter\_event',
- 'axes\_leave\_event'
- 'close\_event'

For the location events (button and key press/release), if the mouse is over the axes, the variable `event.inaxes` will be set to the *Axes* the event occurs is over, and additionally, the variables `event.xdata` and `event.ydata` will be defined. This is the mouse location in data coords. See *KeyEvent* and *MouseEvent* for more info.

Return value is a connection id that can be used with `mpl_disconnect()`.

### Examples

Usage:

```
def on_press(event):
    print('you pressed', event.button, event.xdata, event.ydata)

cid = canvas.mpl_connect('button_press_event', on_press)
```

`mpl_disconnect(self, cid)`  
Disconnect callback id `cid`

### Examples

Usage:

```
cid = canvas.mpl_connect('button_press_event', on_press)
#...later
canvas.mpl_disconnect(cid)
```

`new_timer(self, *args, **kwargs)`

Creates a new backend-specific subclass of `backend_bases.Timer`. This is useful for getting periodic events through the backend's native event loop. Implemented only for backends with GUIs.

#### Other Parameters

**interval** [scalar] Timer interval in milliseconds

**callbacks** [List[Tuple[callable, Tuple, Dict]]] Sequence of (func, args, kwargs) where `func(*args, **kwargs)` will be executed by the timer every *interval*.

callbacks which return `False` or `0` will be removed from the timer.

## Examples

```
>>> timer = fig.canvas.new_timer(callbacks=[(f1, (1, ), {'a': 3}),])
```

`pick(self, mouseevent)`

`pick_event(self, mouseevent, artist, **kwargs)`

This method will be called by artists who are picked and will fire off `PickEvent` callbacks registered listeners

`print_figure(self, filename, dpi=None, facecolor=None, edgecolor=None, orientation='portrait', format=None, *, bbox_inches=None, **kwargs)`

Render the figure to hardcopy. Set the figure patch face and edge colors. This is useful because some of the GUIs have a gray figure face color background and you'll probably want to override this on hardcopy.

### Parameters

**filename** can also be a file object on image backends

**orientation** [`'landscape'`, `'portrait'`], optional] only currently applies to PostScript printing.

**dpi** [scalar, optional] the dots per inch to save the figure in; if None, use `savefig.dpi`

**facecolor** [color or None, optional] the facecolor of the figure; if None, defaults to `savefig.facecolor`

**edgecolor** [color or None, optional] the edgecolor of the figure; if None, defaults to `savefig.edgecolor`

**format** [str, optional] when set, forcibly set the file format to save to

**bbox\_inches** [str or `Bbox`, optional] Bbox in inches. Only the given portion of the figure is saved. If `'tight'`, try to figure out the tight bbox of the figure. If None, use `savefig.bbox`

**pad\_inches** [scalar, optional] Amount of padding around the figure when `bbox_inches` is `'tight'`. If None, use `savefig.pad_inches`

**bbox\_extra\_artists** [list of `Artist`, optional] A list of extra artists that will be considered when the tight bbox is calculated.

`release_mouse(self, ax)`

Release the mouse grab held by the axes, `ax`. Usually called by the widgets. It is ok to call this even if you `ax` doesn't have the mouse grab currently.

`resize(self, w, h)`

Set the canvas size in pixels.

`resize_event(self)`

Pass a `ResizeEvent` to all functions connected to `resize_event`.

`scroll_event(self, x, y, step, guiEvent=None)`

Backend derived classes should call this function on any scroll wheel event. `x,y` are the canvas coords: 0,0 is lower, left. `button` and `key` are as defined in `MouseEvent`.

This method will call all functions connected to the `'scroll_event'` with a `MouseEvent` instance.

`set_window_title(self, title)`

Set the title text of the window containing the figure. Note that this has no effect if there is no window (e.g., a PS backend).

`start_event_loop(self, timeout=0)`

Start a blocking event loop.

Such an event loop is used by interactive functions, such as `ginput` and `waitforbuttonpress`, to wait for events.

The event loop blocks until a callback function triggers `stop_event_loop`, or `timeout` is reached.

If `timeout` is negative, never timeout.

Only interactive backends need to reimplement this method and it relies on `flush_events` being properly implemented.

Interactive backends should implement this in a more native way.

`stop_event_loop(self)`

Stop the current blocking event loop.

Interactive backends need to reimplement this to match `start_event_loop`

`supports_blit = True`

`switch_backends(self, FigureCanvasClass)`

Instantiate an instance of `FigureCanvasClass`

This is used for backend switching, e.g., to instantiate a `FigureCanvasPS` from a `FigureCanvasGTK`. Note, deep copying is not done, so any changes to one of the instances (e.g., setting figure size or line props), will be reflected in the other

`class matplotlib.backend_bases.FigureManagerBase(canvas, num)`

Bases: `object`

Helper class for pyplot mode, wraps everything up into a neat bundle

### Attributes

**canvas** [`FigureCanvasBase`] The backend-specific canvas instance

**num** [int or str] The figure number

**key\_press\_handler\_id** [int] The default key handler cid, when using the toolmanager. To disable the default key press handling use:

```
figure.canvas.mpl_disconnect(
    figure.canvas.manager.key_press_handler_id)
```

**button\_press\_handler\_id** [int] The default mouse button handler cid, when using the toolmanager. To disable the default button press handling use:

```
figure.canvas.mpl_disconnect(
    figure.canvas.manager.button_press_handler_id)
```

`button_press(self, event)`

The default Matplotlib button actions for extra mouse buttons.

`destroy(self)`

`full_screen_toggle(self)`

```

get_window_title(self)
    Get the title text of the window containing the figure.
    Return None for non-GUI (e.g., PS) backends.

key_press(self, event)
    Implement the default mpl key bindings defined at Navigation Keyboard Shortcuts

resize(self, w, h)
    "For GUI backends, resize the window (in pixels).

set_window_title(self, title)
    Set the title text of the window containing the figure.
    This has no effect for non-GUI (e.g., PS) backends.

show(self)
    For GUI backends, show the figure window and redraw. For non-GUI backends,
    raise an exception to be caught by show(), for an optional warning.

```

class matplotlib.backend\_bases.GraphicsContextBase

Bases: `object`

An abstract base class that provides color, line styles, etc.

```

copy_properties(self, gc)
    Copy properties from gc to self

get_alpha(self)
    Return the alpha value used for blending - not supported on all backends.

get_antialiased(self)
    Return whether the object should try to do antialiased rendering.

get_capstyle(self)
    Return the capstyle as a string in ('butt', 'round', 'projecting').

get_clip_path(self)
    Return the clip path in the form (path, transform), where path is a Path instance,
    and transform is an affine transform to apply to the path before clipping.

get_clip_rectangle(self)
    Return the clip rectangle as a Bbox instance.

get_dashes(self)
    Return the dash information as an offset dashlist tuple.
    The dash list is a even size list that gives the ink on, ink off in pixels.
    See p107 of to PostScript BLUEBOOK for more info.
    Default value is None

get_forced_alpha(self)
    Return whether the value given by get_alpha() should be used to override any other
    alpha-channel values.

get_gid(self)
    Return the object identifier if one is set, None otherwise.

get_hatch(self)
    Get the current hatch style.

get_hatch_color(self)
    Get the hatch color.

```

`get_hatch_linewidth(self)`

Get the hatch linewidth.

`get_hatch_path(self, density=6.0)`

Return a Path for the current hatch.

`get_joinstyle(self)`

Return the line join style as one of ('miter', 'round', 'bevel').

`get_linewidth(self)`

Return the line width in points.

`get_rgb(self)`

Return a tuple of three or four floats from 0-1.

`get_sketch_params(self)`

Return the sketch parameters for the artist.

### Returns

**sketch\_params** [tuple or `None`] A 3-tuple with the following elements:

- `scale`: The amplitude of the wiggle perpendicular to the source line.
- `length`: The length of the wiggle along the line.
- `randomness`: The scale factor by which the length is shrunk or expanded.

May return `None` if no sketch parameters were set.

`get_snap(self)`

Returns the snap setting, which can be:

- `True`: snap vertices to the nearest pixel center
- `False`: leave vertices as-is
- `None`: (auto) If the path contains only rectilinear line segments, round to the nearest pixel center

`get_url(self)`

Return a url if one is set, `None` otherwise.

`restore(self)`

Restore the graphics context from the stack - needed only for backends that save graphics contexts on a stack.

`set_alpha(self, alpha)`

Set the alpha value used for blending - not supported on all backends.

If `alpha=None` (the default), the alpha components of the foreground and fill colors will be used to set their respective transparencies (where applicable); otherwise, `alpha` will override them.

`set_antialiased(self, b)`

Set whether object should be drawn with antialiased rendering.

`set_capstyle(self, cs)`

Set the capstyle to be one of ('butt', 'round', 'projecting').

`set_clip_path(self, path)`

Set the clip path and transformation. Path should be a *TransformedPath* instance.

`set_clip_rectangle(self, rectangle)`

Set the clip rectangle with sequence (left, bottom, width, height)

`set_dashes(self, dash_offset, dash_list)`

Set the dash style for the gc.

#### Parameters

**dash\_offset** [float] is the offset (usually 0).

**dash\_list** [array\_like] specifies the on-off sequence as points. (None, None) specifies a solid line

`set_foreground(self, fg, isRGBA=False)`

Set the foreground color.

#### Parameters

**fg** [color]

**isRGBA** [bool] If *fg* is known to be an (r, g, b, a) tuple, *isRGBA* can be set to True to improve performance.

`set_gid(self, id)`

Set the id.

`set_hatch(self, hatch)`

Set the hatch style (for fills).

`set_hatch_color(self, hatch_color)`

Set the hatch color.

`set_joinstyle(self, js)`

Set the join style to be one of ('miter', 'round', 'bevel').

`set_linewidth(self, w)`

Set the linewidth in points.

`set_sketch_params(self, scale=None, length=None, randomness=None)`

Set the sketch parameters.

#### Parameters

**scale** [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If *scale* is *None*, or not provided, no sketch filter will be provided.

**length** [float, optional] The length of the wiggle along the line, in pixels (default 128).

**randomness** [float, optional] The scale factor by which the length is shrunk or expanded (default 16).

`set_snap(self, snap)`

Set the snap setting which may be:

- True: snap vertices to the nearest pixel center
- False: leave vertices as-is
- None: (auto) If the path contains only rectilinear line segments, round to the nearest pixel center

`set_url(self, url)`

Set the url for links in compatible backends.

```
class matplotlib.backend_bases.KeyEvent(name, canvas, key, x=0, y=0, guiEvent=None)
    Bases: matplotlib.backend_bases.LocationEvent
```

A key event (key press, key release).

Attach additional attributes as defined in *FigureCanvasBase.mpl\_connect()*.

In addition to the *Event* and *LocationEvent* attributes, the following attributes are defined:

### Notes

Modifier keys will be prefixed to the pressed key and will be in the order "ctrl", "alt", "super". The exception to this rule is when the pressed key is itself a modifier key, therefore "ctrl+alt" and "alt+control" can both be valid key values.

### Examples

Usage:

```
def on_key(event):
    print('you pressed', event.key, event.xdata, event.ydata)

cid = fig.canvas.mpl_connect('key_press_event', on_key)
```

### Attributes

**key** [None or str] the key(s) pressed. Could be **None**, a single case sensitive ascii character ("g", "G", "#", etc.), a special key ("control", "shift", "f1", "up", etc.) or a combination of the above (e.g., "ctrl+alt+g", "ctrl+alt+G").

```
class matplotlib.backend_bases.LocationEvent(name, canvas, x, y, guiEvent=None)
    Bases: matplotlib.backend_bases.Event
```

An event that has a screen location.

The following additional attributes are defined and shown with their default values.

In addition to the *Event* attributes, the following event attributes are defined:

### Attributes

**x** [scalar] x position - pixels from left of canvas  
**y** [scalar] y position - pixels from bottom of canvas  
**inaxes** [bool] the *Axes* instance if mouse is over axes  
**xdata** [scalar] x coord of mouse in data coords  
**ydata** [scalar] y coord of mouse in data coords

x, y in figure coords, 0,0 = bottom, left

lastevent = None

```
class matplotlib.backend_bases.MouseButton
    Bases: enum.IntEnum
```

An enumeration.

```

BACK = 8
FORWARD = 9
LEFT = 1
MIDDLE = 2
RIGHT = 3

```

```

class matplotlib.backend_bases.MouseEvent(name, canvas, x, y, button=None,
                                          key=None, step=0, dblclick=False,
                                          guiEvent=None)
Bases: matplotlib.backend_bases.LocationEvent

```

**A mouse event ('button\_press\_event', 'button\_release\_event', 'scroll\_event', 'motion\_notify\_event').**

In addition to the *Event* and *LocationEvent* attributes, the following attributes are defined:

### Examples

Usage:

```

def on_press(event):
    print('you pressed', event.button, event.xdata, event.ydata)

cid = fig.canvas.mpl_connect('button_press_event', on_press)

```

### Attributes

**button** [{None, MouseButton.LEFT, MouseButton.MIDDLE, MouseButton.RIGHT, 'up', 'down'}] The button pressed. 'up' and 'down' are used for scroll events. Note that in the nbagg backend, both the middle and right clicks return RIGHT since right clicking will bring up the context menu in some browsers. Note that LEFT and RIGHT actually refer to the "primary" and "secondary" buttons, i.e. if the user inverts their left and right buttons ("left-handed setting") then the LEFT button will be the one physically on the right.

**key** [None or str] The key pressed when the mouse event triggered, e.g. 'shift'. See *KeyEvent*.

**step** [scalar] The number of scroll steps (positive for 'up', negative for 'down'). This applies only to 'scroll\_event' and defaults to 0 otherwise.

**dblclick** [bool] Whether the event is a double-click. This applies only to 'button\_press\_event' and is False otherwise. In particular, it's not used in 'button\_release\_event'.

x, y in figure coords, 0,0 = bottom, left button pressed None, 1, 2, 3, 'up', 'down'

```

class matplotlib.backend_bases.NavigationToolbar2(canvas)
Bases: object

```

Base class for the navigation cursor, version 2

backends must implement a canvas that handles connections for 'button\_press\_event' and 'button\_release\_event'. See *FigureCanvasBase.mpl\_connect()* for more information

They must also define

*save\_figure()* save the current figure  
*set\_cursor()* if you want the pointer icon to change  
*\_init\_toolbar()* create your toolbar widget  
*draw\_rubberband()* **(optional)** draw the zoom to rect "rubberband" rectangle  
*press()* **(optional)** whenever a mouse button is pressed, you'll be notified with the event  
*release()* **(optional)** whenever a mouse button is released, you'll be notified with the event  
*set\_message()* **(optional)** display message  
*set\_history\_buttons()* **(optional)** you can change the history back / forward buttons to indicate disabled / enabled state.

That's it, we'll do the rest!

*back(self, \*args)*  
move back up the view lim stack

*drag\_pan(self, event)*  
Callback for dragging in pan/zoom mode.

*drag\_zoom(self, event)*  
Callback for dragging in zoom mode.

*draw(self)*  
Redraw the canvases, update the locators.

*draw\_rubberband(self, event, x0, y0, x1, y1)*  
Draw a rectangle rubberband to indicate zoom limits.  
Note that it is not guaranteed that  $x_0 \leq x_1$  and  $y_0 \leq y_1$ .

*forward(self, \*args)*  
Move forward in the view lim stack.

*home(self, \*args)*  
Restore the original view.

*mouse\_move(self, event)*

*pan(self, \*args)*  
Activate the pan/zoom tool. pan with left button, zoom with right

*press(self, event)*  
Called whenever a mouse button is pressed.

*press\_pan(self, event)*  
Callback for mouse button press in pan/zoom mode.

*press\_zoom(self, event)*  
Callback for mouse button press in zoom to rect mode.

*push\_current(self)*  
Push the current view limits and position onto the stack.

*release(self, event)*  
Callback for mouse button release.

`release_pan(self, event)`

Callback for mouse button release in pan/zoom mode.

`release_zoom(self, event)`

Callback for mouse button release in zoom to rect mode.

`remove_rubberband(self)`

Remove the rubberband.

`save_figure(self, *args)`

Save the current figure.

`set_cursor(self, cursor)`

Set the current cursor to one of the `Cursors` enums values.

If required by the backend, this method should trigger an update in the backend event loop after the cursor is set, as this method may be called e.g. before a long-running task during which the GUI is not updated.

`set_history_buttons(self)`

Enable or disable the back/forward button.

`set_message(self, s)`

Display a message on toolbar or in status bar.

`toolitems = (('Home', 'Reset original view', 'home', 'home'), ('Back', 'Back to previous view', 'ba`

`update(self)`

Reset the axes stack.

`zoom(self, *args)`

Activate zoom to rect mode.

`exception matplotlib.backend_bases.NonGuiException`

Bases: `Exception`

`class matplotlib.backend_bases.PickEvent(name, canvas, mouseevent, artist, guiEvent=None, **kwargs)`

Bases: `matplotlib.backend_bases.Event`

a pick event, fired when the user picks a location on the canvas sufficiently close to an artist.

Attrs: all the `Event` attributes plus

## Examples

Usage:

```
ax.plot(np.rand(100), 'o', picker=5) # 5 points tolerance

def on_pick(event):
    line = event.artist
    xdata, ydata = line.get_data()
    ind = event.ind
    print('on pick line:', np.array([xdata[ind], ydata[ind]]).T)

cid = fig.canvas.mpl_connect('pick_event', on_pick)
```

## Attributes

**mouseevent** [*MouseEvent*] the mouse event that generated the pick

**artist** [*matplotlib.artist.Artist*] the picked artist

**other** extra class dependent attrs - e.g., a *Line2D* pick may define different extra attributes than a *PatchCollection* pick event

```
class matplotlib.backend_bases.RendererBase
```

```
    Bases: object
```

An abstract base class to handle drawing/rendering operations.

The following methods must be implemented in the backend for full functionality (though just implementing *draw\_path()* alone would give a highly capable backend):

- *draw\_path()*
- *draw\_image()*
- *draw\_gouraud\_triangle()*

The following methods *should* be implemented in the backend for optimization reasons:

- *draw\_text()*
- *draw\_markers()*
- *draw\_path\_collection()*
- *draw\_quad\_mesh()*

```
close_group(self, s)
```

Close a grouping element with label *s*

Only used by the SVG renderer.

```
draw_gouraud_triangle(self, gc, points, colors, transform)
```

Draw a Gouraud-shaded triangle.

#### Parameters

**points** [array\_like, shape=(3, 2)] Array of (x, y) points for the triangle.

**colors** [array\_like, shape=(3, 4)] RGBA colors for each point of the triangle.

**transform** [*matplotlib.transforms.Transform*] An affine transform to apply to the points.

```
draw_gouraud_triangles(self, gc, triangles_array, colors_array, transform)
```

Draws a series of Gouraud triangles.

#### Parameters

**points** [array\_like, shape=(N, 3, 2)] Array of *N* (x, y) points for the triangles.

**colors** [array\_like, shape=(N, 3, 4)] Array of *N* RGBA colors for each point of the triangles.

**transform** [*matplotlib.transforms.Transform*] An affine transform to apply to the points.

```
draw_image(self, gc, x, y, im, transform=None)
```

Draw an RGBA image.

#### Parameters

- gc** [*GraphicsContextBase*] a graphics context with clipping information.
- x** [scalar] the distance in physical units (i.e., dots or pixels) from the left hand side of the canvas.
- y** [scalar] the distance in physical units (i.e., dots or pixels) from the bottom side of the canvas.
- im** [array\_like, shape=(N, M, 4), dtype=np.uint8] An array of RGBA pixels.
- transform** [*matplotlib.transforms.Affine2DBase*] If and only if the concrete backend is written such that *option\_scale\_image()* returns True, an affine transformation *may* be passed to *draw\_image()*. It takes the form of a *Affine2DBase* instance. The translation vector of the transformation is given in physical units (i.e., dots or pixels). Note that the transformation does not override *x* and *y*, and has to be applied *before* translating the result by *x* and *y* (this can be accomplished by adding *x* and *y* to the translation vector defined by *transform*).

`draw_markers(self, gc, marker_path, marker_trans, path, trans, rgbFace=None)`

Draws a marker at each of the vertices in *path*. This includes all vertices, including control points on curves. To avoid that behavior, those vertices should be removed before calling this function.

This provides a fallback implementation of `draw_markers` that makes multiple calls to `draw_path()`. Some backends may want to override this method in order to draw the marker only once and reuse it multiple times.

### Parameters

- gc** [*GraphicsContextBase*] The graphics context
- marker\_trans** [*matplotlib.transforms.Transform*] An affine transform applied to the marker.
- trans** [*matplotlib.transforms.Transform*] An affine transform applied to the path.

`draw_path(self, gc, path, transform, rgbFace=None)`

Draws a *Path* instance using the given affine transform.

`draw_path_collection(self, gc, master_transform, paths, all_transforms, offsets, offsetTrans, facecolors, edgecolors, linewidths, linestyle, antialiaseds, urls, offset_position)`

Draws a collection of paths selecting drawing properties from the lists *facecolors*, *edgecolors*, *linewidths*, *linestyle* and *antialiaseds*. *offsets* is a list of offsets to apply to each of the paths. The offsets in *offsets* are first transformed by *offsetTrans* before being applied. *offset\_position* may be either "screen" or "data" depending on the space that the offsets are in.

This provides a fallback implementation of `draw_path_collection()` that makes multiple calls to `draw_path()`. Some backends may want to override this in order to render each set of path data only once, and then reference that path multiple times with the different offsets, colors, styles etc. The generator methods `_iter_collection_raw_paths()` and `_iter_collection()` are provided to help with (and standardize) the implementation across backends. It is highly recommended to use those generators, so that changes to the behavior of `draw_path_collection()` can be made globally.

`draw_quad_mesh(self, gc, master_transform, meshWidth, meshHeight, coordinates, offsets, offsetTrans, facecolors, antialiased, edgcolors)`

This provides a fallback implementation of `draw_quad_mesh()` that generates paths and then calls `draw_path_collection()`.

`draw_tex(self, gc, x, y, s, prop, angle, ismath='TeX!', mtext=None)`

`draw_text(self, gc, x, y, s, prop, angle, ismath=False, mtext=None)`

Draw the text instance.

### Parameters

**gc** [*GraphicsContextBase*] The graphics context.

**x** [scalar] The x location of the text in display coords.

**y** [scalar] The y location of the text baseline in display coords.

**s** [str] The text string.

**prop** [*matplotlib.font\_manager.FontProperties*] The font properties.

**angle** [scalar] The rotation angle in degrees.

**mtext** [*matplotlib.text.Text*] The original text object to be rendered.

### Notes

#### backend implementers note

When you are trying to determine if you have gotten your bounding box right (which is what enables the text layout/alignment to work properly), it helps to change the line in `text.py`:

```
if 0: bbox_artist(self, renderer)
```

to if 1, and then the actual bounding box will be plotted along with your text.

`flipy(self)`

Return whether y values increase from top to bottom.

Note that this only affects drawing of texts and images.

`get_canvas_width_height(self)`

Return the canvas width and height in display coords.

`get_image_magnification(self)`

Get the factor by which to magnify images passed to `draw_image()`. Allows a backend to have images at a different resolution to other artists.

`get_texmanager(self)`

Return the `TexManager` instance.

`get_text_width_height_descent(self, s, prop, ismath)`

Get the width, height, and descent (offset from the bottom to the baseline), in display coords, of the string `s` with `FontProperties prop`

`new_gc(self)`

Return an instance of a `GraphicsContextBase`.

`open_group(self, s, gid=None)`

Open a grouping element with label `s` and `gid` (if set) as id.

Only used by the SVG renderer.

`option_image_nocomposite(self)`

Return whether image composition by Matplotlib should be skipped.

Raster backends should usually return False (letting the C-level rasterizer take care of image composition); vector backends should usually return not `rcParams["image.composite_image"]`.

`option_scale_image(self)`

Return whether arbitrary affine transformations in `draw_image()` are supported (True for most vector backends).

`points_to_pixels(self, points)`

Convert points to display units.

You need to override this function (unless your backend doesn't have a dpi, e.g., postscript or svg). Some imaging systems assume some value for pixels per inch:

```
points to pixels = points * pixels_per_inch/72.0 * dpi/72.0
```

### Parameters

**points** [scalar or array\_like] a float or a numpy array of float

### Returns

**Points converted to pixels**

`start_filter(self)`

Switch to a temporary renderer for image filtering effects.

Currently only supported by the agg renderer.

`start_rasterizing(self)`

Switch to the raster renderer.

Used by `MixedModeRenderer`.

`stop_filter(self, filter_func)`

Switch back to the original renderer. The contents of the temporary renderer is processed with the `filter_func` and is drawn on the original renderer as an image.

Currently only supported by the agg renderer.

`stop_rasterizing(self)`

Switch back to the vector renderer and draw the contents of the raster renderer as an image on the vector renderer.

Used by `MixedModeRenderer`.

`strip_math(self, s)`  
[*Deprecated*]

### Notes

Deprecated since version 3.1:

```
class matplotlib.backend_bases.ResizeEvent(name, canvas)
```

Bases: `matplotlib.backend_bases.Event`

An event triggered by a canvas resize

In addition to the *Event* attributes, the following event attributes are defined:

### Attributes

**width** [scalar] width of the canvas in pixels

**height** [scalar] height of the canvas in pixels

```
class matplotlib.backend_bases.ShowBase
```

```
    Bases: matplotlib.backend_bases._Backend
```

Simple base class to generate a show() callable in backends.

Subclass must override mainloop() method.

```
class matplotlib.backend_bases.StatusbarBase(toolmanager)
```

```
    Bases: object
```

Base class for the statusbar

```
    set_message(self, s)
```

Display a message on toolbar or in status bar

### Parameters

**s** [str] Message text

```
class matplotlib.backend_bases.TimerBase(interval=None, callbacks=None)
```

```
    Bases: object
```

A base class for providing timer events, useful for things animations. Backends need to implement a few specific methods in order to use their own timing mechanisms so that the timer events are integrated into their event loops.

Mandatory functions that must be implemented:

- `_timer_start`: Contains backend-specific code for starting the timer
- `_timer_stop`: Contains backend-specific code for stopping the timer

Optional overrides:

- `_timer_set_single_shot`: Code for setting the timer to single shot operating mode, if supported by the timer object. If not, the `Timer` class itself will store the flag and the `_on_timer` method should be overridden to support such behavior.
- `_timer_set_interval`: Code for setting the interval on the timer, if there is a method for doing so on the timer object.
- `_on_timer`: This is the internal function that any timer object should call, which will handle the task of running all callbacks that have been set.

### Attributes

**interval** [scalar] The time between timer events in milliseconds. Default is 1000 ms.

**single\_shot** [bool] Boolean flag indicating whether this timer should operate as single shot (run once and then stop). Defaults to `False`.

**callbacks** [List[Tuple[callable, Tuple, Dict]]] Stores list of (func, args, kwargs) tuples that will be called upon timer events. This list can be manipulated directly, or the functions `add_callback` and `remove_callback` can be used.

`add_callback(self, func, *args, **kwargs)`

Register *func* to be called by timer when the event fires. Any additional arguments provided will be passed to *func*.

This function returns *func*, which makes it possible to use it as a decorator.

`interval`

`remove_callback(self, func, *args, **kwargs)`

Remove *func* from list of callbacks.

*args* and *kwargs* are optional and used to distinguish between copies of the same function registered to be called with different arguments. This behavior is deprecated. In the future, *\*args*, *\*\*kwargs* won't be considered anymore; to keep a specific callback removable by itself, pass it to `add_callback` as a `functools.partial` object.

`single_shot`

`start(self, interval=None)`

Start the timer object.

### Parameters

**interval** [int, optional] Timer interval in milliseconds; overrides a previously set interval if provided.

`stop(self)`

Stop the timer.

`class matplotlib.backend_bases.ToolContainerBase(toolmanager)`

Bases: `object`

Base class for all tool containers, e.g. toolbars.

### Attributes

**toolmanager** [`ToolManager`] The tools with which this `ToolContainer` wants to communicate.

`add_tool(self, tool, group, position=-1)`

Adds a tool to this container

### Parameters

**tool** [`tool_like`] The tool to add, see `ToolManager.get_tool`.

**group** [`str`] The name of the group to add this tool to.

**position** [int (optional)] The position within the group to place this tool. Defaults to end.

`add_toolitem(self, name, group, position, image, description, toggle)`

Add a toolitem to the container

This method must get implemented per backend

The callback associated with the button click event, must be **EXACTLY** `self.trigger_tool(name)`

### Parameters

**name** [`string`] Name of the tool to add, this gets used as the tool's ID and as the default label of the buttons

**group** [`String`] Name of the group that this tool belongs to

**position** [Int] Position of the tool within its group, if -1 it goes at the End

**image\_file** [String] Filename of the image for the button or `None`

**description** [String] Description of the tool, used for the tooltips

**toggle** [Bool]

- `True` : The button is a toggle (change the pressed/unpressed state between consecutive clicks)
- `False` : The button is a normal button (returns to unpressed state after release)

`remove_toolitem(self, name)`

Remove a toolitem from the `ToolContainer`

This method must get implemented per backend

Called when `ToolManager` emits a `tool_removed_event`

#### Parameters

**name** [string] Name of the tool to remove

`toggle_toolitem(self, name, toggled)`

Toggle the toolitem without firing event

#### Parameters

**name** [String] Id of the tool to toggle

**toggled** [bool] Whether to set this tool as toggled or not.

`trigger_tool(self, name)`

Trigger the tool

#### Parameters

**name** [string] Name (id) of the tool triggered from within the container

`matplotlib.backend_bases.button_press_handler(event, canvas, toolbar=None)`

The default Matplotlib button actions for extra mouse buttons.

`matplotlib.backend_bases.get_registered_canvas_class(format)`

Return the registered default canvas for given file format. Handles deferred import of required backend.

`matplotlib.backend_bases.key_press_handler(event, canvas, toolbar=None)`

Implement the default mpl key bindings for the canvas and toolbar described at *Navigation Keyboard Shortcuts*

#### Parameters

**event** [*KeyEvent*] a key press/release event

**canvas** [*FigureCanvasBase*] the backend-specific canvas instance

**toolbar** [*NavigationToolbar2*] the navigation cursor toolbar

`matplotlib.backend_bases.register_backend(format, backend, description=None)`

Register a backend for saving to a given file format.

#### Parameters

**format** [str] File extension

**backend** [module string or canvas class] Backend for handling file output

**description** [str, optional] Description of the file type. Defaults to an empty string

## 17.8 matplotlib.backend\_managers

class matplotlib.backend\_managers.ToolEvent(*name, sender, tool, data=None*)

Bases: `object`

Event for tool manipulation (add/remove).

class matplotlib.backend\_managers.ToolManager(*figure=None*)

Bases: `object`

Manager for actions triggered by user interactions (key press, toolbar clicks, ...) on a Figure.

### Attributes

*figure* [Figure] Figure that holds the canvas.

**keypresslock** [widgets.LockDraw] LockDraw object to know if the *canvas* key\_press\_event is locked

**messagelock** [widgets.LockDraw] LockDraw object to know if the message is available to write

*active\_toggle*

Currently toggled tools.

*add\_tool(self, name, tool, \*args, \*\*kwargs)*

Add *tool* to *ToolManager*.

If successful, adds a new event `tool_trigger_{name}` where `{name}` is the *name* of the tool; the event is fired everytime the tool is triggered.

### Parameters

**name** [str] Name of the tool, treated as the ID, has to be unique.

**tool** [class\_like, i.e. str or type] Reference to find the class of the Tool to added.

### See also:

`matplotlib.backend_tools.ToolBase` The base class for tools.

### Notes

args and kwargs get passed directly to the tools constructor.

*canvas*

Canvas managed by FigureManager.

*figure*

Figure that holds the canvas.

*get\_tool(self, name, warn=True)*

Return the tool object, also accepts the actual tool for convenience.

### Parameters

**name** [str, ToolBase] Name of the tool, or the tool itself

**warn** [bool, optional] If this method should give warnings.

`get_tool_keymap(self, name)`

Get the keymap associated with the specified tool.

**Parameters**

**name** [string] Name of the Tool

**Returns**

**list** [list of keys associated with the Tool]

`message_event(self, message, sender=None)`

Emit a *ToolManagerMessageEvent*.

`remove_tool(self, name)`

Remove tool named *name*.

**Parameters**

**name** [string] Name of the Tool

`set_figure(self, figure, update_tools=True)`

Bind the given figure to the tools.

**Parameters**

**figure** [*Figure*]

**update\_tools** [bool] Force tools to update figure

`toolmanager_connect(self, s, func)`

Connect event with string *s* to *func*.

**Parameters**

**s** [String] Name of the event

The following events are recognized

- 'tool\_message\_event'
- 'tool\_removed\_event'
- 'tool\_added\_event'

For every tool added a new event is created

- 'tool\_trigger\_TOOLNAME' Where TOOLNAME is the id of the tool.

**func** [function] Function to be called with signature `def func(event)`

`toolmanager_disconnect(self, cid)`

Disconnect callback id *cid*.

Example usage:

```
cid = toolmanager.toolmanager_connect('tool_trigger_zoom', onpress)
#...later
toolmanager.toolmanager_disconnect(cid)
```

`tools`

A dict mapping tool name -> controlled tool.

`trigger_tool(self, name, sender=None, canvasevent=None, data=None)`  
 Trigger a tool and emit the `tool_trigger_{name}` event.

#### Parameters

**name** [string] Name of the tool  
**sender** [object] Object that wishes to trigger the tool  
**canvasevent** [Event] Original Canvas event or None  
**data** [Object] Extra data to pass to the tool when triggering

`update_keymap(self, name, *keys)`  
 Set the keymap to associate with the specified tool.

#### Parameters

**name** [string] Name of the Tool  
**keys** [keys to associate with the Tool]

`class matplotlib.backend_managers.ToolManagerMessageEvent(name, sender, message)`  
 Bases: `object`

Event carrying messages from toolmanager.  
 Messages usually get displayed to the user by the toolbar.

`class matplotlib.backend_managers.ToolTriggerEvent(name, sender, tool, canvasevent=None, data=None)`  
 Bases: `matplotlib.backend_managers.ToolEvent`

Event to inform that a tool has been triggered.

## 17.9 matplotlib.backend\_tools

Abstract base classes define the primitives for Tools. These tools are used by `matplotlib.backend_managers.ToolManager`

`ToolBase` Simple stateless tool

`ToolToggleBase` Tool that has two states, only one Toggle tool can be active at any given time for the same `matplotlib.backend_managers.ToolManager`

`class matplotlib.backend_tools.AxisScaleBase(*args, **kwargs)`  
 Bases: `matplotlib.backend_tools.ToolToggleBase`

Base Tool to toggle between linear and logarithmic

`disable(self, event)`  
 Disable the toggle tool

*trigger* call this method when toggled is True.

This can happen in different circumstances

- Click on the toolbar tool button
- Call to `matplotlib.backend_managers.ToolManager.trigger_tool`
- Another `ToolToggleBase` derived tool is triggered (from the same `ToolManager`)

```
enable(self, event)
    Enable the toggle tool

    trigger calls this method when toggled is False

trigger(self, sender, event, data=None)
    Calls enable or disable based on toggled value
```

```
class matplotlib.backend_tools.ConfigureSubplotsBase(toolmanager, name)
    Bases: matplotlib.backend_tools.ToolBase

    Base tool for the configuration of subplots

    description = 'Configure subplots'

    image = 'subplots'
```

```
class matplotlib.backend_tools.Cursors
    Bases: object

    Simple namespace for cursor reference

    HAND = 0

    MOVE = 3

    POINTER = 1

    SELECT_REGION = 2

    WAIT = 4
```

```
class matplotlib.backend_tools.RubberbandBase(toolmanager, name)
    Bases: matplotlib.backend_tools.ToolBase

    Draw and remove rubberband

    draw_rubberband(self, *data)
        Draw rubberband

        This method must get implemented per backend

    remove_rubberband(self)
        Remove rubberband

        This method should get implemented per backend

    trigger(self, sender, event, data)
        Call draw_rubberband or remove_rubberband based on data
```

```
class matplotlib.backend_tools.SaveFigureBase(toolmanager, name)
    Bases: matplotlib.backend_tools.ToolBase

    Base tool for figure saving

    default_keymap = ['s', 'ctrl+s']

    description = 'Save the figure'

    image = 'filesave'
```

```
class matplotlib.backend_tools.SetCursorBase(*args, **kwargs)
    Bases: matplotlib.backend_tools.ToolBase

    Change to the current cursor while inaxes

    This tool, keeps track of all ToolToggleBase derived tools, and calls set_cursor when a tool gets triggered
```

`set_cursor(self, cursor)`  
Set the cursor

This method has to be implemented per backend

`set_figure(self, figure)`  
Assign a figure to the tool

### Parameters

**figure** [Figure]

```
class matplotlib.backend_tools.ToolBack(toolmanager, name)
```

Bases: `matplotlib.backend_tools.ViewsPositionsBase`

Move back up the view lim stack

`default_keymap` = ['left', 'c', 'backspace', 'MouseButton.BACK']

`description` = 'Back to previous view'

`image` = 'back'

```
class matplotlib.backend_tools.ToolBase(toolmanager, name)
```

Bases: `object`

Base tool class

A base tool, only implements `trigger` method or not method at all. The tool is instantiated by `matplotlib.backend_managers.ToolManager`

### Attributes

**toolmanager** [`matplotlib.backend_managers.ToolManager`] ToolManager that controls this Tool

**figure** [FigureCanvas] Figure instance that is affected by this Tool

`name` [string] Tool Id

`canvas`

`default_keymap` = None

Keymap to associate with this tool

**String:** List of comma separated keys that will be used to call this tool when the keypress event of `self.figure.canvas` is emitted

`description` = None

Description of the Tool

**String:** If the Tool is included in the Toolbar this text is used as a Tooltip

`destroy(self)`

Destroy the tool

This method is called when the tool is removed by `matplotlib.backend_managers.ToolManager.remove_tool`

`figure`

`image` = None

Filename of the image

**String:** Filename of the image to use in the toolbar. If None, the `name` is used as a label in the toolbar button

`name`

Tool Id

`set_figure(self, figure)`

Assign a figure to the tool

### Parameters

**figure** [Figure]

`toolmanager`

`trigger(self, sender, event, data=None)`

Called when this tool gets used

This method is called by `matplotlib.backend_managers.ToolManager.trigger_tool`

### Parameters

**event** [Event] The Canvas event that caused this tool to be called

**sender** [object] Object that requested the tool to be triggered

**data** [object] Extra data

`matplotlib.backend_tools.ToolCopyToClipboard`

alias of `matplotlib.backend_tools.ToolCopyToClipboardBase`

`class matplotlib.backend_tools.ToolCopyToClipboardBase(toolmanager, name)`

Bases: `matplotlib.backend_tools.ToolBase`

Tool to copy the figure to the clipboard

`default_keymap = ['ctrl+c', 'cmd+c']`

`description = 'Copy the canvas figure to clipboard'`

`trigger(self, *args, **kwargs)`

Called when this tool gets used

This method is called by `matplotlib.backend_managers.ToolManager.trigger_tool`

### Parameters

**event** [Event] The Canvas event that caused this tool to be called

**sender** [object] Object that requested the tool to be triggered

**data** [object] Extra data

`class matplotlib.backend_tools.ToolCursorPosition(*args, **kwargs)`

Bases: `matplotlib.backend_tools.ToolBase`

Send message with the current pointer position

This tool runs in the background reporting the position of the cursor

`send_message(self, event)`

Call `matplotlib.backend_managers.ToolManager.message_event`

`set_figure(self, figure)`

Assign a figure to the tool

### Parameters

**figure** [Figure]

```
class matplotlib.backend_tools.ToolEnableAllNavigation(toolmanager, name)
    Bases: matplotlib.backend_tools.ToolBase
    Tool to enable all axes for toolmanager interaction
    default_keymap = ['a']
    description = 'Enable all axes toolmanager'
    trigger(self, sender, event, data=None)
        Called when this tool gets used
        This method is called by matplotlib.backend_managers.ToolManager.trigger_tool
```

#### Parameters

**event** [Event] The Canvas event that caused this tool to be called  
**sender** [object] Object that requested the tool to be triggered  
**data** [object] Extra data

```
class matplotlib.backend_tools.ToolEnableNavigation(toolmanager, name)
    Bases: matplotlib.backend_tools.ToolBase
    Tool to enable a specific axes for toolmanager interaction
    default_keymap = (1, 2, 3, 4, 5, 6, 7, 8, 9)
    description = 'Enable one axes toolmanager'
    trigger(self, sender, event, data=None)
        Called when this tool gets used
        This method is called by matplotlib.backend_managers.ToolManager.trigger_tool
```

#### Parameters

**event** [Event] The Canvas event that caused this tool to be called  
**sender** [object] Object that requested the tool to be triggered  
**data** [object] Extra data

```
class matplotlib.backend_tools.ToolForward(toolmanager, name)
    Bases: matplotlib.backend_tools.ViewsPositionsBase
    Move forward in the view lim stack
    default_keymap = ['right', 'v', 'MouseButton.FORWARD']
    description = 'Forward to next view'
    image = 'forward'
```

```
class matplotlib.backend_tools.ToolFullScreen(*args, **kwargs)
    Bases: matplotlib.backend_tools.ToolToggleBase
    Tool to toggle full screen
    default_keymap = ['f', 'ctrl+f']
    description = 'Toggle fullscreen mode'
    disable(self, event)
        Disable the toggle tool
        trigger call this method when toggled is True.
```

This can happen in different circumstances

- Click on the toolbar tool button
- Call to `matplotlib.backend_managers.ToolManager.trigger_tool`
- Another `ToolToggleBase` derived tool is triggered (from the same `ToolManager`)

`enable(self, event)`

Enable the toggle tool

`trigger` calls this method when `toggled` is `False`

```
class matplotlib.backend_tools.ToolGrid(toolmanager, name)
```

Bases: `matplotlib.backend_tools._ToolGridBase`

Tool to toggle the major grids of the figure

`default_keymap = ['g']`

`description = 'Toggle major grids'`

```
class matplotlib.backend_tools.ToolHelpBase(toolmanager, name)
```

Bases: `matplotlib.backend_tools.ToolBase`

`default_keymap = ['f1']`

`description = 'Print tool list, shortcuts and description'`

`static format_shortcut(key_sequence)`

Converts a shortcut string from the notation used in rc config to the standard notation for displaying shortcuts, e.g. `'ctrl+a' -> 'Ctrl+A'`.

`image = 'help.png'`

```
class matplotlib.backend_tools.ToolHome(toolmanager, name)
```

Bases: `matplotlib.backend_tools.ViewsPositionsBase`

Restore the original view lim

`default_keymap = ['h', 'r', 'home']`

`description = 'Reset original view'`

`image = 'home'`

```
class matplotlib.backend_tools.ToolMinorGrid(toolmanager, name)
```

Bases: `matplotlib.backend_tools._ToolGridBase`

Tool to toggle the major and minor grids of the figure

`default_keymap = ['G']`

`description = 'Toggle major and minor grids'`

```
class matplotlib.backend_tools.ToolPan(*args)
```

Bases: `matplotlib.backend_tools.ZoomPanBase`

Pan axes with left mouse, zoom with right

`cursor = 3`

`default_keymap = ['p']`

`description = 'Pan axes with left mouse, zoom with right'`

`image = 'move'`

`radio_group = 'default'`

```
class matplotlib.backend_tools.ToolQuit(toolmanager, name)
    Bases: matplotlib.backend_tools.ToolBase
    Tool to call the figure manager destroy method
    default_keymap = ['ctrl+w', 'cmd+w', 'q']
    description = 'Quit the figure'
    trigger(self, sender, event, data=None)
        Called when this tool gets used
        This method is called by matplotlib.backend_managers.ToolManager.trigger_tool
```

### Parameters

**event** [Event] The Canvas event that caused this tool to be called  
**sender** [object] Object that requested the tool to be triggered  
**data** [object] Extra data

```
class matplotlib.backend_tools.ToolQuitAll(toolmanager, name)
    Bases: matplotlib.backend_tools.ToolBase
    Tool to call the figure manager destroy method
    default_keymap = ['W', 'cmd+W', 'Q']
    description = 'Quit all figures'
    trigger(self, sender, event, data=None)
        Called when this tool gets used
        This method is called by matplotlib.backend_managers.ToolManager.trigger_tool
```

### Parameters

**event** [Event] The Canvas event that caused this tool to be called  
**sender** [object] Object that requested the tool to be triggered  
**data** [object] Extra data

```
class matplotlib.backend_tools.ToolToggleBase(*args, **kwargs)
    Bases: matplotlib.backend_tools.ToolBase
    Toggleable tool
    Every time it is triggered, it switches between enable and disable
```

### Parameters

**\*\*args** Variable length argument to be used by the Tool  
**\*\*kwargs** *toggle* if present and True, sets the initial state of the Tool  
 Arbitrary keyword arguments to be consumed by the Tool

```
cursor = None
    Cursor to use when the tool is active
default_toggled = False
    Default of toggled state
disable(self, event=None)
    Disable the toggle tool
    trigger call this method when toggle is True.
```

This can happen in different circumstances

- Click on the toolbar tool button
- Call to `matplotlib.backend_managers.ToolManager.trigger_tool`
- Another `ToolToggleBase` derived tool is triggered (from the same `ToolManager`)

`enable(self, event=None)`  
Enable the toggle tool

`trigger` calls this method when `toggled` is `False`

`radio_group = None`  
Attribute to group 'radio' like tools (mutually exclusive)

**String** that identifies the group or **None** if not belonging to a group

`set_figure(self, figure)`  
Assign a figure to the tool

### Parameters

**figure** [Figure]

`toggled`  
State of the toggled tool

`trigger(self, sender, event, data=None)`  
Calls `enable` or `disable` based on `toggled` value

`class matplotlib.backend_tools.ToolViewsPositions(*args, **kwargs)`  
Bases: `matplotlib.backend_tools.ToolBase`

Auxiliary Tool to handle changes in views and positions

Runs in the background and should get used by all the tools that need to access the figure's history of views and positions, e.g.

- `ToolZoom`
- `ToolPan`
- `ToolHome`
- `ToolBack`
- `ToolForward`

`add_figure(self, figure)`  
Add the current figure to the stack of views and positions

`back(self)`  
Back one step in the stack of views and positions

`clear(self, figure)`  
Reset the axes stack

`forward(self)`  
Forward one step in the stack of views and positions

`home(self)`  
Recall the first view and position from the stack

`push_current(self, figure=None)`  
Push the current view limits and position onto their respective stacks

```

refresh_locators(self)
    Redraw the canvases, update the locators

update_home_views(self, figure=None)
    Make sure that self.home_views has an entry for all axes present in the figure

update_view(self)
    Update the view limits and position for each axes from the current stack position. If
    any axes are present in the figure that aren't in the current stack position, use the
    home view limits for those axes and don't update any positions.

class matplotlib.backend_tools.ToolXScale(*args, **kwargs)
    Bases: matplotlib.backend_tools.AxisScaleBase

    Tool to toggle between linear and logarithmic scales on the X axis

    default_keymap = ['k', 'L']

    description = 'Toggle scale X axis'

    set_scale(self, ax, scale)

class matplotlib.backend_tools.ToolYScale(*args, **kwargs)
    Bases: matplotlib.backend_tools.AxisScaleBase

    Tool to toggle between linear and logarithmic scales on the Y axis

    default_keymap = ['1']

    description = 'Toggle scale Y axis'

    set_scale(self, ax, scale)

class matplotlib.backend_tools.ToolZoom(*args)
    Bases: matplotlib.backend_tools.ZoomPanBase

    Zoom to rectangle

    cursor = 2

    default_keymap = ['o']

    description = 'Zoom to rectangle'

    image = 'zoom_to_rect'

    radio_group = 'default'

class matplotlib.backend_tools.ViewsPositionsBase(toolmanager, name)
    Bases: matplotlib.backend_tools.ToolBase

    Base class for ToolHome, ToolBack and ToolForward

    trigger(self, sender, event, data=None)
        Called when this tool gets used

        This method is called by matplotlib.backend_managers.ToolManager.trigger_tool

```

### Parameters

- event** [Event] The Canvas event that caused this tool to be called
- sender** [object] Object that requested the tool to be triggered
- data** [object] Extra data

```
class matplotlib.backend_tools.ZoomPanBase(*args)
    Bases: matplotlib.backend_tools.ToolToggleBase
    Base class for ToolZoom and ToolPan
    disable(self, event)
        Release the canvas and disconnect press/release events
    enable(self, event)
        Connect press/release events and lock the canvas
    scroll_zoom(self, event)
    trigger(self, sender, event, data=None)
        Calls enable or disable based on toggled value
matplotlib.backend_tools.add_tools_to_container(container,
                                               tools=[[ 'navigation',
                                               [ 'home', 'back', 'forward' ]], [ 'zoom-pan',
                                               [ 'pan', 'zoom', 'subplots' ]], [ 'io',
                                               [ 'save', 'help' ] ] ] ])
```

Add multiple tools to the container.

### Parameters

**container** [Container] backend\_bases.ToolContainerBase object that will get the tools added

**tools** [list, optional] List in the form [[group1, [tool1, tool2 ...]], [group2, [...]]] Where the tools given by tool1, and tool2 will display in group1. See `add_tool` for details.

```

matplotlib.backend_tools.add_tools_to_manager(toolmanager, tools={'home': <class
    'matplotlib.backend_tools.ToolHome'>,
    'back': <class 'matplotlib.backend_tools.ToolBack'>,
    'forward': <class 'matplotlib.backend_tools.ToolForward'>,
    'zoom': <class 'matplotlib.backend_tools.ToolZoom'>,
    'pan': <class 'matplotlib.backend_tools.ToolPan'>,
    'subplots': 'ToolConfigureSubplots',
    'save': 'ToolSaveFigure', 'grid': <class
    'matplotlib.backend_tools.ToolGrid'>,
    'grid_minor': <class 'matplotlib.backend_tools.ToolMinorGrid'>,
    'fullscreen': <class 'matplotlib.backend_tools.ToolFullScreen'>,
    'quit': <class 'matplotlib.backend_tools.ToolQuit'>,
    'quit_all': <class 'matplotlib.backend_tools.ToolQuitAll'>,
    'allnav': <class 'matplotlib.backend_tools.ToolEnableAllNavigation'>,
    'nav': <class 'matplotlib.backend_tools.ToolEnableNavigation'>,
    'xscale': <class 'matplotlib.backend_tools.ToolXScale'>,
    'yscale': <class 'matplotlib.backend_tools.ToolYScale'>,
    'position': <class 'matplotlib.backend_tools.ToolCursorPosition'>,
    'viewpos': <class 'matplotlib.backend_tools.ToolViewsPositions'>,
    'cursor': 'ToolSetCursor', 'rubberband':
    'ToolRubberband', 'help': 'ToolHelp',
    'copy': 'ToolCopyToClipboard'})

```

Add multiple tools to ToolManager

### Parameters

**toolmanager** [ToolManager] backend\_managers.ToolManager object that will get the tools added

**tools** [{str: class\_like}, optional] The tools to add in a {name: tool} dict, see add\_tool for more info.

```
matplotlib.backend_tools.default_toolbar_tools = [['navigation', ['home', 'back', 'forward']], ['zoompan']]
Default tools in the toolbar
```

```
matplotlib.backend_tools.default_tools = {'allnav': <class 'matplotlib.backend_tools.ToolEnableAllNavigation'>}
Default tools
```

## 17.10 matplotlib.backends

### 17.10.1 matplotlib.backends.backend\_mixed

```
class matplotlib.backends.backend_mixed.MixedModeRenderer(figure, width, height,  
                                                         dpi, vector_renderer,  
                                                         raster_renderer_class=None,  
                                                         bbox_inches_restore=None)
```

Bases: `object`

A helper class to implement a renderer that switches between vector and raster drawing. An example may be a PDF writer, where most things are drawn with PDF vector commands, but some very complex objects, such as quad meshes, are rasterised and then output as images.

#### Parameters

**figure** [*matplotlib.figure.Figure*] The figure instance.

**width** [scalar] The width of the canvas in logical units

**height** [scalar] The height of the canvas in logical units

**dpi** [scalar] The dpi of the canvas

**vector\_renderer** [*matplotlib.backend\_bases.RendererBase*] An instance of a subclass of *RendererBase* that will be used for the vector drawing.

**raster\_renderer\_class** [*matplotlib.backend\_bases.RendererBase*] The renderer class to use for the raster drawing. If not provided, this will use the Agg backend (which is currently the only viable option anyway.)

`start_rasterizing(self)`

Enter "raster" mode. All subsequent drawing commands (until `stop_rasterizing` is called) will be drawn with the raster backend.

If `start_rasterizing` is called multiple times before `stop_rasterizing` is called, this method has no effect.

`stop_rasterizing(self)`

Exit "raster" mode. All of the drawing that was done since the last `start_rasterizing` command will be copied to the vector backend by calling `draw_image`.

If `stop_rasterizing` is called multiple times before `start_rasterizing` is called, this method has no effect.

### 17.10.2 matplotlib.backends.backend\_agg

An agg <http://antigrain.com/> backend

Features that are implemented

- capstyles and join styles
- dashes
- linewidth
- lines, rectangles, ellipses
- clipping to a rectangle

- output to RGBA and PNG, optionally JPEG and TIFF
- alpha blending
- DPI scaling properly - everything scales properly (dashes, linewidths, etc)
- draw polygon
- freetype2 w/ ft2font

TODO:

- integrate screen dpi w/ ppi and text

```
matplotlib.backends.backend_agg.FigureCanvas
    alias of matplotlib.backends.backend_agg.FigureCanvasAgg
class matplotlib.backends.backend_agg.FigureCanvasAgg(figure)
    Bases: matplotlib.backend_bases.FigureCanvasBase
```

The canvas the figure renders into. Calls the draw and print fig methods, creates the renderers, etc...

### Attributes

**figure** [*matplotlib.figure.Figure*] A high-level Figure instance

**buffer\_rgba(*self*)**

Get the image as a memoryview to the renderer's buffer.

*draw* must be called at least once before this function will work and to update the renderer for any subsequent changes to the Figure.

### Returns

**memoryview**

**copy\_from\_bbox(*self*, *bbox*)**

**draw(*self*)**

Draw the figure using the renderer.

**get\_renderer(*self*, *cleared=False*)**

**print\_jpeg(*self*, *filename\_or\_obj*, \**args*, *dryrun=False*, *pil\_kwargs=None*, \*\**kwargs*)**  
Write the figure to a JPEG file.

### Parameters

**filename\_or\_obj** [str or PathLike or file-like object] The file to write to.

### Other Parameters

**quality** [int] The image quality, on a scale from 1 (worst) to 100 (best). The default is `rcParams["savefig.jpeg_quality"]`. Values above 95 should be avoided; 100 completely disables the JPEG quantization stage.

**optimize** [bool] If present, indicates that the encoder should make an extra pass over the image in order to select optimal encoder settings.

**progressive** [bool] If present, indicates that this image should be stored as a progressive JPEG file.

**pil\_kwargs** [dict, optional] Additional keyword arguments that are passed to `PIL.Image.save` when saving the figure. These take precedence over *quality*, *optimize* and *progressive*.

```
print_jpg(self, filename_or_obj, *args, dryrun=False, pil_kwargs=None, **kwargs)
```

Write the figure to a JPEG file.

**Parameters**

**filename\_or\_obj** [str or PathLike or file-like object] The file to write to.

**Other Parameters**

**quality** [int] The image quality, on a scale from 1 (worst) to 100 (best). The default is `rcParams["savefig.jpeg_quality"]`. Values above 95 should be avoided; 100 completely disables the JPEG quantization stage.

**optimize** [bool] If present, indicates that the encoder should make an extra pass over the image in order to select optimal encoder settings.

**progressive** [bool] If present, indicates that this image should be stored as a progressive JPEG file.

**pil\_kwargs** [dict, optional] Additional keyword arguments that are passed to `PIL.Image.save` when saving the figure. These take precedence over *quality*, *optimize* and *progressive*.

```
print_png(self, filename_or_obj, *args, metadata=None, pil_kwargs=None, **kwargs)
```

Write the figure to a PNG file.

**Parameters**

**filename\_or\_obj** [str or PathLike or file-like object] The file to write to.

**metadata** [dict, optional] Metadata in the PNG file as key-value pairs of bytes or latin-1 encodable strings. According to the PNG specification, keys must be shorter than 79 chars.

The [PNG specification](#) defines some common keywords that may be used as appropriate:

- Title: Short (one line) title or caption for image.
- Author: Name of image's creator.
- Description: Description of image (possibly long).
- Copyright: Copyright notice.
- Creation Time: Time of original image creation (usually RFC 1123 format).
- Software: Software used to create the image.
- Disclaimer: Legal disclaimer.
- Warning: Warning of nature of content.
- Source: Device used to create the image.
- Comment: Miscellaneous comment; conversion from other image format.

Other keywords may be invented for other purposes.

If 'Software' is not given, an autogenerated value for matplotlib will be used.

For more details see the [PNG specification](#).

**pil\_kwargs** [dict, optional] If set to a non-None value, use Pillow to save the figure instead of Matplotlib's builtin PNG support, and pass these keyword arguments to `PIL.Image.save`.

If the 'pnginfo' key is present, it completely overrides *metadata*, including the default 'Software' key.

```
print_raw(self, filename_or_obj, *args, **kwargs)
```

```
print_rgba(self, filename_or_obj, *args, **kwargs)
```

```
print_tif(self, filename_or_obj, *args, dryrun=False, pil_kwargs=None, **kwargs)
```

```
print_tiff(self, filename_or_obj, *args, dryrun=False, pil_kwargs=None, **kwargs)
```

```
print_to_buffer(self)
```

```
restore_region(self, region, bbox=None, xy=None)
```

```
tostring_argb(self)
```

Get the image as an ARGB byte string.

*draw* must be called at least once before this function will work and to update the renderer for any subsequent changes to the Figure.

#### Returns

**bytes**

```
tostring_rgb(self)
```

Get the image as an RGB byte string.

*draw* must be called at least once before this function will work and to update the renderer for any subsequent changes to the Figure.

#### Returns

**bytes**

```
class matplotlib.backends.backend_agg.RendererAgg(width, height, dpi)
```

Bases: `matplotlib.backends_bases.RendererBase`

The renderer handles all the drawing primitives using a graphics context instance that controls the colors/styles

```
buffer_rgba(self)
```

```
clear(self)
```

```
draw_mathtext(self, gc, x, y, s, prop, angle)
```

Draw the math text using `matplotlib.mathtext`

```
draw_path(self, gc, path, transform, rgbFace=None)
```

Draws a *Path* instance using the given affine transform.

```
draw_tex(self, gc, x, y, s, prop, angle, ismath='TeX!', mtext=None)
```

```
draw_text(self, gc, x, y, s, prop, angle, ismath=False, mtext=None)
```

Draw the text instance.

#### Parameters

**gc** [GraphicsContextBase] The graphics context.

**x** [scalar] The x location of the text in display coords.

- y** [scalar] The y location of the text baseline in display coords.
- s** [str] The text string.
- prop** [*matplotlib.font\_manager.FontProperties*] The font properties.
- angle** [scalar] The rotation angle in degrees.
- mtext** [*matplotlib.text.Text*] The original text object to be rendered.

## Notes

### backend implementers note

When you are trying to determine if you have gotten your bounding box right (which is what enables the text layout/alignment to work properly), it helps to change the line in `text.py`:

```
if 0: bbox_artist(self, renderer)
```

to if 1, and then the actual bounding box will be plotted along with your text.

`get_canvas_width_height(self)`

Return the canvas width and height in display coords.

`get_text_width_height_descent(self, s, prop, ismath)`

Get the width, height, and descent (offset from the bottom to the baseline), in display coords, of the string `s` with *FontProperties* `prop`

`lock = <unlocked _thread.RLock object owner=0 count=0>`

`option_image_nocomposite(self)`

Return whether image composition by Matplotlib should be skipped.

Raster backends should usually return `False` (letting the C-level rasterizer take care of image composition); vector backends should usually return `not rcParams["image.composite_image"]`.

`option_scale_image(self)`

Return whether arbitrary affine transformations in `draw_image()` are supported (`True` for most vector backends).

`points_to_pixels(self, points)`

Convert points to display units.

You need to override this function (unless your backend doesn't have a dpi, e.g., postscript or svg). Some imaging systems assume some value for pixels per inch:

```
points to pixels = points * pixels_per_inch/72.0 * dpi/72.0
```

## Parameters

**points** [scalar or array\_like] a float or a numpy array of float

## Returns

### Points converted to pixels

`restore_region(self, region, bbox=None, xy=None)`

Restore the saved region. If `bbox` (instance of `BboxBase`, or its extents) is given, only the region specified by the `bbox` will be restored. `xy` (a pair of floats) optionally

specifies the new position (the LLC of the original region, not the LLC of the bbox) where the region will be restored.

```
>>> region = renderer.copy_from_bbox()
>>> x1, y1, x2, y2 = region.get_extents()
>>> renderer.restore_region(region, bbox=(x1+dx, y1, x2, y2),
...                               xy=(x1-dx, y1))
```

`start_filter(self)`

Start filtering. It simply create a new canvas (the old one is saved).

`stop_filter(self, post_processing)`

Save the plot in the current canvas as a image and apply the *post\_processing* function.

```
def post_processing(image, dpi): # ny, nx, depth = image.shape # image
    (numpy array) has RGBA channels and has a depth of 4. ... # create
    a new_image (numpy array of 4 channels, size can be # different). The
    resulting image may have offsets from # lower-left corner of the original
    image return new_image, offset_x, offset_y
```

The saved renderer is restored and the returned image from *post\_processing* is plotted (using *draw\_image*) on it.

`tostring_argb(self)`

`tostring_rgb(self)`

`tostring_rgba_minimized(self)`

`matplotlib.backends.backend_agg.get_hinting_flag()`

### 17.10.3 matplotlib.backends.backend\_cairo

#### A Cairo backend for matplotlib

**Author** Steve Chaplin and others

This backend depends on `cairocffi` or `pycairo`.

```
class matplotlib.backends.backend_cairo.ArrayWrapper(**kwargs)
    Bases: object
```

[*Deprecated*] Thin wrapper around numpy ndarray to expose the interface expected by `cairocffi`. Basically replicates the `array.array` interface.

#### Notes

Deprecated since version 3.0.

`buffer_info(self)`

```
matplotlib.backends.backend_cairo.FigureCanvas
    alias of matplotlib.backends.backend_cairo.FigureCanvasCairo
```

```
class matplotlib.backends.backend_cairo.FigureCanvasCairo(figure)
    Bases: matplotlib.backends_bases.FigureCanvasBase
    print_pdf(self, fobj, *args, **kwargs)
```

```
print_png(self, fobj, *args, **kwargs)
print_ps(self, fobj, *args, **kwargs)
print_raw(self, fobj, *args, **kwargs)
print_rgba(self, fobj, *args, **kwargs)
print_svg(self, fobj, *args, **kwargs)
print_svgz(self, fobj, *args, **kwargs)
supports_blit = False
```

```
class matplotlib.backends.backend_cairo.GraphicsContextCairo(renderer)
```

```
    Bases: matplotlib.backend_bases.GraphicsContextBase
```

```
    get_rgb(self)
```

Return a tuple of three or four floats from 0-1.

```
    restore(self)
```

Restore the graphics context from the stack - needed only for backends that save graphics contexts on a stack.

```
    set_alpha(self, alpha)
```

Set the alpha value used for blending - not supported on all backends.

If `alpha=None` (the default), the alpha components of the foreground and fill colors will be used to set their respective transparencies (where applicable); otherwise, `alpha` will override them.

```
    set_capstyle(self, cs)
```

Set the capstyle to be one of ('butt', 'round', 'projecting').

```
    set_clip_path(self, path)
```

Set the clip path and transformation. Path should be a *TransformedPath* instance.

```
    set_clip_rectangle(self, rectangle)
```

Set the clip rectangle with sequence (left, bottom, width, height)

```
    set_dashes(self, offset, dashes)
```

Set the dash style for the gc.

#### Parameters

**dash\_offset** [float] is the offset (usually 0).

**dash\_list** [array\_like] specifies the on-off sequence as points. (None, None) specifies a solid line

```
    set_foreground(self, fg, isRGBA=None)
```

Set the foreground color.

#### Parameters

**fg** [color]

**isRGBA** [bool] If `fg` is known to be an (r, g, b, a) tuple, `isRGBA` can be set to True to improve performance.

```
    set_joinstyle(self, js)
```

Set the join style to be one of ('miter', 'round', 'bevel').

```
    set_linewidth(self, w)
```

Set the linewidth in points.

```
class matplotlib.backends.backend_cairo.RendererCairo(dpi)
    Bases: matplotlib.backends_bases.RendererBase

    static convert_path(ctx, path, transform, clip=None)
        [Deprecated]
```

### Notes

Deprecated since version 3.0:

```
draw_image(self, gc, x, y, im)
    Draw an RGBA image.
```

### Parameters

- gc** [GraphicsContextBase] a graphics context with clipping information.
- x** [scalar] the distance in physical units (i.e., dots or pixels) from the left hand side of the canvas.
- y** [scalar] the distance in physical units (i.e., dots or pixels) from the bottom side of the canvas.
- im** [array\_like, shape=(N, M, 4), dtype=np.uint8] An array of RGBA pixels.
- transform** [*matplotlib.transforms.Affine2DBase*] If and only if the concrete backend is written such that `option_scale_image()` returns `True`, an affine transformation *may* be passed to `draw_image()`. It takes the form of a *Affine2DBase* instance. The translation vector of the transformation is given in physical units (i.e., dots or pixels). Note that the transformation does not override `x` and `y`, and has to be applied *before* translating the result by `x` and `y` (this can be accomplished by adding `x` and `y` to the translation vector defined by `transform`).

```
draw_markers(self, gc, marker_path, marker_trans, path, transform, rgbFace=None)
    Draws a marker at each of the vertices in path. This includes all vertices, including control points on curves. To avoid that behavior, those vertices should be removed before calling this function.
```

This provides a fallback implementation of `draw_markers` that makes multiple calls to `draw_path()`. Some backends may want to override this method in order to draw the marker only once and reuse it multiple times.

### Parameters

- gc** [GraphicsContextBase] The graphics context
- marker\_trans** [*matplotlib.transforms.Transform*] An affine transform applied to the marker.
- trans** [*matplotlib.transforms.Transform*] An affine transform applied to the path.

```
draw_path(self, gc, path, transform, rgbFace=None)
    Draws a Path instance using the given affine transform.
```

```
draw_text(self, gc, x, y, s, prop, angle, ismath=False, mtext=None)
    Draw the text instance.
```

### Parameters

**gc** [GraphicsContextBase] The graphics context.

**x** [scalar] The x location of the text in display coords.

**y** [scalar] The y location of the text baseline in display coords.

**s** [str] The text string.

**prop** [*matplotlib.font\_manager.FontProperties*] The font properties.

**angle** [scalar] The rotation angle in degrees.

**mtext** [*matplotlib.text.Text*] The original text object to be rendered.

## Notes

### backend implementers note

When you are trying to determine if you have gotten your bounding box right (which is what enables the text layout/alignment to work properly), it helps to change the line in `text.py`:

```
if 0: bbox_artist(self, renderer)
```

to if 1, and then the actual bounding box will be plotted along with your text.

```
fontangles = {'italic': <MyCairoCffi name='mock.FONT_SLANT_ITALIC' id='140090861286512'>, 'normal'
```

```
fontweights = {100: <MyCairoCffi name='mock.FONT_WEIGHT_NORMAL' id='140090862217424'>, 200: <MyCai
```

```
get_canvas_width_height(self)
```

Return the canvas width and height in display coords.

```
get_text_width_height_descent(self, s, prop, ismath)
```

Get the width, height, and descent (offset from the bottom to the baseline), in display coords, of the string `s` with *FontProperties* `prop`

```
new_gc(self)
```

Return an instance of a GraphicsContextBase.

```
points_to_pixels(self, points)
```

Convert points to display units.

You need to override this function (unless your backend doesn't have a dpi, e.g., postscript or svg). Some imaging systems assume some value for pixels per inch:

```
points to pixels = points * pixels_per_inch/72.0 * dpi/72.0
```

### Parameters

**points** [scalar or array\_like] a float or a numpy array of float

### Returns

**Points converted to pixels**

```
set_ctx_from_surface(self, surface)
```

```
set_width_height(self, width, height)
```

#### 17.10.4 `matplotlib.backends.backend_gtk3agg`

**TODO** We'll add this later, importing the gtk3 backends requires an active X-session, which is not compatible with cron jobs.

#### 17.10.5 `matplotlib.backends.backend_gtk3cairo`

**TODO** We'll add this later, importing the gtk3 backends requires an active X-session, which is not compatible with cron jobs.

#### 17.10.6 `matplotlib.backends.backend_nbagg`

Interactive figures in the IPython notebook

```
class matplotlib.backends.backend_nbagg.CommSocket(manager)
    Bases: object
```

Manages the Comm connection between IPython and the browser (client).

Comms are 2 way, with the CommSocket being able to publish a message via the `send_json` method, and handle a message with `on_message`. On the JS side `figure.send_message` and `figure.ws.onmessage` do the sending and receiving respectively.

```
is_open(self)
on_close(self)
on_message(self, message)
send_binary(self, blob)
send_json(self, content)
```

```
matplotlib.backends.backend_nbagg.FigureCanvas
    alias of matplotlib.backends.backend_nbagg.FigureCanvasNbAgg
```

```
class matplotlib.backends.backend_nbagg.FigureCanvasNbAgg(*args, **kwargs)
    Bases: matplotlib.backends.backend_webagg_core.FigureCanvasWebAggCore
```

```
new_timer(self, *args, **kwargs)
```

Creates a new backend-specific subclass of `backend_bases.Timer`. This is useful for getting periodic events through the backend's native event loop. Implemented only for backends with GUIs.

##### Other Parameters

**interval** [scalar] Timer interval in milliseconds

**callbacks** [List[Tuple[callable, Tuple, Dict]]] Sequence of (func, args, kwargs) where `func(*args, **kwargs)` will be executed by the timer every *interval*.

callbacks which return `False` or `0` will be removed from the timer.

## Examples

```
>>> timer = fig.canvas.new_timer(callbacks=[(f1, (1, )), {'a': 3}],)
```

`matplotlib.backends.backend_nbagg.FigureManager`

alias of `matplotlib.backends.backend_nbagg.FigureManagerNbAgg`

`class matplotlib.backends.backend_nbagg.FigureManagerNbAgg(canvas, num)`

Bases: `matplotlib.backends.backend_webagg_core.FigureManagerWebAgg`

`ToolbarCls`

alias of `NavigationIPy`

`cleanup_closed(self)`

Clear up any closed Comms.

`connected`

`destroy(self)`

`display_js(self)`

`classmethod get_javascript(stream=None)`

`remove_comm(self, comm_id)`

`reshow(self)`

A special method to re-show the figure in the notebook.

`show(self)`

For GUI backends, show the figure window and redraw. For non-GUI backends, raise an exception to be caught by `show()`, for an optional warning.

`class matplotlib.backends.backend_nbagg.NavigationIPy(canvas)`

Bases: `matplotlib.backends.backend_webagg_core.NavigationToolbar2WebAgg`

`toolitems = [('Home', 'Reset original view', 'fa fa-home icon-home', 'home'), ('Back', 'Back to pre`

`matplotlib.backends.backend_nbagg.connection_info()`

Return a string showing the figure and connection status for the backend.

This is intended as a diagnostic tool, and not for general use.

`matplotlib.backends.backend_nbagg.new_figure_manager_given_figure(num, figure)`

Create a new figure manager instance for the given figure.

`matplotlib.backends.backend_nbagg.show(*args, block=None, **kwargs)`

Show all figures.

`show` blocks by calling `mainloop` if `block` is `True`, or if it is `None` and we are neither in IPython's `%pylab` mode, nor in interactive mode.

### 17.10.7 `matplotlib.backends.backend_pdf`

A PDF matplotlib backend Author: Jouni K Seppänen <[jks@iki.fi](mailto:jks@iki.fi)>

`matplotlib.backends.backend_pdf.FigureCanvas`

alias of `matplotlib.backends.backend_pdf.FigureCanvasPdf`

`class matplotlib.backends.backend_pdf.FigureCanvasPdf(figure)`

Bases: `matplotlib.backend_bases.FigureCanvasBase`

The canvas the figure renders into. Calls the draw and print fig methods, creates the renderers, etc...

### Attributes

**figure** [*matplotlib.figure.Figure*] A high-level Figure instance

`draw(self)`

Render the *Figure*.

`filetypes = {'pdf': 'Portable Document Format'}`

`fixed_dpi = 72`

`get_default_filetype(self)`

Get the default savefig file format as specified in rcParam `savefig.format`. Returned string excludes period. Overridden in backends that only support a single file type.

`print_pdf(self, filename, *, dpi=72, bbox_inches_restore=None, metadata=None, **kwargs)`

`class matplotlib.backends.backend_pdf.GraphicsContextPdf(file)`

Bases: *matplotlib.backend\_bases.GraphicsContextBase*

`alpha_cmd(self, alpha, forced, effective_alphas)`

`capstyle_cmd(self, style)`

`capstyles = {'butt': 0, 'projecting': 2, 'round': 1}`

`clip_cmd(self, cliprect, clippath)`

Set clip rectangle. Calls `self.pop()` and `self.push()`.

`commands = (('cliprect', '_cliprect'), <function GraphicsContextPdf.clip_cmd>), (('alpha', '_alpha'), '_for`

`copy_properties(self, other)`

Copy properties of other into self.

`dash_cmd(self, dashes)`

`delta(self, other)`

Copy properties of other into self and return PDF commands needed to transform self into other.

`fill(self, *args)`

Predicate: does the path need to be filled?

An optional argument can be used to specify an alternative `_fillcolor`, as needed by `RendererPdf.draw_markers`.

`fillcolor_cmd(self, rgb)`

`finalize(self)`

Make sure every pushed graphics state is popped.

`hatch_cmd(self, hatch, hatch_color)`

`joinstyle_cmd(self, style)`

`joinstyles = {'bevel': 2, 'miter': 0, 'round': 1}`

`linewidth_cmd(self, width)`

`paint(self)`

Return the appropriate pdf operator to cause the path to be stroked, filled, or both.

`pop(self)`

```
push(self)
rgb_cmd(self, rgb)
stroke(self)
    Predicate: does the path need to be stroked (its outline drawn)? This tests for the
    various conditions that disable stroking the path, in which case it would presumably
    be filled.
class matplotlib.backends.backend_pdf.Name(name)
    Bases: object
    PDF name object.
    static hexify(match)
    name
    pdfRepr(self)
class matplotlib.backends.backend_pdf.Operator(op)
    Bases: object
    PDF operator object.
    op
    pdfRepr(self)
class matplotlib.backends.backend_pdf.PdfFile(filename, metadata=None)
    Bases: object
    PDF file object.
    addGouraudTriangles(self, points, colors)
    alphaState(self, alpha)
        Return name of an ExtGState that sets alpha to the given value.
    beginStream(self, id, len, extra=None, png=None)
    close(self)
        Flush all buffers and free all resources.
    createType1Descriptor(self, t1font, fontfile)
    dviFontName(self, dvifont)
        Given a dvi font object, return a name suitable for Op.selectfont. This registers the
        font information in self.dviFontInfo if not yet registered.
    embedTTF(self, filename, characters)
        Embed the TTF font from the named file into the document.
    endStream(self)
    finalize(self)
        Write out the various deferred objects and the pdf end matter.
    fontName(self, fontprop)
        Select a font based on fontprop and return a name suitable for Op.selectfont. If
        fontprop is a string, it will be interpreted as the filename of the font.
    hatchPattern(self, hatch_style)
    imageObject(self, image)
        Return name of an imageXObject representing the given image.
```

```

markerObject(self, path, trans, fill, stroke, lw, joinstyle, capstyle)
    Return name of a marker XObject representing the given path.

newPage(self, width, height)

newTextnote(self, text, positionRect=[-100, -100, 0, 0])

output(self, *data)

pathCollectionObject(self, gc, path, trans, padding, filled, stroked)

static pathOperations(path, transform, clip=None, simplify=None, sketch=None)

recordXref(self, id)

reserveObject(self, name="")
    Reserve an ID for an indirect object. The name is used for debugging in case we
    forget to print out the object with writeObject.

texFontMap

write(self, data)

writeFonts(self)

writeGouraudTriangles(self)

writeHatches(self)

writeImages(self)

writeInfoDict(self)
    Write out the info dictionary, checking it for good form

writeMarkers(self)

writeObject(self, object, contents)

writePath(self, path, transform, clip=False, sketch=None)

writePathCollectionTemplates(self)

writeTrailer(self)
    Write out the PDF trailer.

writeXref(self)
    Write out the xref table.

```

```

class matplotlib.backends.backend_pdf.PdfPages(filename, keep_empty=True, meta-
data=None)

```

Bases: `object`

A multi-page PDF file.

### Notes

In reality `PdfPages` is a thin wrapper around `PdfFile`, in order to avoid confusion when using `savefig()` and forgetting the format argument.

### Examples

```

>>> import matplotlib.pyplot as plt
>>> # Initialize:
>>> with PdfPages('foo.pdf') as pdf:
...     # As many times as you like, create a figure fig and save it:
...     fig = plt.figure()
...     pdf.savefig(fig)
...     # When no figure is specified the current figure is saved
...     pdf.savefig()

```

Create a new PdfPages object.

### Parameters

**filename** [str] Plots using `PdfPages.savefig()` will be written to a file at this location. The file is opened at once and any older file with the same name is overwritten.

**keep\_empty** [bool, optional] If set to False, then empty pdf files will be deleted automatically when closed.

**metadata** [dictionary, optional] Information dictionary object (see PDF reference section 10.2.1 'Document Information Dictionary'), e.g.:  
 {'Creator': 'My software', 'Author': 'Me', 'Title': 'Awesome fig'}

The standard keys are 'Title', 'Author', 'Subject', 'Keywords', 'Creator', 'Producer', 'CreationDate', 'ModDate', and 'Trapped'. Values have been predefined for 'Creator', 'Producer' and 'CreationDate'. They can be removed by setting them to `None`.

`attach_note(self, text, positionRect=[-100, -100, 0, 0])`

Add a new text note to the page to be saved next. The optional `positionRect` specifies the position of the new note on the page. It is outside the page per default to make sure it is invisible on printouts.

`close(self)`

Finalize this object, making the underlying file a complete PDF file.

`get_pagecount(self)`

Returns the current number of pages in the multipage pdf file.

`infodict(self)`

Return a modifiable information dictionary object (see PDF reference section 10.2.1 'Document Information Dictionary').

`keep_empty`

`savefig(self, figure=None, **kwargs)`

Saves a *Figure* to this file as a new page.

Any other keyword arguments are passed to `savefig()`.

### Parameters

**figure** [*Figure* or int, optional] Specifies what figure is saved to file. If not specified, the active figure is saved. If a *Figure* instance is provided, this figure is saved. If an int is specified, the figure instance to save is looked up by number.

```

class matplotlib.backends.backend_pdf.Reference(id)
  Bases: object

```

PDF reference object. Use PdfFile.reserveObject() to create References.

`pdfRepr(self)`

`write(self, contents, file)`

`class matplotlib.backends.backend_pdf.RendererPdf(file, image_dpi, height, width)`

Bases: `matplotlib.backends._backend_pdf_ps.RendererPDFPSBase`

`afm_font_cache`

[*Deprecated*]

### Notes

Deprecated since version 3.1:

`check_gc(self, gc, fillcolor=None)`

`draw_gouraud_triangle(self, gc, points, colors, trans)`

Draw a Gouraud-shaded triangle.

#### Parameters

**points** [array\_like, shape=(3, 2)] Array of (x, y) points for the triangle.

**colors** [array\_like, shape=(3, 4)] RGBA colors for each point of the triangle.

**transform** [`matplotlib.transforms.Transform`] An affine transform to apply to the points.

`draw_gouraud_triangles(self, gc, points, colors, trans)`

Draws a series of Gouraud triangles.

#### Parameters

**points** [array\_like, shape=(N, 3, 2)] Array of *N* (x, y) points for the triangles.

**colors** [array\_like, shape=(N, 3, 4)] Array of *N* RGBA colors for each point of the triangles.

**transform** [`matplotlib.transforms.Transform`] An affine transform to apply to the points.

`draw_image(self, gc, x, y, im, transform=None)`

Draw an RGBA image.

#### Parameters

**gc** [`GraphicsContextBase`] a graphics context with clipping information.

**x** [scalar] the distance in physical units (i.e., dots or pixels) from the left hand side of the canvas.

**y** [scalar] the distance in physical units (i.e., dots or pixels) from the bottom side of the canvas.

**im** [array\_like, shape=(N, M, 4), dtype=np.uint8] An array of RGBA pixels.

**transform** [`matplotlib.transforms.Affine2DBase`] If and only if the concrete backend is written such that `option_scale_image()` returns True, an affine transformation *may* be passed to `draw_image()`. It takes the

form of a *Affine2DBase* instance. The translation vector of the transformation is given in physical units (i.e., dots or pixels). Note that the transformation does not override *x* and *y*, and has to be applied *before* translating the result by *x* and *y* (this can be accomplished by adding *x* and *y* to the translation vector defined by *transform*).

`draw_markers(self, gc, marker_path, marker_trans, path, trans, rgbFace=None)`

Draws a marker at each of the vertices in *path*. This includes all vertices, including control points on curves. To avoid that behavior, those vertices should be removed before calling this function.

This provides a fallback implementation of `draw_markers` that makes multiple calls to `draw_path()`. Some backends may want to override this method in order to draw the marker only once and reuse it multiple times.

### Parameters

**gc** [GraphicsContextBase] The graphics context

**marker\_trans** [*matplotlib.transforms.Transform*] An affine transform applied to the marker.

**trans** [*matplotlib.transforms.Transform*] An affine transform applied to the path.

`draw_mathtext(self, gc, x, y, s, prop, angle)`

`draw_path(self, gc, path, transform, rgbFace=None)`

Draws a *Path* instance using the given affine transform.

`draw_path_collection(self, gc, master_transform, paths, all_transforms, offsets, offsetTrans, facecolors, edgecolors, linewidths, linestyle, antialiaseds, urls, offset_position)`

Draws a collection of paths selecting drawing properties from the lists *facecolors*, *edgecolors*, *linewidths*, *linestyle* and *antialiaseds*. *offsets* is a list of offsets to apply to each of the paths. The offsets in *offsets* are first transformed by *offsetTrans* before being applied. *offset\_position* may be either "screen" or "data" depending on the space that the offsets are in.

This provides a fallback implementation of `draw_path_collection()` that makes multiple calls to `draw_path()`. Some backends may want to override this in order to render each set of path data only once, and then reference that path multiple times with the different offsets, colors, styles etc. The generator methods `_iter_collection_raw_paths()` and `_iter_collection()` are provided to help with (and standardize) the implementation across backends. It is highly recommended to use those generators, so that changes to the behavior of `draw_path_collection()` can be made globally.

`draw_tex(self, gc, x, y, s, prop, angle, ismath='TeX!', mtext=None)`

`draw_text(self, gc, x, y, s, prop, angle, ismath=False, mtext=None)`

Draw the text instance.

### Parameters

**gc** [GraphicsContextBase] The graphics context.

**x** [scalar] The x location of the text in display coords.

**y** [scalar] The y location of the text baseline in display coords.

**s** [str] The text string.

**prop** [*matplotlib.font\_manager.FontProperties*] The font properties.  
**angle** [scalar] The rotation angle in degrees.  
**mtext** [*matplotlib.text.Text*] The original text object to be rendered.

## Notes

### backend implementers note

When you are trying to determine if you have gotten your bounding box right (which is what enables the text layout/alignment to work properly), it helps to change the line in `text.py`:

```
if 0: bbox_artist(self, renderer)
```

to if 1, and then the actual bounding box will be plotted along with your text.

`encode_string(self, s, fonttype)`

`finalize(self)`

`get_image_magnification(self)`

Get the factor by which to magnify images passed to `draw_image()`. Allows a backend to have images at a different resolution to other artists.

`merge_used_characters(self, other)`

`new_gc(self)`

Return an instance of a `GraphicsContextBase`.

`track_characters(self, font, s)`

Keeps track of which characters are required from each font.

```
class matplotlib.backends.backend_pdf.Stream(id, len, file, extra=None, png=None)
```

Bases: `object`

PDF stream object.

This has no `pdfRepr` method. Instead, call `begin()`, then output the contents of the stream by calling `write()`, and finally call `end()`.

`id`: object id of stream; `len`: an unused `Reference` object for the length of the stream, or `None` (to use a memory buffer); `file`: a `PdfFile`; `extra`: a dictionary of extra key-value pairs to include in the stream header; `png`: if the data is already png compressed, the decode parameters

`compressobj`

`end(self)`

Finalize stream.

`extra`

`file`

`id`

`len`

`pdfFile`

`pos`

```
write(self, data)
```

Write some data on the stream.

```
class matplotlib.backends.backend_pdf.Verbatim(x)
```

Bases: `object`

Store verbatim PDF command content for later inclusion in the stream.

```
pdfRepr(self)
```

```
matplotlib.backends.backend_pdf.fill(strings, linelen=75)
```

Make one string from sequence of strings, with whitespace in between. The whitespace is chosen to form lines of at most `linelen` characters, if possible.

```
matplotlib.backends.backend_pdf.pdfRepr(obj)
```

Map Python objects to PDF syntax.

### 17.10.8 `matplotlib.backends.backend_pgf`

```
matplotlib.backends.backend_pgf.FigureCanvas
```

alias of `matplotlib.backends.backend_pgf.FigureCanvasPgf`

```
class matplotlib.backends.backend_pgf.FigureCanvasPgf(figure)
```

Bases: `matplotlib.backends.backend_bases.FigureCanvasBase`

```
filetypes = {'pdf': 'LaTeX compiled PGF picture', 'pgf': 'LaTeX PGF picture', 'png': 'Portable Net
```

```
get_default_filetype(self)
```

Get the default savefig file format as specified in `rcParam savefig.format`. Returned string excludes period. Overridden in backends that only support a single file type.

```
get_renderer(self)
```

```
print_pdf(self, fname_or_fh, *args, **kwargs)
```

Use LaTeX to compile a Pgf generated figure to PDF.

```
print_pgf(self, fname_or_fh, *args, **kwargs)
```

Output pgf commands for drawing the figure so it can be included and rendered in latex documents.

```
print_png(self, fname_or_fh, *args, **kwargs)
```

Use LaTeX to compile a pgf figure to pdf and convert it to png.

```
matplotlib.backends.backend_pgf.FigureManager
```

alias of `matplotlib.backends.backend_pgf.FigureManagerPgf`

```
class matplotlib.backends.backend_pgf.FigureManagerPgf(canvas, num)
```

Bases: `matplotlib.backends.backend_bases.FigureManagerBase`

```
class matplotlib.backends.backend_pgf.GraphicsContextPgf
```

Bases: `matplotlib.backends.backend_bases.GraphicsContextBase`

```
exception matplotlib.backends.backend_pgf.LatexError(message, latex_output="")
```

Bases: `Exception`

```
class matplotlib.backends.backend_pgf.LatexManager
```

Bases: `object`

The `LatexManager` opens an instance of the LaTeX application for determining the metrics of text elements. The LaTeX environment can be modified by setting fonts and/or a custom preamble in the `rc` parameters.

`get_width_height_descent(self, text, prop)`  
 Get the width, total height and descent for a text typeset by the current LaTeX environment.

```
class matplotlib.backends.backend_pgf.LatexManagerFactory(**kwargs)
    Bases: object
    [Deprecated]
```

### Notes

Deprecated since version 3.1:

```
static get_latex_manager()
previous_instance = None
```

```
class matplotlib.backends.backend_pgf.PdfPages(filename, *, keep_empty=True, metadata=None)
```

Bases: object

A multi-page PDF file using the pgf backend

### Examples

```
>>> import matplotlib.pyplot as plt
>>> # Initialize:
>>> with PdfPages('foo.pdf') as pdf:
...     # As many times as you like, create a figure fig and save it:
...     fig = plt.figure()
...     pdf.savefig(fig)
...     # When no figure is specified the current figure is saved
...     pdf.savefig()
```

Create a new PdfPages object.

### Parameters

**filename** [str] Plots using `PdfPages.savefig()` will be written to a file at this location. Any older file with the same name is overwritten.

**keep\_empty** [bool, optional] If set to False, then empty pdf files will be deleted automatically when closed.

**metadata** [dictionary, optional] Information dictionary object (see PDF reference section 10.2.1 'Document Information Dictionary'), e.g.:  
 {'Creator': 'My software', 'Author': 'Me', 'Title': 'Awesome fig'}

The standard keys are 'Title', 'Author', 'Subject', 'Keywords', 'Producer', 'Creator' and 'Trapped'. Values have been predefined for 'Creator' and 'Producer'. They can be removed by setting them to the empty string.

`close(self)`

Finalize this object, running LaTeX in a temporary directory and moving the final pdf file to filename.

`get_pagecount(self)`

Returns the current number of pages in the multipage pdf file.

`keep_empty`

`metadata`

`savefig(self, figure=None, **kwargs)`

Saves a *Figure* to this file as a new page.

Any other keyword arguments are passed to `savefig()`.

### Parameters

**figure** [*Figure* or int, optional] Specifies what figure is saved to file. If not specified, the active figure is saved. If a *Figure* instance is provided, this figure is saved. If an int is specified, the figure instance to save is looked up by number.

`class matplotlib.backends.backend_pgf.RendererPgf (figure, fh, dummy=False)`

Bases: `matplotlib.backend_bases.RendererBase`

Creates a new PGF renderer that translates any drawing instruction into text commands to be interpreted in a latex pgfpicture environment.

### Attributes

**figure** [`matplotlib.figure.Figure`] Matplotlib figure to initialize height, width and dpi from.

**fh** [file-like] File handle for the output of the drawing commands.

`draw_image(self, gc, x, y, im, transform=None)`

Draw an RGBA image.

### Parameters

**gc** [`GraphicsContextBase`] a graphics context with clipping information.

**x** [scalar] the distance in physical units (i.e., dots or pixels) from the left hand side of the canvas.

**y** [scalar] the distance in physical units (i.e., dots or pixels) from the bottom side of the canvas.

**im** [array\_like, shape=(N, M, 4), dtype=np.uint8] An array of RGBA pixels.

**transform** [`matplotlib.transforms.Affine2DBase`] If and only if the concrete backend is written such that `option_scale_image()` returns True, an affine transformation may be passed to `draw_image()`. It takes the form of a `Affine2DBase` instance. The translation vector of the transformation is given in physical units (i.e., dots or pixels). Note that the transformation does not override *x* and *y*, and has to be applied *before* translating the result by *x* and *y* (this can be accomplished by adding *x* and *y* to the translation vector defined by `transform`).

`draw_markers(self, gc, marker_path, marker_trans, path, trans, rgbFace=None)`

Draws a marker at each of the vertices in `path`. This includes all vertices, including control points on curves. To avoid that behavior, those vertices should be removed before calling this function.

This provides a fallback implementation of `draw_markers` that makes multiple calls to `draw_path()`. Some backends may want to override this method in order to draw the marker only once and reuse it multiple times.

### Parameters

**gc** [GraphicsContextBase] The graphics context

**marker\_trans** [*matplotlib.transforms.Transform*] An affine transform applied to the marker.

**trans** [*matplotlib.transforms.Transform*] An affine transform applied to the path.

`draw_path(self, gc, path, transform, rgbFace=None)`

Draws a *Path* instance using the given affine transform.

`draw_tex(self, gc, x, y, s, prop, angle, ismath='TeX!', mtext=None)`

`draw_text(self, gc, x, y, s, prop, angle, ismath=False, mtext=None)`

Draw the text instance.

### Parameters

**gc** [GraphicsContextBase] The graphics context.

**x** [scalar] The x location of the text in display coords.

**y** [scalar] The y location of the text baseline in display coords.

**s** [str] The text string.

**prop** [*matplotlib.font\_manager.FontProperties*] The font properties.

**angle** [scalar] The rotation angle in degrees.

**mtext** [*matplotlib.text.Text*] The original text object to be rendered.

### Notes

#### backend implementers note

When you are trying to determine if you have gotten your bounding box right (which is what enables the text layout/alignment to work properly), it helps to change the line in `text.py`:

```
if 0: bbox_artist(self, renderer)
```

to `if 1`, and then the actual bounding box will be plotted along with your text.

`flipy(self)`

Return whether y values increase from top to bottom.

Note that this only affects drawing of texts and images.

`get_canvas_width_height(self)`

Return the canvas width and height in display coords.

`get_text_width_height_descent(self, s, prop, ismath)`

Get the width, height, and descent (offset from the bottom to the baseline), in display coords, of the string *s* with *FontProperties* *prop*

`new_gc(self)`

Return an instance of a *GraphicsContextBase*.

`option_image_nocomposite(self)`

Return whether image composition by Matplotlib should be skipped.

Raster backends should usually return `False` (letting the C-level rasterizer take care of image composition); vector backends should usually return `not rcParams["image.composite_image"]`.

`option_scale_image(self)`

Return whether arbitrary affine transformations in `draw_image()` are supported (`True` for most vector backends).

`points_to_pixels(self, points)`

Convert points to display units.

You need to override this function (unless your backend doesn't have a `dpi`, e.g., `postscript` or `svg`). Some imaging systems assume some value for pixels per inch:

```
points to pixels = points * pixels_per_inch/72.0 * dpi/72.0
```

### Parameters

**points** [scalar or array\_like] a float or a numpy array of float

### Returns

**Points converted to pixels**

```
class matplotlib.backends.backend_pgf.TmpDirCleaner
```

```
    Bases: object
```

```
    static add(tmpdir)
```

```
    static cleanup_remaining_tmpdirs()
```

```
    remaining_tmpdirs = {}
```

```
matplotlib.backends.backend_pgf.common_texification(text)
```

Do some necessary and/or useful substitutions for texts to be included in LaTeX documents.

```
matplotlib.backends.backend_pgf.get_fontspec()
```

Build fontspec preamble from rc.

```
matplotlib.backends.backend_pgf.get_preamble()
```

Get LaTeX preamble from rc.

```
matplotlib.backends.backend_pgf.get_texcommand()
```

[*Deprecated*] Get chosen TeX system from rc.

### Notes

Deprecated since version 3.0.

```
matplotlib.backends.backend_pgf.make_pdf_to_png_converter()
```

Returns a function that converts a pdf file to a png file.

```
matplotlib.backends.backend_pgf.repl_escapetext(m)
```

```
matplotlib.backends.backend_pgf.repl_mathdefault(m)
```

```
matplotlib.backends.backend_pgf.writeln(fh, line)
```

### 17.10.9 matplotlib.backends.backend\_ps

A PostScript backend, which can produce both PostScript .ps and .eps.

```
matplotlib.backends.backend_ps.FigureCanvas
    alias of matplotlib.backends.backend_ps.FigureCanvasPS

class matplotlib.backends.backend_ps.FigureCanvasPS(figure)
    Bases: matplotlib.backend_bases.FigureCanvasBase

    draw(self)
        Render the Figure.

    filetypes = {'eps': 'Encapsulated Postscript', 'ps': 'Postscript'}

    fixed_dpi = 72

    get_default_filetype(self)
        Get the default savefig file format as specified in rcParam savefig.format. Returned
        string excludes period. Overridden in backends that only support a single file type.

    print_eps(self, outfile, *args, **kwargs)

    print_ps(self, outfile, *args, **kwargs)

class matplotlib.backends.backend_ps.GraphicsContextPS
    Bases: matplotlib.backend_bases.GraphicsContextBase

    get_capstyle(self)
        Return the capstyle as a string in ('butt', 'round', 'projecting').

    get_joinstyle(self)
        Return the line join style as one of ('miter', 'round', 'bevel').

    shouldstroke(self)
        [Deprecated]
```

#### Notes

Deprecated since version 3.1:

```
class matplotlib.backends.backend_ps.PsBackendHelper
    Bases: object

    gs_exe

    gs_version

    supports_ps2write

class matplotlib.backends.backend_ps.RendererPS(width, height, pswriter, im-
    agedpi=72)
    Bases: matplotlib.backends._backend_pdf_ps.RendererPDFPSBase

    The renderer handles all the drawing primitives using a graphics context instance that
    controls the colors/styles.

    afmfontd
        [Deprecated]
```

## Notes

Deprecated since version 3.1:

`create_hatch(self, hatch)`

`draw_gouraud_triangle(self, gc, points, colors, trans)`

Draw a Gouraud-shaded triangle.

### Parameters

**points** [array\_like, shape=(3, 2)] Array of (x, y) points for the triangle.

**colors** [array\_like, shape=(3, 4)] RGBA colors for each point of the triangle.

**transform** [*matplotlib.transforms.Transform*] An affine transform to apply to the points.

`draw_gouraud_triangles(self, gc, points, colors, trans)`

Draws a series of Gouraud triangles.

### Parameters

**points** [array\_like, shape=(N, 3, 2)] Array of *N* (x, y) points for the triangles.

**colors** [array\_like, shape=(N, 3, 4)] Array of *N* RGBA colors for each point of the triangles.

**transform** [*matplotlib.transforms.Transform*] An affine transform to apply to the points.

`draw_image(self, gc, x, y, im, transform=None)`

Draw an RGBA image.

### Parameters

**gc** [*GraphicsContextBase*] a graphics context with clipping information.

**x** [scalar] the distance in physical units (i.e., dots or pixels) from the left hand side of the canvas.

**y** [scalar] the distance in physical units (i.e., dots or pixels) from the bottom side of the canvas.

**im** [array\_like, shape=(N, M, 4), dtype=np.uint8] An array of RGBA pixels.

**transform** [*matplotlib.transforms.Affine2DBase*] If and only if the concrete backend is written such that `option_scale_image()` returns True, an affine transformation *may* be passed to `draw_image()`. It takes the form of a *Affine2DBase* instance. The translation vector of the transformation is given in physical units (i.e., dots or pixels). Note that the transformation does not override *x* and *y*, and has to be applied *before* translating the result by *x* and *y* (this can be accomplished by adding *x* and *y* to the translation vector defined by `transform`).

`draw_markers(self, gc, marker_path, marker_trans, path, trans, rgbFace=None)`

Draws a marker at each of the vertices in `path`. This includes all vertices, including control points on curves. To avoid that behavior, those vertices should be removed before calling this function.

This provides a fallback implementation of `draw_markers` that makes multiple calls to `draw_path()`. Some backends may want to override this method in order to draw the marker only once and reuse it multiple times.

### Parameters

**gc** [GraphicsContextBase] The graphics context

**marker\_trans** [*matplotlib.transforms.Transform*] An affine transform applied to the marker.

**trans** [*matplotlib.transforms.Transform*] An affine transform applied to the path.

`draw_mathtext(self, gc, x, y, s, prop, angle)`

Draw the math text using `matplotlib.mathtext`.

`draw_path(self, gc, path, transform, rgbFace=None)`

Draws a *Path* instance using the given affine transform.

`draw_path_collection(self, gc, master_transform, paths, all_transforms, offsets, offsetTrans, facecolors, edgecolors, linewidths, linestyle, antialiaseds, urls, offset_position)`

Draws a collection of paths selecting drawing properties from the lists *facecolors*, *edgecolors*, *linewidths*, *linestyle* and *antialiaseds*. *offsets* is a list of offsets to apply to each of the paths. The offsets in *offsets* are first transformed by *offsetTrans* before being applied. *offset\_position* may be either "screen" or "data" depending on the space that the offsets are in.

This provides a fallback implementation of `draw_path_collection()` that makes multiple calls to `draw_path()`. Some backends may want to override this in order to render each set of path data only once, and then reference that path multiple times with the different offsets, colors, styles etc. The generator methods `_iter_collection_raw_paths()` and `_iter_collection()` are provided to help with (and standardize) the implementation across backends. It is highly recommended to use those generators, so that changes to the behavior of `draw_path_collection()` can be made globally.

`draw_tex(self, gc, x, y, s, prop, angle, ismath='TeX!', mtext=None)`

`draw_text(self, gc, x, y, s, prop, angle, ismath=False, mtext=None)`

Draw the text instance.

### Parameters

**gc** [GraphicsContextBase] The graphics context.

**x** [scalar] The x location of the text in display coords.

**y** [scalar] The y location of the text baseline in display coords.

**s** [str] The text string.

**prop** [*matplotlib.font\_manager.FontProperties*] The font properties.

**angle** [scalar] The rotation angle in degrees.

**mtext** [*matplotlib.text.Text*] The original text object to be rendered.

### Notes

#### backend implementers note

When you are trying to determine if you have gotten your bounding box right (which is what enables the text layout/alignment to work properly), it helps to change the line in `text.py`:

```
if 0: bbox_artist(self, renderer)
```

to if 1, and then the actual bounding box will be plotted along with your text.

`get_image_magnification(self)`

Get the factor by which to magnify images passed to `draw_image`. Allows a backend to have images at a different resolution to other artists.

`merge_used_characters(self, other)`

`new_gc(self)`

Return an instance of a `GraphicsContextBase`.

`set_color(self, r, g, b, store=1)`

`set_font(self, fontname, fontsize, store=1)`

`set_linecap(self, linecap, store=1)`

`set_linedash(self, offset, seq, store=1)`

`set_linejoin(self, linejoin, store=1)`

`set_linewidth(self, linewidth, store=1)`

`track_characters(self, font, s)`

Keeps track of which characters are required from each font.

`matplotlib.backends.backend_ps.convert_psfrags(tmpfile, psfrags, font_preamble, custom_preamble, paperWidth, paperHeight, orientation)`

When we want to use the LaTeX backend with postscript, we write PSFrag tags to a temporary postscript file, each one marking a position for LaTeX to render some text. `convert_psfrags` generates a LaTeX document containing the commands to convert those tags to text. LaTeX/dvips produces the postscript file that includes the actual text.

`matplotlib.backends.backend_ps.get_bbox(tmpfile, bbox)`

[*Deprecated*] Use ghostscript's `bbox` device to find the center of the bounding box. Return an appropriately sized `bbox` centered around that point. A bit of a hack.

## Notes

Deprecated since version 3.0.

`matplotlib.backends.backend_ps.get_bbox_header(lbrt, rotated=False)`

return a postscript header string for the given `bbox` `lbrt`=(l, b, r, t). Optionally, return rotate command.

`matplotlib.backends.backend_ps.gs_distill(tmpfile, eps=False, ptype='letter', bbox=None, rotated=False)`

Use ghostscript's `pswrite` or `epswrite` device to distill a file. This yields smaller files without illegal encapsulated postscript operators. The output is low-level, converting text to outlines.

`matplotlib.backends.backend_ps.pstoeps(tmpfile, bbox=None, rotated=False)`

Convert the postscript to encapsulated postscript. The `bbox` of the eps file will be replaced with the given `bbox` argument. If `None`, original `bbox` will be used.

`matplotlib.backends.backend_ps.quote_ps_string(s)`

Quote dangerous characters of S for use in a PostScript string constant.

`matplotlib.backends.backend_ps.xpdf_distill(tmpfile, eps=False, ptype='letter',  
bbox=None, rotated=False)`

Use ghostscript's ps2pdf and xpdf's/poppler's pdftops to distill a file. This yields smaller files without illegal encapsulated postscript operators. This distiller is preferred, generating high-level postscript output that treats text as text.

### 17.10.10 `matplotlib.backends.backend_qt4agg`

**NOTE** Not included, to avoid adding a dependency to building the docs.

### 17.10.11 `matplotlib.backends.backend_qt4cairo`

**NOTE** Not included, to avoid adding a dependency to building the docs.

### 17.10.12 `matplotlib.backends.backend_qt5agg`

**NOTE** Not included, to avoid adding a dependency to building the docs.

### 17.10.13 `matplotlib.backends.backend_qt5cairo`

**NOTE** Not included, to avoid adding a dependency to building the docs.

### 17.10.14 `matplotlib.backends.backend_svg`

`matplotlib.backends.backend_svg.FigureCanvas`

alias of `matplotlib.backends.backend_svg.FigureCanvasSVG`

`class matplotlib.backends.backend_svg.FigureCanvasSVG(figure)`

Bases: `matplotlib.backend_bases.FigureCanvasBase`

`filetypes = {'svg': 'Scalable Vector Graphics', 'svgz': 'Scalable Vector Graphics'}`

`fixed_dpi = 72`

`get_default_filetype(self)`

Get the default savefig file format as specified in rcParam `savefig.format`. Returned string excludes period. Overridden in backends that only support a single file type.

`print_svg(self, filename, *args, **kwargs)`

`print_svgz(self, filename, *args, **kwargs)`

`class matplotlib.backends.backend_svg.RendererSVG(width, height, svgwriter, base-  
name=None, image_dpi=72)`

Bases: `matplotlib.backend_bases.RendererBase`

`close_group(self, s)`

Close a grouping element with label *s*

Only used by the SVG renderer.

`draw_gouraud_triangle(self, gc, points, colors, trans)`  
Draw a Gouraud-shaded triangle.

**Parameters**

**points** [array\_like, shape=(3, 2)] Array of (x, y) points for the triangle.

**colors** [array\_like, shape=(3, 4)] RGBA colors for each point of the triangle.

**transform** [*matplotlib.transforms.Transform*] An affine transform to apply to the points.

`draw_gouraud_triangles(self, gc, triangles_array, colors_array, transform)`  
Draws a series of Gouraud triangles.

**Parameters**

**points** [array\_like, shape=(N, 3, 2)] Array of *N* (x, y) points for the triangles.

**colors** [array\_like, shape=(N, 3, 4)] Array of *N* RGBA colors for each point of the triangles.

**transform** [*matplotlib.transforms.Transform*] An affine transform to apply to the points.

`draw_image(self, gc, x, y, im, transform=None)`  
Draw an RGBA image.

**Parameters**

**gc** [*GraphicsContextBase*] a graphics context with clipping information.

**x** [scalar] the distance in physical units (i.e., dots or pixels) from the left hand side of the canvas.

**y** [scalar] the distance in physical units (i.e., dots or pixels) from the bottom side of the canvas.

**im** [array\_like, shape=(N, M, 4), dtype=np.uint8] An array of RGBA pixels.

**transform** [*matplotlib.transforms.Affine2DBase*] If and only if the concrete backend is written such that *option\_scale\_image()* returns True, an affine transformation *may* be passed to *draw\_image()*. It takes the form of a *Affine2DBase* instance. The translation vector of the transformation is given in physical units (i.e., dots or pixels). Note that the transformation does not override *x* and *y*, and has to be applied *before* translating the result by *x* and *y* (this can be accomplished by adding *x* and *y* to the translation vector defined by *transform*).

`draw_markers(self, gc, marker_path, marker_trans, path, trans, rgbFace=None)`  
Draws a marker at each of the vertices in *path*. This includes all vertices, including control points on curves. To avoid that behavior, those vertices should be removed before calling this function.

This provides a fallback implementation of `draw_markers` that makes multiple calls to `draw_path()`. Some backends may want to override this method in order to draw the marker only once and reuse it multiple times.

**Parameters**

**gc** [*GraphicsContextBase*] The graphics context

**marker\_trans** [*matplotlib.transforms.Transform*] An affine transform applied to the marker.

**trans** [*matplotlib.transforms.Transform*] An affine transform applied to the path.

`draw_path(self, gc, path, transform, rgbFace=None)`  
 Draws a *Path* instance using the given affine transform.

`draw_path_collection(self, gc, master_transform, paths, all_transforms, offsets, offsetTrans, facecolors, edgecolors, linewidths, linestyle, antialiaseds, urls, offset_position)`

Draws a collection of paths selecting drawing properties from the lists *facecolors*, *edgecolors*, *linewidths*, *linestyle* and *antialiaseds*. *offsets* is a list of offsets to apply to each of the paths. The offsets in *offsets* are first transformed by *offsetTrans* before being applied. *offset\_position* may be either "screen" or "data" depending on the space that the offsets are in.

This provides a fallback implementation of *draw\_path\_collection()* that makes multiple calls to *draw\_path()*. Some backends may want to override this in order to render each set of path data only once, and then reference that path multiple times with the different offsets, colors, styles etc. The generator methods *\_iter\_collection\_raw\_paths()* and *\_iter\_collection()* are provided to help with (and standardize) the implementation across backends. It is highly recommended to use those generators, so that changes to the behavior of *draw\_path\_collection()* can be made globally.

`draw_tex(self, gc, x, y, s, prop, angle, ismath='TeX!', mtext=None)`

`draw_text(self, gc, x, y, s, prop, angle, ismath=False, mtext=None)`  
 Draw the text instance.

### Parameters

**gc** [*GraphicsContextBase*] The graphics context.

**x** [scalar] The x location of the text in display coords.

**y** [scalar] The y location of the text baseline in display coords.

**s** [str] The text string.

**prop** [*matplotlib.font\_manager.FontProperties*] The font properties.

**angle** [scalar] The rotation angle in degrees.

**mtext** [*matplotlib.text.Text*] The original text object to be rendered.

### Notes

#### backend implementers note

When you are trying to determine if you have gotten your bounding box right (which is what enables the text layout/alignment to work properly), it helps to change the line in `text.py`:

```
if 0: bbox_artist(self, renderer)
```

to if 1, and then the actual bounding box will be plotted along with your text.

```
finalize(self)
```

`flipy(self)`

Return whether y values increase from top to bottom.

Note that this only affects drawing of texts and images.

`get_canvas_width_height(self)`

Return the canvas width and height in display coords.

`get_image_magnification(self)`

Get the factor by which to magnify images passed to `draw_image()`. Allows a backend to have images at a different resolution to other artists.

`get_text_width_height_descent(self, s, prop, ismath)`

Get the width, height, and descent (offset from the bottom to the baseline), in display coords, of the string `s` with `FontProperties prop`

`open_group(self, s, gid=None)`

Open a grouping element with label `s` and `gid` (if set) as id.

Only used by the SVG renderer.

`option_image_nocomposite(self)`

Return whether image composition by Matplotlib should be skipped.

Raster backends should usually return `False` (letting the C-level rasterizer take care of image composition); vector backends should usually return `not rcParams["image.composite_image"]`.

`option_scale_image(self)`

Return whether arbitrary affine transformations in `draw_image()` are supported (`True` for most vector backends).

`class matplotlib.backends.backend_svg.XMLWriter(file)`

Bases: `object`

### Parameters

**file** [writable text file-like object]

`close(self, id)`

Closes open elements, up to (and including) the element identified by the given identifier.

### Parameters

**id** Element identifier, as returned by the `start()` method.

`comment(self, comment)`

Adds a comment to the output stream.

### Parameters

**comment** [str] Comment text.

`data(self, text)`

Adds character data to the output stream.

### Parameters

**text** [str] Character data.

`element(self, tag, text=None, attrib={}, **extra)`

Adds an entire element. This is the same as calling `start()`, `data()`, and `end()` in sequence. The `text` argument can be omitted.

`end(self, tag=None, indent=True)`

Closes the current element (opened by the most recent call to `start()`).

#### Parameters

**tag** Element tag. If given, the tag must match the start tag. If omitted, the current element is closed.

`flush(self)`

Flushes the output stream.

`start(self, tag, attrib={}, **extra)`

Opens a new element. Attributes can be given as keyword arguments, or as a string/string dictionary. The method returns an opaque identifier that can be passed to the `close()` method, to close all open elements up to and including this one.

#### Parameters

**tag** Element tag.

**attrib** Attribute dictionary. Alternatively, attributes can be given as keyword arguments.

#### Returns

**An element identifier.**

`matplotlib.backends.backend_svg.escape_attrib(s)`

`matplotlib.backends.backend_svg.escape_cdata(s)`

`matplotlib.backends.backend_svg.escape_comment(s)`

`matplotlib.backends.backend_svg.generate_css(attrib={})`

`matplotlib.backends.backend_svg.generate_transform(transform_list=[])`

`matplotlib.backends.backend_svg.short_float_fmt(x)`

Create a short string representation of a float, which is %f formatting with trailing zeros and the decimal point removed.

### 17.10.15 `matplotlib.backends.backend_tkagg`

`matplotlib.backends.backend_tkagg.FigureCanvas`

alias of `matplotlib.backends.backend_tkagg.FigureCanvasTkAgg`

`class matplotlib.backends.backend_tkagg.FigureCanvasTkAgg(figure, master=None, resize_callback=None)`

Bases: `matplotlib.backends.backend_agg.FigureCanvasAgg`, `matplotlib.backends._backend_tk.FigureCanvasTk`

`blit(self, bbox=None)`

Blit the canvas in `bbox` (default entire canvas).

`draw(self)`

Draw the figure using the renderer.

### 17.10.16 `matplotlib.backends.backend_webagg`

**Note:** The WebAgg backend is not documented here, in order to avoid adding Tornado to the doc build requirements.

---

### 17.10.17 `matplotlib.backends.backend_wxagg`

**NOTE** Not included, to avoid adding a dependency to building the docs.

## 17.11 `matplotlib.blocking_input`

This provides several classes used for blocking interaction with figure windows:

*BlockingInput* Creates a callable object to retrieve events in a blocking way for interactive sessions. Base class of the other classes listed here.

*BlockingKeyMouseEvent* Creates a callable object to retrieve key or mouse clicks in a blocking way for interactive sessions. Used by `waitforbuttonpress`.

*BlockingMouseEvent* Creates a callable object to retrieve mouse clicks in a blocking way for interactive sessions. Used by `ginput`.

*BlockingContourLabeler* Creates a callable object to retrieve mouse clicks in a blocking way that will then be used to place labels on a `ContourSet`. Used by `clabel`.

```
class matplotlib.blocking_input.BlockingContourLabeler(CS)
    Bases: matplotlib.blocking_input.BlockingMouseEvent
```

Callable for retrieving mouse clicks and key presses in a blocking way.

Used to place contour labels.

```
add_click(self, event)
```

Add the coordinates of an event to the list of clicks.

#### Parameters

**event** [*MouseEvent*]

```
button1(self, event)
```

Process an button-1 event (add a label to a contour).

#### Parameters

**event** [*MouseEvent*]

```
button3(self, event)
```

Process an button-3 event (remove a label if not in inline mode).

Unfortunately, if one is doing inline labels, then there is currently no way to fix the broken contour - once humpty-dumpty is broken, he can't be put back together. In inline mode, this does nothing.

#### Parameters

**event** [*MouseEvent*]

```
pop_click(self, event, index=-1)
```

Remove a click (by default, the last) from the list of clicks.

**Parameters****event** [*MouseEvent*]`class matplotlib.blocking_input.BlockingInput(fig, eventslist=())`Bases: `object`

Callable for retrieving events in a blocking way.

`add_event(self, event)`

For base class, this just appends an event to events.

`cleanup(self)`

Disconnect all callbacks.

`on_event(self, event)`

Event handler; will be passed to the current figure to retrieve events.

`pop(self, index=-1)`

Remove an event from the event list - by default, the last.

Note that this does not check that there are events, much like the normal pop method. If no events exist, this will throw an exception.

`pop_event(self, index=-1)`

Remove an event from the event list - by default, the last.

Note that this does not check that there are events, much like the normal pop method. If no events exist, this will throw an exception.

`post_event(self)`

For baseclass, do nothing but collect events.

`class matplotlib.blocking_input.BlockingKeyMouseInput(fig)`Bases: `matplotlib.blocking_input.BlockingInput`

Callable for retrieving mouse clicks and key presses in a blocking way.

`post_event(self)`

Determine if it is a key event.

`class matplotlib.blocking_input.BlockingMouseInput(fig, mouse_add=1, mouse_pop=3,  
mouse_stop=2)`Bases: `matplotlib.blocking_input.BlockingInput`

Callable for retrieving mouse clicks in a blocking way.

This class will also retrieve keypresses and map them to mouse clicks: delete and backspace are like mouse button 3, enter is like mouse button 2 and all others are like mouse button 1.

`add_click(self, event)`

Add the coordinates of an event to the list of clicks.

**Parameters****event** [*MouseEvent*]`button_add = 1``button_pop = 3``button_stop = 2``cleanup(self, event=None)`

**Parameters****event** [*MouseEvent*, optional] Not used`key_event(self)`

Process a key press event, mapping keys to appropriate mouse clicks.

`mouse_event(self)`

Process a mouse click event.

`mouse_event_add(self, event)`

Process an button-1 event (add a click if inside axes).

**Parameters****event** [*MouseEvent*]`mouse_event_pop(self, event)`

Process an button-3 event (remove the last click).

**Parameters****event** [*MouseEvent*]`mouse_event_stop(self, event)`

Process an button-2 event (end blocking input).

**Parameters****event** [*MouseEvent*]`pop(self, event, index=-1)`

Removes a click and the associated event from the list of clicks.

Defaults to the last click.

`pop_click(self, event, index=-1)`

Remove a click (by default, the last) from the list of clicks.

**Parameters****event** [*MouseEvent*]`post_event(self)`

Process an event.

## 17.12 matplotlib.category

Module that allows plotting of string "category" data. i.e. `plot(['d', 'f', 'a'], [1, 2, 3])` will plot three points with x-axis values of 'd', 'f', 'a'.

See [/gallery/lines\\_bars\\_and\\_markers/categorical\\_variables](#) for an example.

The module uses Matplotlib's `matplotlib.units` mechanism to convert from strings to integers, provides a tick locator and formatter, and the class: `UnitData` that creates and stores the string-to-integer mapping.

```
class matplotlib.category.StrCategoryConverter
    Bases: matplotlib.units.ConversionInterface
    static axisinfo(unit, axis)
        Sets the default axis ticks and labels
```

**Parameters**

**unit** [*UnitData*] object string unit information for value  
**axis** [*axis*] axis for which information is being set

**Returns**

**axisinfo** [*AxisInfo*] Information to support default tick labeling

`static convert(value, unit, axis)`

Convert strings in value to floats using mapping information store in the unit object.

**Parameters**

**value** [string or iterable] Value or list of values to be converted.  
**unit** [*UnitData*] An object mapping strings to integers.  
**axis** [*Axis*] axis on which the converted value is plotted.

---

**Note:** *axis* is unused.

---

**Returns**

**mapped\_value** [float or ndarray[float]]

`static default_units(data, axis)`

Sets and updates the axis units.

**Parameters**

**data** [string or iterable of strings]  
**axis** [*axis*] axis on which the data is plotted

**Returns**

**class** [*UnitData*] object storing string to integer mapping

`class matplotlib.category.StrCategoryFormatter(units_mapping)`

Bases: *matplotlib.ticker.Formatter*

String representation of the data at every tick

**Parameters**

**units\_mapping** [Dict[Str, int]] string:integer mapping

`class matplotlib.category.StrCategoryLocator(units_mapping)`

Bases: *matplotlib.ticker.Locator*

tick at every integer mapping of the string data

**Parameters**

**units\_mapping** [Dict[str, int]] string:integer mapping

`tick_values(self, vmin, vmax)`

Return the values of the located ticks given **vmin** and **vmax**.

---

**Note:** To get tick locations with the *vmin* and *vmax* values defined automatically for the associated axis simply call the Locator instance:

```
>>> print(type(loc))
<type 'Locator'>
>>> print(loc())
[1, 2, 3, 4]
```

```
class matplotlib.category.UnitData(data=None)
```

Bases: `object`

Create mapping between unique categorical values and integer ids.

### Parameters

**data** [iterable] sequence of string values

```
update(self, data)
```

Maps new values to integer identifiers.

### Parameters

**data** [iterable] sequence of string values

### Raises

**TypeError** If the value in data is not a string, unicode, bytes type

## 17.13 `matplotlib.cbook`

A collection of utility functions and classes. Originally, many (but not all) were from the Python Cookbook - hence the name cbook.

This module is safe to import from anywhere within matplotlib; it imports matplotlib only at runtime.

```
class matplotlib.cbook.Bunch(**kwargs)
```

Bases: `types.SimpleNamespace`

[*Deprecated*] Often we want to just collect a bunch of stuff together, naming each item of the bunch; a dictionary's OK for that, but a small do-nothing class is even handier, and prettier to use. Whenever you want to group a few variables:

```
>>> point = Bunch(datum=2, squared=4, coord=12)
>>> point.datum
```

### Notes

Deprecated since version 3.0.

```
class matplotlib.cbook.CallbackRegistry(exception_handler=<function           _except-
                                         ion_printer>)
```

Bases: `object`

Handle registering and disconnecting for a set of signals and callbacks:

```
>>> def oneat(x):
...     print('eat', x)
>>> def ondrink(x):
...     print('drink', x)
```

```
>>> from matplotlib.cbook import CallbackRegistry
>>> callbacks = CallbackRegistry()
```

```
>>> id_eat = callbacks.connect('eat', oneat)
>>> id_drink = callbacks.connect('drink', ondrink)
```

```
>>> callbacks.process('drink', 123)
drink 123
>>> callbacks.process('eat', 456)
eat 456
>>> callbacks.process('be merry', 456) # nothing will be called
>>> callbacks.disconnect(id_eat)
>>> callbacks.process('eat', 456)     # nothing will be called
```

In practice, one should always disconnect all callbacks when they are no longer needed to avoid dangling references (and thus memory leaks). However, real code in Matplotlib rarely does so, and due to its design, it is rather difficult to place this kind of code. To get around this, and prevent this class of memory leaks, we instead store weak references to bound methods only, so when the destination object needs to die, the CallbackRegistry won't keep it alive.

### Parameters

**exception\_handler** [callable, optional] If provided must have signature

```
def handler(exc: Exception) -> None:
```

If not None this function will be called with any `Exception` subclass raised by the callbacks in `CallbackRegistry.process`. The handler may either consume the exception or re-raise.

The callable must be pickle-able.

The default handler is

```
def h(exc):
    traceback.print_exc()
```

`connect(self, s, func)`

Register `func` to be called when signal `s` is generated.

`disconnect(self, cid)`

Disconnect the callback registered with callback id `cid`.

`process(self, s, *args, **kwargs)`

Process signal `s`.

All of the functions registered to receive callbacks on `s` will be called with `*args` and `**kwargs`.

```
class matplotlib.cbook.GetRealpathAndStat(**kwargs)
    Bases: object
```

[*Deprecated*]

## Notes

Deprecated since version 3.0:

```
class matplotlib.cbook.Grouper(init=())  
    Bases: object
```

This class provides a lightweight way to group arbitrary objects together into disjoint sets when a full-blown graph data structure would be overkill.

Objects can be joined using `join()`, tested for connectedness using `joined()`, and all disjoint sets can be retrieved by using the object as an iterator.

The objects being joined must be hashable and weak-referenceable.

For example:

```
>>> from matplotlib.cbook import Grouper  
>>> class Foo(object):  
...     def __init__(self, s):  
...         self.s = s  
...     def __repr__(self):  
...         return self.s  
...  
>>> a, b, c, d, e, f = [Foo(x) for x in 'abcdef']  
>>> grp = Grouper()  
>>> grp.join(a, b)  
>>> grp.join(b, c)  
>>> grp.join(d, e)  
>>> sorted(map(tuple, grp))  
[(a, b, c), (d, e)]  
>>> grp.joined(a, b)  
True  
>>> grp.joined(a, c)  
True  
>>> grp.joined(a, d)  
False
```

`clean(self)`

Clean dead weak references from the dictionary.

`get_siblings(self, a)`

Return all of the items joined with *a*, including itself.

`join(self, a, *args)`

Join given arguments into the same set. Accepts one or more arguments.

`joined(self, a, b)`

Return whether *a* and *b* are members of the same set.

`remove(self, a)`

```
exception matplotlib.cbook.IgnoredKeywordWarning
```

Bases: `UserWarning`

A class for issuing warnings about keyword arguments that will be ignored by matplotlib

```
class matplotlib.cbook.Locked(**kwargs)
```

```
    Bases: object
```

[*Deprecated*] Context manager to handle locks.

Based on code from conda.

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### Notes

Deprecated since version 3.0.

```
LOCKFN = '.matplotlib_lock'
```

```
exception TimeoutError
```

```
    Bases: RuntimeError
```

```
class matplotlib.cbook.Stack(default=None)
```

```
    Bases: object
```

Stack of elements with a movable cursor.

Mimics home/back/forward in a web browser.

```
back(self)
```

Move the position back and return the current element.

```
bubble(self, o)
```

Raise *o* to the top of the stack. *o* must be present in the stack.

*o* is returned.

```
clear(self)
```

Empty the stack.

```
empty(self)
```

Return whether the stack is empty.

```
forward(self)
```

Move the position forward and return the current element.

```
home(self)
```

Push the first element onto the top of the stack.

The first element is returned.

```
push(self, o)
```

Push *o* to the stack at current position. Discard all later elements.

*o* is returned.

```
remove(self, o)
```

Remove *o* from the stack.

```
matplotlib.cbook.boxplot_stats(X, whis=1.5, bootstrap=None, labels=None, autorange=False)
```

Returns list of dictionaries of statistics used to draw a series of box and whisker plots. The Returns section enumerates the required keys of the dictionary. Users can skip this

function and pass a user-defined set of dictionaries to the new `axes.bxp` method instead of relying on MPL to do the calculations.

### Parameters

**X** [array-like] Data that will be represented in the boxplots. Should have 2 or fewer dimensions.

**whis** [float, string, or sequence (default = 1.5)] As a float, determines the reach of the whiskers beyond the first and third quartiles. In other words, where IQR is the interquartile range (Q3-Q1), the upper whisker will extend to last datum less than  $Q3 + whis \cdot IQR$ . Similarly, the lower whisker will extend to the first datum greater than  $Q1 - whis \cdot IQR$ . Beyond the whiskers, data are considered outliers and are plotted as individual points. This can be set to an ascending sequence of percentiles (e.g., [5, 95]) to set the whiskers at specific percentiles of the data. Finally, `whis` can be the string 'range' to force the whiskers to the minimum and maximum of the data. In the edge case that the 25th and 75th percentiles are equivalent, `whis` can be automatically set to 'range' via the `autorange` option.

**bootstrap** [int, optional] Number of times the confidence intervals around the median should be bootstrapped (percentile method).

**labels** [array-like, optional] Labels for each dataset. Length must be compatible with dimensions of X.

**autorange** [bool, optional (False)] When `True` and the data are distributed such that the 25th and 75th percentiles are equal, `whis` is set to 'range' such that the whisker ends are at the minimum and maximum of the data.

### Returns

**bxpstats** [list of dict] A list of dictionaries containing the results for each column of data. Keys of each dictionary are the following:

Key	Value Description
label	tick label for the boxplot
mean	arithmetic mean value
med	50th percentile
q1	first quartile (25th percentile)
q3	third quartile (75th percentile)
cilo	lower notch around the median
cihi	upper notch around the median
whislo	end of the lower whisker
whishi	end of the upper whisker
fliers	outliers

### Notes

Non-bootstrapping approach to confidence interval uses Gaussian-based asymptotic approximation:

$$\text{med} \pm 1.57 \times \frac{\text{iqr}}{\sqrt{N}}$$

General approach from: McGill, R., Tukey, J.W., and Larsen, W.A. (1978) "Variations of Boxplots", The American Statistician, 32:12-16.

`matplotlib.cbook.contiguous_regions(mask)`

Return a list of (ind0, ind1) such that `mask[ind0:ind1].all()` is True and we cover all such regions

`matplotlib.cbook.dedent(s)`

[*Deprecated*] Remove excess indentation from docstring `s`.

Discards any leading blank lines, then removes up to `n` whitespace characters from each line, where `n` is the number of leading whitespace characters in the first line. It differs from `textwrap.dedent` in its deletion of leading blank lines and its use of the first non-blank line to determine the indentation.

It is also faster in most cases.

### Notes

Deprecated since version 3.1.

`matplotlib.cbook.delete_masked_points(*args)`

Find all masked and/or non-finite points in a set of arguments, and return the arguments with only the unmasked points remaining.

Arguments can be in any of 5 categories:

- 1) 1-D masked arrays
- 2) 1-D ndarrays
- 3) ndarrays with more than one dimension
- 4) other non-string iterables
- 5) anything else

The first argument must be in one of the first four categories; any argument with a length differing from that of the first argument (and hence anything in category 5) then will be passed through unchanged.

Masks are obtained from all arguments of the correct length in categories 1, 2, and 4; a point is bad if masked in a masked array or if it is a nan or inf. No attempt is made to extract a mask from categories 2, 3, and 4 if `np.isfinite()` does not yield a Boolean array.

All input arguments that are not passed unchanged are returned as ndarrays after removing the points or rows corresponding to masks in any of the arguments.

A vastly simpler version of this function was originally written as a helper for `Axes.scatter()`.

`matplotlib.cbook.file_requires_unicode(x)`

Return whether the given writable file-like object requires Unicode to be written to it.

`matplotlib.cbook.flatten(seq, scalarp=<function is_scalar_or_string at 0x7f6976df8048>)`

Return a generator of flattened nested containers

For example:

```
>>> from matplotlib.cbook import flatten
>>> l = (('John', ['Hunter']), (1, 23), [[[42, (5, 23)], ]])
>>> print(list(flatten(l)))
['John', 'Hunter', 1, 23, 42, 5, 23]
```

By: Composite of Holger Krekel and Luther Blissett From: <https://code.activestate.com/recipes/121294/> and Recipe 1.12 in cookbook

`matplotlib.cbook.get_label(y, default_name)`  
[*Deprecated*]

### Notes

Deprecated since version 3.1:

`matplotlib.cbook.get_realpath_and_stat(path)`

`matplotlib.cbook.get_sample_data(fname, asfileobj=True)`

Return a sample data file. *fname* is a path relative to the `mpl-data/sample_data` directory. If *asfileobj* is `True` return a file object, otherwise just a file path.

Set the `rc` parameter `examples.directory` to the directory where we should look, if `sample_data` files are stored in a location different than default (which is `'mpl-data/sample_data'` at the same level of `'matplotlib'` Python module files).

If the filename ends in `.gz`, the file is implicitly unzipped.

`matplotlib.cbook.index_of(y)`

A helper function to get the index of an input to plot against if `x` values are not explicitly given.

Tries to get `y.index` (works if this is a `pd.Series`), if that fails, return `np.arange(y.shape[0])`.

This will be extended in the future to deal with more types of labeled data.

### Parameters

`y` [scalar or array-like] The proposed `y`-value

### Returns

`x, y` [ndarray] The `x` and `y` values to plot.

`matplotlib.cbook.is_hashable(obj)`

[*Deprecated*] Returns true if *obj* can be hashed

### Notes

Deprecated since version 3.1.

`matplotlib.cbook.is_math_text(s)`

`matplotlib.cbook.is_numlike(obj)`

[*Deprecated*] return true if *obj* looks like a number

### Notes

Deprecated since version 3.0.

`matplotlib.cbook.is_scalar_or_string(val)`

Return whether the given object is a scalar or string like.

`matplotlib.cbook.is_writable_file_like(obj)`

Return whether *obj* looks like a file object with a *write* method.

`matplotlib.cbook.iterable(obj)`

[*Deprecated*] return true if *obj* is iterable

### Notes

Deprecated since version 3.1.

`matplotlib.cbook.listFiles(root, patterns='*', recurse=1, return_folders=0)`

[*Deprecated*] Recursively list files

from Parmar and Martelli in the Python Cookbook

### Notes

Deprecated since version 3.0.

`matplotlib.cbook.local_over_kwdict(local_var, kwargs, *keys)`

Enforces the priority of a local variable over potentially conflicting argument(s) from a *kwargs* dict. The following possible output values are considered in order of priority:

`local_var > kwargs[keys[0]] > ... > kwargs[keys[-1]]`

The first of these whose value is not *None* will be returned. If all are *None* then *None* will be returned. Each key in *keys* will be removed from the *kwargs* dict in place.

### Parameters

**local\_var** [any object]

The local variable (highest priority)

**kwargs** [dict] Dictionary of keyword arguments; modified in place

**keys** [str(s)] Name(s) of keyword arguments to process, in descending order of priority

### Returns

**out** [any object] Either *local\_var* or one of *kwargs[key]* for key in *keys*

### Raises

**IgnoredKeywordWarning** For each key in *keys* that is removed from *kwargs* but not used as the output value

`class matplotlib.cbook.maxdict(maxsize)`

Bases: `dict`

A dictionary with a maximum size; this doesn't override all the relevant methods to constrain the size, just `setitem`, so use with caution

`matplotlib.cbook.mkdirs(newdir, mode=511)`

[*Deprecated*] make directory *newdir* recursively, and set *mode*. Equivalent to

```
> mkdir -p NEWDIR
> chmod MODE NEWDIR
```

### Notes

Deprecated since version 3.0.

`matplotlib.cbook.normalize_kwargs(kw, alias_mapping=None, required=(), forbidden=(), allowed=None)`

Helper function to normalize kwarg inputs

The order they are resolved are:

1. aliasing
2. required
3. forbidden
4. allowed

This order means that only the canonical names need appear in `allowed`, `forbidden`, `required`

### Parameters

**alias\_mapping, dict, optional** A mapping between a canonical name to a list of aliases, in order of precedence from lowest to highest.

If the canonical value is not in the list it is assumed to have the highest priority.

**required** [iterable, optional] A tuple of fields that must be in kwargs.

**forbidden** [iterable, optional] A list of keys which may not be in kwargs

**allowed** [tuple, optional] A tuple of allowed fields. If this not `None`, then raise if `kw` contains any keys not in the union of `required` and `allowed`. To allow only the required fields pass in `()` for `allowed`

### Raises

**TypeError** To match what python raises if invalid args/kwargs are passed to a callable.

`matplotlib.cbook.open_file_cm(path_or_file, mode='r', encoding=None)`

Pass through file objects and context-manage PathLikes.

`matplotlib.cbook.print_cycles(objects, outstream=<_io.TextIOWrapper name='<stdout>' mode='w' encoding='UTF-8'>, show_progress=False)`

**objects** A list of objects to find cycles in. It is often useful to pass in `gc.garbage` to find the cycles that are preventing some objects from being garbage collected.

**outstream** The stream for output.

**show\_progress** If `True`, print the number of objects reached as they are found.

`matplotlib.cbook.pts_to_midstep(x, *args)`  
Convert continuous line to mid-steps.

Given a set of  $N$  points convert to  $2N$  points which when connected linearly give a step function which changes values at the middle of the intervals.

#### Parameters

**x** [array] The x location of the steps. May be empty.

**y1, ..., yp** [array] y arrays to be turned into steps; all must be the same length as x.

#### Returns

**out** [array] The x and y values converted to steps in the same order as the input; can be unpacked as `x_out, y1_out, ..., yp_out`. If the input is length  $N$ , each of these arrays will be length  $2N$ .

#### Examples

```
>> x_s, y1_s, y2_s = pts_to_midstep(x, y1, y2)
```

`matplotlib.cbook.pts_to_poststep(x, *args)`  
Convert continuous line to post-steps.

Given a set of  $N$  points convert to  $2N + 1$  points, which when connected linearly give a step function which changes values at the end of the intervals.

#### Parameters

**x** [array] The x location of the steps. May be empty.

**y1, ..., yp** [array] y arrays to be turned into steps; all must be the same length as x.

#### Returns

**out** [array] The x and y values converted to steps in the same order as the input; can be unpacked as `x_out, y1_out, ..., yp_out`. If the input is length  $N$ , each of these arrays will be length  $2N + 1$ . For  $N=0$ , the length will be 0.

#### Examples

```
>> x_s, y1_s, y2_s = pts_to_poststep(x, y1, y2)
```

`matplotlib.cbook.pts_to_prestep(x, *args)`  
Convert continuous line to pre-steps.

Given a set of  $N$  points, convert to  $2N - 1$  points, which when connected linearly give a step function which changes values at the beginning of the intervals.

#### Parameters

**x** [array] The x location of the steps. May be empty.

**y1, ..., yp** [array] y arrays to be turned into steps; all must be the same length as x.

#### Returns

**out** [array] The x and y values converted to steps in the same order as the input; can be unpacked as `x_out`, `y1_out`, ..., `yp_out`. If the input is length `N`, each of these arrays will be length `2N + 1`. For `N=0`, the length will be 0.

### Examples

```
>> x_s, y1_s, y2_s = pts_to_prestep(x, y1, y2)
matplotlib.cbook.report_memory(i=0)
    Return the memory consumed by the process.
matplotlib.cbook.safe_first_element(obj)
matplotlib.cbook.safe_masked_invalid(x, copy=False)
matplotlib.cbook.safezip(*args)
    [Deprecated] make sure args are equal len before zipping
```

### Notes

Deprecated since version 3.1.

```
matplotlib.cbook.sanitize_sequence(data)
    Converts dictview object to list
class matplotlib.cbook.silent_list(type, seq=None)
    Bases: list
    override repr when returning a list of matplotlib artists to prevent long, meaningless
    output. This is meant to be used for a homogeneous list of a given type
matplotlib.cbook.simple_linear_interpolation(a, steps)
    Resample an array with steps - 1 points between original point pairs.
```

### Parameters

**a** [array, shape (n, ...)]  
**steps** [int]

### Returns

**array, shape ((n - 1) \* steps + 1, ...)**  
**Along each column of a, (steps - 1) points are introduced between each original values; the values are linearly interpolated.**

```
matplotlib.cbook.strip_math(s)
    Remove latex formatting from mathtext.
    Only handles fully math and fully non-math strings.
matplotlib.cbook.to_filehandle(fname, flag='r', return_opened=False, encoding=None)
    Convert a path to an open file handle or pass-through a file-like object.
    Consider using open_file_cm instead, as it allows one to properly close newly created file
    objects more easily.
```

### Parameters

**fname** [str or PathLike or file-like object] If `str` or `os.PathLike`, the file is opened using the flags specified by `flag` and `encoding`. If a file-like object, it is passed through.

**flag** [str, default 'r'] Passed as the `mode` argument to `open` when `fname` is `str` or `os.PathLike`; ignored if `fname` is file-like.

**return\_opened** [bool, default False] If True, return both the file object and a boolean indicating whether this was a new file (that the caller needs to close). If False, return only the new file.

**encoding** [str or None, default None] Passed as the `mode` argument to `open` when `fname` is `str` or `os.PathLike`; ignored if `fname` is file-like.

### Returns

**fh** [file-like]

**opened** [bool] `opened` is only returned if `return_opened` is True.

`matplotlib.cbook.unicode_safe(s)`  
[*Deprecated*]

### Notes

Deprecated since version 3.0:

`matplotlib.cbook.violin_stats(X, method, points=100)`

Returns a list of dictionaries of data which can be used to draw a series of violin plots. See the Returns section below to view the required keys of the dictionary. Users can skip this function and pass a user-defined set of dictionaries to the `axes.vplot` method instead of using MPL to do the calculations.

### Parameters

**X** [array-like] Sample data that will be used to produce the gaussian kernel density estimates. Must have 2 or fewer dimensions.

**method** [callable] The method used to calculate the kernel density estimate for each column of data. When called via `method(v, coords)`, it should return a vector of the values of the KDE evaluated at the values specified in `coords`.

**points** [scalar, default = 100] Defines the number of points to evaluate each of the gaussian kernel density estimates at.

### Returns

**A list of dictionaries containing the results for each column of data.**

**The dictionaries contain at least the following:**

- `coords`: A list of scalars containing the coordinates this particular kernel density estimate was evaluated at.
- `vals`: A list of scalars containing the values of the kernel density estimate at each of the coordinates given in `coords`.
- `mean`: The mean value for this column of data.
- `median`: The median value for this column of data.

- min: The minimum value for this column of data.
- max: The maximum value for this column of data.

## 17.14 matplotlib.cm

Builtin colormaps, colormap handling utilities, and the *ScalarMappable* mixin.

### See also:

[/gallery/color/colormap\\_reference](#) for a list of builtin colormaps.

*Creating Colormaps in Matplotlib* for examples of how to make colormaps and

*Choosing Colormaps in Matplotlib* an in-depth discussion of choosing colormaps.

*Colormap Normalization* for more details about data normalization

```
class matplotlib.cm.ScalarMappable(norm=None, cmap=None)
```

Bases: `object`

This is a mixin class to support scalar data to RGBA mapping. The `ScalarMappable` makes use of data normalization before returning RGBA colors from the given colormap.

### Parameters

**norm** [*matplotlib.colors.Normalize* instance] The normalizing object which scales data, typically into the interval `[0, 1]`. If `None`, `norm` defaults to a *colors.Normalize* object which initializes its scaling based on the first data processed.

**cmap** [str or *Colormap* instance] The colormap used to map normalized data values to RGBA colors.

`add_checker(self, checker)`

Add an entry to a dictionary of boolean flags that are set to `True` when the mappable is changed.

`autoscale(self)`

Autoscale the scalar limits on the `norm` instance using the current array

`autoscale_None(self)`

Autoscale the scalar limits on the `norm` instance using the current array, changing only limits that are `None`

`changed(self)`

Call this whenever the mappable is changed to notify all the `callbackSM` listeners to the 'changed' signal

`check_update(self, checker)`

If mappable has changed since the last check, return `True`; else return `False`

`cmap = None`

The `Colormap` instance of this `ScalarMappable`.

`colorbar = None`

The last colorbar associated with this `ScalarMappable`. May be `None`.

`get_alpha(self)`

### Returns

**alpha** [float] Always returns 1.

`get_array(self)`

Return the array

`get_clim(self)`

return the min, max of the color limits for image scaling

`get_cmap(self)`

return the colormap

`norm = None`

The Normalization instance of this ScalarMappable.

`set_array(self, A)`

Set the image array from numpy array *A*.

### Parameters

**A** [ndarray]

`set_clim(self, vmin=None, vmax=None)`

set the norm limits for image scaling; if *vmin* is a length2 sequence, interpret it as (*vmin*, *vmax*) which is used to support setp

ACCEPTS: a length 2 sequence of floats; may be overridden in methods that have *vmin* and *vmax* kwargs.

`set_cmap(self, cmap)`

set the colormap for luminance data

### Parameters

**cmap** [colormap or registered colormap name]

`set_norm(self, norm)`

Set the normalization instance.

### Parameters

**norm** [*Normalize*]

### Notes

If there are any colorbars using the mappable for this norm, setting the norm of the mappable will reset the norm, locator, and formatters on the colorbar to default.

`to_rgba(self, x, alpha=None, bytes=False, norm=True)`

Return a normalized rgba array corresponding to *x*.

In the normal case, *x* is a 1-D or 2-D sequence of scalars, and the corresponding ndarray of rgba values will be returned, based on the norm and colormap set for this ScalarMappable.

There is one special case, for handling images that are already rgb or rgba, such as might have been read from an image file. If *x* is an ndarray with 3 dimensions, and the last dimension is either 3 or 4, then it will be treated as an rgb or rgba array, and no mapping will be done. The array can be uint8, or it can be floating point with values in the 0-1 range; otherwise a `ValueError` will be raised. If it is a masked array, the mask will be ignored. If the last dimension is 3, the *alpha* kwarg (defaulting to 1) will be used to fill in the transparency. If the last dimension is 4, the *alpha* kwarg

is ignored; it does not replace the pre-existing alpha. A `ValueError` will be raised if the third dimension is other than 3 or 4.

In either case, if `bytes` is `False` (default), the `rgba` array will be floats in the 0-1 range; if it is `True`, the returned `rgba` array will be `uint8` in the 0 to 255 range.

If `norm` is `False`, no normalization of the input data is performed, and it is assumed to be in the range (0-1).

`matplotlib.cm.get_cmap(name=None, lut=None)`

Get a colormap instance, defaulting to `rc` values if `name` is `None`.

Colormaps added with `register_cmap()` take precedence over built-in colormaps.

If `name` is a `matplotlib.colors.Colormap` instance, it will be returned.

If `lut` is not `None` it must be an integer giving the number of entries desired in the lookup table, and `name` must be a standard `mpl` colormap name.

`matplotlib.cm.register_cmap(name=None, cmap=None, data=None, lut=None)`

Add a colormap to the set recognized by `get_cmap()`.

It can be used in two ways:

```
register_cmap(name='swirly', cmap=swirly_cmap)

register_cmap(name='choppy', data=choppydata, lut=128)
```

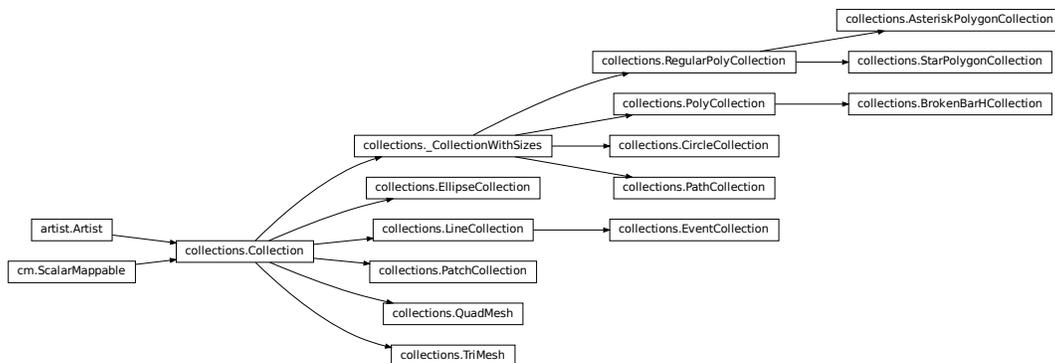
In the first case, `cmap` must be a `matplotlib.colors.Colormap` instance. The `name` is optional; if absent, the name will be the name attribute of the `cmap`.

In the second case, the three arguments are passed to the `LinearSegmentedColormap` initializer, and the resulting colormap is registered.

`matplotlib.cm.revcmmap(data)`

Can only handle specification `data` in dictionary format.

## 17.15 matplotlib.collections



Classes for the efficient drawing of large collections of objects that share most properties,

e.g., a large number of line segments or polygons.

The classes are not meant to be as flexible as their single element counterparts (e.g., you may not be able to select all line styles) but they are meant to be fast for common use cases (e.g., a large set of solid line segments).

```
class matplotlib.collections.AsteriskPolygonCollection(numsides, rotation=0,
                                                    sizes=(1, ), **kwargs)
```

Bases: `matplotlib.collections.RegularPolyCollection`

Draw a collection of regular asterisks with *numsides* points.

**numsides** the number of sides of the polygon

**rotation** the rotation of the polygon in radians

**sizes** gives the area of the circle circumscribing the regular polygon in  $\text{points}^2$

Valid Collection keyword arguments:

- *edgecolors*: None
- *facecolors*: None
- *linewidths*: None
- *antialiaseds*: None
- *offsets*: None
- *transOffset*: `transforms.IdentityTransform()`
- *norm*: None (optional for `matplotlib.cm.ScalarMappable`)
- *cmap*: None (optional for `matplotlib.cm.ScalarMappable`)

*offsets* and *transOffset* are used to translate the patch after rendering (default no offsets)

If any of *edgecolors*, *facecolors*, *linewidths*, *antialiaseds* are None, they default to their `matplotlib.rcParams` patch setting, in sequence form.

Example: see `/gallery/event_handling/lasso_demo` for a complete example:

```
offsets = np.random.rand(20,2)
facecolors = [cm.jet(x) for x in np.random.rand(20)]
black = (0,0,0,1)

collection = RegularPolyCollection(
    numsides=5, # a pentagon
    rotation=0, sizes=(50,),
    facecolors=facecolors,
    edgecolors=(black,),
    linewidths=(1,),
    offsets=offsets,
    transOffset=ax.transData,
)
```

`add_callback(self, func)`

Add a callback function that will be called whenever one of the *Artist's* properties changes.

### Parameters

**func** [callable] The callback function. It must have the signature:

```
def func(artist: Artist) -> Any
```

where *artist* is the calling *Artist*. Return values may exist but are ignored.

### Returns

**oid** [int] The observer id associated with the callback. This id can be used for removing the callback with *remove\_callback* later.

### See also:

*remove\_callback*

*add\_checker(self, checker)*

Add an entry to a dictionary of boolean flags that are set to True when the mappable is changed.

*aname*

*autoscale(self)*

Autoscale the scalar limits on the norm instance using the current array

*autoscale\_None(self)*

Autoscale the scalar limits on the norm instance using the current array, changing only limits that are None

*axes*

The *Axes* instance the artist resides in, or *None*.

*changed(self)*

Call this whenever the mappable is changed to notify all the callbackSM listeners to the 'changed' signal

*check\_update(self, checker)*

If mappable has changed since the last check, return True; else return False

*contains(self, mouseevent)*

Test whether the mouse event occurred in the collection.

Returns bool, dict(ind=itemlist), where every item in itemlist contains the event.

*convert\_xunits(self, x)*

Convert x using the unit type of the xaxis.

If the artist is not in contained in an Axes or if the xaxis does not have units, x itself is returned.

*convert\_yunits(self, y)*

Convert y using the unit type of the yaxis.

If the artist is not in contained in an Axes or if the yaxis does not have units, y itself is returned.

*draw(self, renderer)*

Draw the Artist using the given renderer.

This method will be overridden in the Artist subclasses. Typically, it is implemented to not have any effect if the Artist is not visible (*Artist.get\_visible* is *False*).

### Parameters

**renderer** [*RendererBase* subclass.]

`findobj(self, match=None, include_self=True)`  
Find artist objects.

Recursively find all *Artist* instances contained in the artist.

### Parameters

**match** A filter criterion for the matches. This can be

- *None*: Return all objects contained in artist.
- A function with signature `def match(artist: Artist) -> bool`. The result will only contain artists for which the function returns *True*.
- A class instance: e.g., *Line2D*. The result will only contain artists of this class or its subclasses (instance check).

**include\_self** [bool] Include *self* in the list to be checked for a match.

### Returns

**artists** [list of *Artist*]

`format_cursor_data(self, data)`  
Return a string representation of *data*.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

The default implementation converts ints and floats and arrays of ints and floats into a comma-separated string enclosed in square brackets.

### See also:

`get_cursor_data`

`get_agg_filter(self)`  
Return filter function to be used for agg filter.

`get_alpha(self)`  
Return the alpha value used for blending - not supported on all backends

`get_animated(self)`  
Return the animated state.

`get_array(self)`  
Return the array

`get_capstyle(self)`

`get_children(self)`  
Return a list of the child *Artists* of this *Artist*.

`get_clim(self)`  
return the min, max of the color limits for image scaling

`get_clip_box(self)`  
Return the clipbox.

`get_clip_on(self)`  
Return whether the artist uses clipping.

`get_clip_path(self)`  
Return the clip path.

`get_cmap(self)`  
return the colormap

`get_contains(self)`  
Return the custom contains function of the artist if set, or *None*.

**See also:**

`set_contains`

`get_cursor_data(self, event)`  
Return the cursor data for a given event.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

Cursor data can be used by Artists to provide additional context information for a given event. The default implementation just returns *None*.

Subclasses can override the method and return arbitrary data. However, when doing so, they must ensure that `format_cursor_data` can convert the data to a string representation.

The only current use case is displaying the z-value of an *AxesImage* in the status bar of a plot window, while moving the mouse.

**Parameters**

**event** [`matplotlib.backend_bases.MouseEvent`]

**See also:**

`format_cursor_data`

`get_dashes(self)`  
Alias for `get_linestyle`.

`get_dataLim(self, transData)`

`get_ec(self)`  
Alias for `get_edgecolor`.

`get_edgecolor(self)`

`get_edgecolors(self)`  
Alias for `get_edgecolor`.

`get_facecolor(self)`

`get_facecolors(self)`  
Alias for `get_facecolor`.

`get_fc(self)`  
Alias for `get_facecolor`.

`get_figure(self)`  
Return the *Figure* instance the artist belongs to.

`get_fill(self)`  
 return whether fill is set

`get_gid(self)`  
 Return the group id.

`get_hatch(self)`  
 Return the current hatching pattern.

`get_in_layout(self)`  
 Return boolean flag, True if artist is included in layout calculations.  
 E.g. *Constrained Layout Guide*, `Figure.tight_layout()`, and `fig.savefig(fname, bbox_inches='tight')`.

`get_joinstyle(self)`

`get_label(self)`  
 Return the label used for this artist in the legend.

`get_linestyle(self)`

`get_linestyles(self)`  
 Alias for `get_linestyle`.

`get_linewidth(self)`

`get_linewidths(self)`  
 Alias for `get_linewidth`.

`get_ls(self)`  
 Alias for `get_linestyle`.

`get_lw(self)`  
 Alias for `get_linewidth`.

`get_numsides(self)`

`get_offset_position(self)`  
 Returns how offsets are applied for the collection. If `offset_position` is 'screen', the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If `offset_position` is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

`get_offset_transform(self)`

`get_offsets(self)`  
 Return the offsets for the collection.

`get_path_effects(self)`

`get_paths(self)`

`get_picker(self)`  
 Return the picking behavior of the artist.  
 The possible values are described in `set_picker`.

**See also:**

`set_picker`, `pickable`, `pick`

`get_pickradius(self)`

`get_rasterized(self)`

Return whether the artist is to be rasterized.

`get_rotation(self)`

`get_sizes(self)`

Returns the sizes of the elements in the collection. The value represents the 'area' of the element.

**Returns**

**sizes** [array] The 'area' of each element.

`get_sketch_params(self)`

Returns the sketch parameters for the artist.

**Returns**

**sketch\_params** [tuple or None] A 3-tuple with the following elements:

- *scale*: The amplitude of the wiggle perpendicular to the source line.
- *length*: The length of the wiggle along the line.
- *randomness*: The scale factor by which the length is shrunken or expanded.

Returns *None* if no sketch parameters were set.

`get_snap(self)`

Returns the snap setting.

See `set_snap` for details.

`get_tightbbox(self, renderer)`

Like `Artist.get_window_extent`, but includes any clipping.

**Parameters**

**renderer** [*RendererBase* instance] renderer that will be used to draw the figures (i.e. `fig.canvas.get_renderer()`)

**Returns**

**bbbox** [BBox] The enclosing bounding box (in figure pixel co-ordinates).

`get_transform(self)`

Return the *Transform* instance used by this artist.

`get_transformed_clip_path_and_affine(self)`

Return the clip path with the non-affine part of its transformation applied, and the remaining affine part of its transformation.

`get_transforms(self)`

`get_url(self)`

Return the url.

`get_urls(self)`

`get_visible(self)`

Return the visibility.

`get_window_extent(self, renderer)`

Get the axes bounding box in display space.

The bounding box' width and height are nonnegative.

Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

`get_zorder(self)`

Return the artist's zorder.

`have_units(self)`

Return *True* if units are set on the x or y axes.

`is_transform_set(self)`

Return whether the Artist has an explicitly set transform.

This is *True* after *set\_transform* has been called.

`mouseover`

`pchanged(self)`

Call all of the registered callbacks.

This function is triggered internally when a property is changed.

**See also:**

*add\_callback*

*remove\_callback*

`pick(self, mouseevent)`

Process a pick event.

Each child artist will fire a pick event if *mouseevent* is over the artist and the artist has picker set.

**See also:**

*set\_picker, get\_picker, pickable*

`pickable(self)`

Return whether the artist is pickable.

**See also:**

*set\_picker, get\_picker, pick*

`properties(self)`

Return a dictionary of all the properties of the artist.

`remove(self)`

Remove the artist from the figure if possible.

The effect will not be visible until the figure is redrawn, e.g., with *FigureCanvasBase.draw\_idle*. Call *relim* to update the axes limits if desired.

Note: *relim* will not see collections even if the collection was added to the axes with *autolim = True*.

Note: there is no support for removing the artist's legend entry.

`remove_callback(self, oid)`

Remove a callback based on its observer id.

**See also:**

`add_callback`

`set(self, **kwargs)`

A property batch setter. Pass *kwargs* to set properties.

`set_aa(self, aa)`

Alias for `set_antialiased`.

`set_agg_filter(self, filter_func)`

Set the agg filter.

**Parameters**

**filter\_func** [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

`set_alpha(self, alpha)`

Set the alpha transparencies of the collection.

**Parameters**

**alpha** [float or None]

`set_animated(self, b)`

Set the artist's animation state.

**Parameters**

**b** [bool]

`set_antialiased(self, aa)`

Set the antialiasing state for rendering.

**Parameters**

**aa** [bool or sequence of bools]

`set_antialiaseds(self, aa)`

Alias for `set_antialiased`.

`set_array(self, A)`

Set the image array from numpy array *A*.

**Parameters**

**A** [ndarray]

`set_capstyle(self, cs)`

Set the capstyle for the collection (for all its elements).

**Parameters**

**cs** [{'butt', 'round', 'projecting'}] The capstyle

`set_clim(self, vmin=None, vmax=None)`

set the norm limits for image scaling; if *vmin* is a length2 sequence, interpret it as (*vmin*, *vmax*) which is used to support setp

ACCEPTS: a length 2 sequence of floats; may be overridden in methods that have `vmin` and `vmax` kwargs.

`set_clip_box(self, clipbox)`  
Set the artist's clip *Bbox*.

#### Parameters

**clipbox** [*Bbox*]

`set_clip_on(self, b)`  
Set whether the artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

#### Parameters

**b** [bool]

`set_clip_path(self, path, transform=None)`  
Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- None, to remove a previously set clipping path.

For efficiency, if the path happens to be an axis-aligned rectangle, this method will set the clipping box to the corresponding rectangle and set the clipping path to None.

ACCEPTS: [(*Path*, *Transform*) | *Patch* | None]

`set_cmap(self, cmap)`  
set the colormap for luminance data

#### Parameters

**cmap** [colormap or registered colormap name]

`set_color(self, c)`  
Set both the edgecolor and the facecolor.

#### Parameters

**c** [color or sequence of rgba tuples]

#### See also:

`Collection.set_facecolor`, `Collection.set_edgecolor` For setting the edge or face color individually.

`set_contains(self, picker)`  
Define a custom contains test for the artist.

The provided callable replaces the default *contains* method of the artist.

#### Parameters

**picker** [callable] A custom picker function to evaluate if an event is within the artist. The function must have the signature:

```
def contains(artist: Artist, event: MouseEvent) -> bool, dict
```

that returns:

- a bool indicating if the event is within the artist
- a dict of additional information. The dict should at least return the same information as the default `contains()` implementation of the respective artist, but may provide additional information.

`set_dashes(self, ls)`  
Alias for `set_linestyle`.

`set_ec(self, c)`  
Alias for `set_edgecolor`.

`set_edgecolor(self, c)`  
Set the edgecolor(s) of the collection.

#### Parameters

**c** [color or sequence of colors or 'face'] The collection edgecolor(s). If a sequence, the patches cycle through it. If 'face', match the facecolor.

`set_edgecolors(self, c)`  
Alias for `set_edgecolor`.

`set_facecolor(self, c)`  
Set the facecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; if it is a sequence the patches will cycle through the sequence.

If *c* is 'none', the patch will not be filled.

#### Parameters

**c** [color or sequence of colors]

`set_facecolors(self, c)`  
Alias for `set_facecolor`.

`set_fc(self, c)`  
Alias for `set_facecolor`.

`set_figure(self, fig)`  
Set the *Figure* instance the artist belongs to.

#### Parameters

**fig** [*Figure*]

`set_gid(self, gid)`  
Set the (group) id for the artist.

#### Parameters

**gid** [str]

`set_hatch(self, hatch)`  
Set the hatching pattern

*hatch* can be one of:

```

/ - diagonal hatching
\ - back diagonal
| - vertical
- - horizontal
+ - crossed
x - crossed diagonal
o - small circle
O - large circle
. - dots
* - stars

```

Letters can be combined, in which case all the specified hatchings are done. If same letter repeats, it increases the density of hatching of that pattern.

Hatching is supported in the PostScript, PDF, SVG and Agg backends only.

Unlike other properties such as linewidth and colors, hatching can only be specified for the collection as a whole, not separately for each member.

### Parameters

**hatch** [{'/', '\\', '|', '-', '+', 'x', 'o', 'O', '.', '\*'}]

`set_in_layout(self, in_layout)`

Set if artist is to be included in layout calculations, E.g. *Constrained Layout Guide*, *Figure.tight\_layout()*, and `fig.savefig(fname, bbox_inches='tight')`.

### Parameters

**in\_layout** [bool]

`set_joinstyle(self, js)`

Set the joinstyle for the collection (for all its elements).

### Parameters

**js** [{'miter', 'round', 'bevel'}] The joinstyle

`set_label(self, s)`

Set a label that will be displayed in the legend.

### Parameters

**s** [object] *s* will be converted to a string by calling `str`.

`set_linestyle(self, ls)`

Set the linestyle(s) for the collection.

linestyle	description
'-' or 'solid'	solid line
'--' or 'dashed'	dashed line
'-.' or 'dashdot'	dash-dotted line
':' or 'dotted'	dotted line

Alternatively a dash tuple of the following form can be provided:

```
(offset, onoffseq),
```

where `onoffseq` is an even length tuple of on and off ink in points.

**Parameters**

**ls** [{'-', '-', '-.', ':', ''], (offset, on-off-seq), ...}] The line style.

`set_linestyles(self, ls)`

Alias for `set_linestyle`.

`set_linewidth(self, lw)`

Set the linewidth(s) for the collection. `lw` can be a scalar or a sequence; if it is a sequence the patches will cycle through the sequence

**Parameters**

**lw** [float or sequence of floats]

`set_linewidths(self, lw)`

Alias for `set_linewidth`.

`set_ls(self, ls)`

Alias for `set_linestyle`.

`set_lw(self, lw)`

Alias for `set_linewidth`.

`set_norm(self, norm)`

Set the normalization instance.

**Parameters**

**norm** [*Normalize*]

**Notes**

If there are any colorbars using the mappable for this norm, setting the norm of the mappable will reset the norm, locator, and formatters on the colorbar to default.

`set_offset_position(self, offset_position)`

Set how offsets are applied. If `offset_position` is 'screen' (default) the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If `offset_position` is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

**Parameters**

**offset\_position** [{'screen', 'data'}]

`set_offsets(self, offsets)`

Set the offsets for the collection.

**Parameters**

**offsets** [float or sequence of floats]

`set_path_effects(self, path_effects)`

Set the path effects.

**Parameters**

**path\_effects** [*AbstractPathEffect*]

`set_paths(self)`

`set_picker(self, picker)`

Define the picking behavior of the artist.

**Parameters**

**picker** [None or bool or float or callable] This can be one of the following:

- *None*: Picking is disabled for this artist (default).
- A boolean: If *True* then picking will be enabled and the artist will fire a pick event if the mouse event is over the artist.
- A float: If *picker* is a number it is interpreted as an epsilon tolerance in points and the artist will fire off an event if it's data is within epsilon of the mouse event. For some artists like lines and patch collections, the artist may provide additional data to the pick event that is generated, e.g., the indices of the data within epsilon of the pick event
- A function: If *picker* is callable, it is a user supplied function which determines whether the artist is hit by the mouse event:

```
hit, props = picker(artist, mouseevent)
```

to determine the hit test. if the mouse event is over the artist, return *hit=True* and *props* is a dictionary of properties you want added to the *PickEvent* attributes.

`set_pickradius(self, pr)`

Set the pick radius used for containment tests.

**Parameters**

**d** [float] Pick radius, in points.

`set_rasterized(self, rasterized)`

Force rasterized (bitmap) drawing in vector backend output.

Defaults to *None*, which implies the backend's default behavior.

**Parameters**

**rasterized** [bool or *None*]

`set_sizes(self, sizes, dpi=72.0)`

Set the sizes of each member of the collection.

**Parameters**

**sizes** [ndarray or *None*] The size to set for each element of the collection. The value is the 'area' of the element.

**dpi** [float] The dpi of the canvas. Defaults to 72.0.

`set_sketch_params(self, scale=None, length=None, randomness=None)`

Sets the sketch parameters.

**Parameters**

**scale** [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If *scale* is *None*, or not provided, no sketch filter will be provided.

**length** [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

**randomness** [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

`set_snap(self, snap)`

Set the snapping behavior.

Snapping aligns positions with the pixel grid, which results in clearer images. For example, if a black line of 1px width was defined at a position in between two pixels, the resulting image would contain the interpolated value of that line in the pixel grid, which would be a grey value on both adjacent pixel positions. In contrast, snapping will move the line to the nearest integer pixel value, so that the resulting image will really contain a 1px wide black line.

Snapping is currently only supported by the Agg and MacOSX backends.

#### Parameters

**snap** [bool or None] Possible values:

- *True*: Snap vertices to the nearest pixel center.
- *False*: Do not modify vertex positions.
- *None*: (auto) If the path contains only rectilinear line segments, round to the nearest pixel center.

`set_transform(self, t)`

Set the artist transform.

#### Parameters

**t** [*Transform*]

`set_url(self, url)`

Set the url for the artist.

#### Parameters

**url** [str]

`set_urls(self, urls)`

#### Parameters

**urls** [List[str] or None]

`set_visible(self, b)`

Set the artist's visibility.

#### Parameters

**b** [bool]

`set_zorder(self, level)`

Set the zorder for the artist. Artists with lower zorder values are drawn first.

#### Parameters

**level** [float]

`stale`

Whether the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

`sticky_edges`

x and y sticky edge lists for autoscaling.

When performing autoscaling, if a data limit coincides with a value in the corresponding `sticky_edges` list, then no margin will be added-the view limit "sticks" to

the edge. A typical use case is histograms, where one usually expects no margin on the bottom edge (0) of the histogram.

This attribute cannot be assigned to; however, the `x` and `y` lists can be modified in place as needed.

### Examples

```
>>> artist.sticky_edges.x[:] = (xmin, xmax)
>>> artist.sticky_edges.y[:] = (ymin, ymax)
```

`to_rgba(self, x, alpha=None, bytes=False, norm=True)`

Return a normalized rgba array corresponding to `x`.

In the normal case, `x` is a 1-D or 2-D sequence of scalars, and the corresponding ndarray of rgba values will be returned, based on the `norm` and `colormap` set for this `ScalarMappable`.

There is one special case, for handling images that are already rgb or rgba, such as might have been read from an image file. If `x` is an ndarray with 3 dimensions, and the last dimension is either 3 or 4, then it will be treated as an rgb or rgba array, and no mapping will be done. The array can be uint8, or it can be floating point with values in the 0-1 range; otherwise a `ValueError` will be raised. If it is a masked array, the mask will be ignored. If the last dimension is 3, the `alpha` kwarg (defaulting to 1) will be used to fill in the transparency. If the last dimension is 4, the `alpha` kwarg is ignored; it does not replace the pre-existing alpha. A `ValueError` will be raised if the third dimension is other than 3 or 4.

In either case, if `bytes` is `False` (default), the rgba array will be floats in the 0-1 range; if it is `True`, the returned rgba array will be uint8 in the 0 to 255 range.

If `norm` is `False`, no normalization of the input data is performed, and it is assumed to be in the range (0-1).

`update(self, props)`

Update this artist's properties from the dictionary `props`.

`update_from(self, other)`

copy properties from `other` to `self`

`update_scalarmappable(self)`

Update colors from the scalar mappable array, if it is not `None`.

`zorder = 0`

`class matplotlib.collections.BrokenBarHCollection(xranges, yrange, **kwargs)`

Bases: `matplotlib.collections.PolyCollection`

A collection of horizontal bars spanning `yrange` with a sequence of `xranges`.

**xranges** sequence of (`xmin`, `xwidth`)

**yrange** `ymin`, `ywidth`

Valid Collection keyword arguments:

- `edgecolors`: None
- `facecolors`: None
- `linewidths`: None

- *antialiaseds*: None
- *offsets*: None
- *transOffset*: `transforms.IdentityTransform()`
- *norm*: None (optional for `matplotlib.cm.ScalarMappable`)
- *cmap*: None (optional for `matplotlib.cm.ScalarMappable`)

*offsets* and *transOffset* are used to translate the patch after rendering (default no offsets)

If any of *edgecolors*, *facecolors*, *linewidths*, *antialiaseds* are None, they default to their `matplotlib.rcParams` patch setting, in sequence form.

`add_callback(self, func)`

Add a callback function that will be called whenever one of the *Artist*'s properties changes.

### Parameters

**func** [callable] The callback function. It must have the signature:

```
def func(artist: Artist) -> Any
```

where *artist* is the calling *Artist*. Return values may exist but are ignored.

### Returns

**oid** [int] The observer id associated with the callback. This id can be used for removing the callback with `remove_callback` later.

### See also:

`remove_callback`

`add_checker(self, checker)`

Add an entry to a dictionary of boolean flags that are set to True when the mappable is changed.

`aname`

`autoscale(self)`

Autoscale the scalar limits on the norm instance using the current array

`autoscale_None(self)`

Autoscale the scalar limits on the norm instance using the current array, changing only limits that are None

`axes`

The *Axes* instance the artist resides in, or *None*.

`changed(self)`

Call this whenever the mappable is changed to notify all the callbackSM listeners to the 'changed' signal

`check_update(self, checker)`

If mappable has changed since the last check, return True; else return False

`contains(self, mouseevent)`

Test whether the mouse event occurred in the collection.

Returns `bool`, `dict(ind=itemlist)`, where every item in `itemlist` contains the event.

`convert_xunits(self, x)`

Convert `x` using the unit type of the xaxis.

If the artist is not contained in an `Axes` or if the xaxis does not have units, `x` itself is returned.

`convert_yunits(self, y)`

Convert `y` using the unit type of the yaxis.

If the artist is not contained in an `Axes` or if the yaxis does not have units, `y` itself is returned.

`draw(self, renderer)`

Draw the Artist using the given renderer.

This method will be overridden in the Artist subclasses. Typically, it is implemented to not have any effect if the Artist is not visible (`Artist.get_visible` is `False`).

### Parameters

**renderer** [`RendererBase` subclass.]

`findobj(self, match=None, include_self=True)`

Find artist objects.

Recursively find all `Artist` instances contained in the artist.

### Parameters

**match** A filter criterion for the matches. This can be

- `None`: Return all objects contained in artist.
- A function with signature `def match(artist: Artist) -> bool`. The result will only contain artists for which the function returns `True`.
- A class instance: e.g., `Line2D`. The result will only contain artists of this class or its subclasses (`isinstance` check).

**include\_self** [bool] Include `self` in the list to be checked for a match.

### Returns

**artists** [list of `Artist`]

`format_cursor_data(self, data)`

Return a string representation of `data`.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

The default implementation converts ints and floats and arrays of ints and floats into a comma-separated string enclosed in square brackets.

### See also:

`get_cursor_data`

`get_agg_filter(self)`

Return filter function to be used for agg filter.

`get_alpha(self)`  
Return the alpha value used for blending - not supported on all backends

`get_animated(self)`  
Return the animated state.

`get_array(self)`  
Return the array

`get_capstyle(self)`

`get_children(self)`  
Return a list of the child *Artists* of this *Artist*.

`get_clim(self)`  
return the min, max of the color limits for image scaling

`get_clip_box(self)`  
Return the clipbox.

`get_clip_on(self)`  
Return whether the artist uses clipping.

`get_clip_path(self)`  
Return the clip path.

`get_cmap(self)`  
return the colormap

`get_contains(self)`  
Return the custom contains function of the artist if set, or *None*.

**See also:**

`set_contains`

`get_cursor_data(self, event)`  
Return the cursor data for a given event.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

Cursor data can be used by Artists to provide additional context information for a given event. The default implementation just returns *None*.

Subclasses can override the method and return arbitrary data. However, when doing so, they must ensure that `format_cursor_data` can convert the data to a string representation.

The only current use case is displaying the z-value of an *AxesImage* in the status bar of a plot window, while moving the mouse.

**Parameters**

**event** [`matplotlib.backend_bases.MouseEvent`]

**See also:**

`format_cursor_data`

---

`get_dashes(self)`  
Alias for `get_linestyle`.

`get_dataLim(self, transData)`

`get_ec(self)`  
Alias for `get_edgecolor`.

`get_edgecolor(self)`

`get_edgecolors(self)`  
Alias for `get_edgecolor`.

`get_facecolor(self)`

`get_facecolors(self)`  
Alias for `get_facecolor`.

`get_fc(self)`  
Alias for `get_facecolor`.

`get_figure(self)`  
Return the *Figure* instance the artist belongs to.

`get_fill(self)`  
return whether fill is set

`get_gid(self)`  
Return the group id.

`get_hatch(self)`  
Return the current hatching pattern.

`get_in_layout(self)`  
Return boolean flag, True if artist is included in layout calculations.  
  
E.g. *Constrained Layout Guide*, `Figure.tight_layout()`, and `fig.savefig(fname, bbox_inches='tight')`.

`get_joinstyle(self)`

`get_label(self)`  
Return the label used for this artist in the legend.

`get_linestyle(self)`

`get_linestyles(self)`  
Alias for `get_linestyle`.

`get_linewidth(self)`

`get_linewidths(self)`  
Alias for `get_linewidth`.

`get_ls(self)`  
Alias for `get_linestyle`.

`get_lw(self)`  
Alias for `get_linewidth`.

`get_offset_position(self)`  
Returns how offsets are applied for the collection. If `offset_position` is 'screen', the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If `offset_position` is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

`get_offset_transform(self)`

`get_offsets(self)`

Return the offsets for the collection.

`get_path_effects(self)`

`get_paths(self)`

`get_picker(self)`

Return the picking behavior of the artist.

The possible values are described in `set_picker`.

**See also:**

`set_picker`, `pickable`, `pick`

`get_pickradius(self)`

`get_rasterized(self)`

Return whether the artist is to be rasterized.

`get_sizes(self)`

Returns the sizes of the elements in the collection. The value represents the 'area' of the element.

**Returns**

**sizes** [array] The 'area' of each element.

`get_sketch_params(self)`

Returns the sketch parameters for the artist.

**Returns**

**sketch\_params** [tuple or None] A 3-tuple with the following elements:

- *scale*: The amplitude of the wiggle perpendicular to the source line.
- *length*: The length of the wiggle along the line.
- *randomness*: The scale factor by which the length is shrunken or expanded.

Returns *None* if no sketch parameters were set.

`get_snap(self)`

Returns the snap setting.

See `set_snap` for details.

`get_tightbbox(self, renderer)`

Like `Artist.get_window_extent`, but includes any clipping.

**Parameters**

**renderer** [`RendererBase` instance] renderer that will be used to draw the figures (i.e. `fig.canvas.get_renderer()`)

**Returns**

**bbox** [`BBox`] The enclosing bounding box (in figure pixel co-ordinates).

`get_transform(self)`

Return the *Transform* instance used by this artist.

`get_transformed_clip_path_and_affine(self)`  
 Return the clip path with the non-affine part of its transformation applied, and the remaining affine part of its transformation.

`get_transforms(self)`

`get_url(self)`  
 Return the url.

`get_urls(self)`

`get_visible(self)`  
 Return the visibility.

`get_window_extent(self, renderer)`  
 Get the axes bounding box in display space.  
 The bounding box' width and height are nonnegative.  
 Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.  
 Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

`get_zorder(self)`  
 Return the artist's zorder.

`have_units(self)`  
 Return *True* if units are set on the x or y axes.

`is_transform_set(self)`  
 Return whether the Artist has an explicitly set transform.  
 This is *True* after *set\_transform* has been called.

`mouseover`

`pchanged(self)`  
 Call all of the registered callbacks.  
 This function is triggered internally when a property is changed.  
**See also:**  
*add\_callback*  
*remove\_callback*

`pick(self, mouseevent)`  
 Process a pick event.  
 Each child artist will fire a pick event if *mouseevent* is over the artist and the artist has picker set.  
**See also:**  
*set\_picker*, *get\_picker*, *pickable*

`pickable(self)`

Return whether the artist is pickable.

**See also:**

`set_picker`, `get_picker`, `pick`

`properties(self)`

Return a dictionary of all the properties of the artist.

`remove(self)`

Remove the artist from the figure if possible.

The effect will not be visible until the figure is redrawn, e.g., with `FigureCanvasBase.draw_idle`. Call `relim` to update the axes limits if desired.

Note: `relim` will not see collections even if the collection was added to the axes with `autolim = True`.

Note: there is no support for removing the artist's legend entry.

`remove_callback(self, oid)`

Remove a callback based on its observer id.

**See also:**

`add_callback`

`set(self, **kwargs)`

A property batch setter. Pass `kwargs` to set properties.

`set_aa(self, aa)`

Alias for `set_antialiased`.

`set_agg_filter(self, filter_func)`

Set the agg filter.

**Parameters**

**filter\_func** [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

`set_alpha(self, alpha)`

Set the alpha transparencies of the collection.

**Parameters**

**alpha** [float or None]

`set_animated(self, b)`

Set the artist's animation state.

**Parameters**

**b** [bool]

`set_antialiased(self, aa)`

Set the antialiasing state for rendering.

**Parameters**

**aa** [bool or sequence of bools]

`set_antialiaseds(self, aa)`  
Alias for `set_antialiased`.

`set_array(self, A)`  
Set the image array from numpy array *A*.

**Parameters**

**A** [ndarray]

`set_capstyle(self, cs)`  
Set the capstyle for the collection (for all its elements).

**Parameters**

**cs** [{'butt', 'round', 'projecting'}] The capstyle

`set_clim(self, vmin=None, vmax=None)`  
set the norm limits for image scaling; if *vmin* is a length2 sequence, interpret it as (*vmin*, *vmax*) which is used to support setp

ACCEPTS: a length 2 sequence of floats; may be overridden in methods that have *vmin* and *vmax* kwargs.

`set_clip_box(self, clipbox)`  
Set the artist's clip *Bbox*.

**Parameters**

**clipbox** [*Bbox*]

`set_clip_on(self, b)`  
Set whether the artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

**Parameters**

**b** [bool]

`set_clip_path(self, path, transform=None)`  
Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- None, to remove a previously set clipping path.

For efficiency, if the path happens to be an axis-aligned rectangle, this method will set the clipping box to the corresponding rectangle and set the clipping path to None.

ACCEPTS: [(*Path*, *Transform*) | *Patch* | None]

`set_cmap(self, cmap)`  
set the colormap for luminance data

**Parameters**

**cmap** [colormap or registered colormap name]

`set_color(self, c)`  
Set both the edgecolor and the facecolor.

**Parameters**

**c** [color or sequence of rgba tuples]

**See also:**

`Collection.set_facecolor`, `Collection.set_edgecolor` For setting the edge or face color individually.

`set_contains(self, picker)`

Define a custom contains test for the artist.

The provided callable replaces the default `contains` method of the artist.

**Parameters**

**picker** [callable] A custom picker function to evaluate if an event is within the artist. The function must have the signature:

```
def contains(artist: Artist, event: MouseEvent) -> bool, dict
```

that returns:

- a bool indicating if the event is within the artist
- a dict of additional information. The dict should at least return the same information as the default `contains()` implementation of the respective artist, but may provide additional information.

`set_dashes(self, ls)`

Alias for `set_linestyle`.

`set_ec(self, c)`

Alias for `set_edgecolor`.

`set_edgecolor(self, c)`

Set the edgecolor(s) of the collection.

**Parameters**

**c** [color or sequence of colors or 'face'] The collection edgecolor(s). If a sequence, the patches cycle through it. If 'face', match the facecolor.

`set_edgecolors(self, c)`

Alias for `set_edgecolor`.

`set_facecolor(self, c)`

Set the facecolor(s) of the collection. `c` can be a matplotlib color spec (all patches have same color), or a sequence of specs; if it is a sequence the patches will cycle through the sequence.

If `c` is 'none', the patch will not be filled.

**Parameters**

**c** [color or sequence of colors]

`set_facecolors(self, c)`

Alias for `set_facecolor`.

`set_fc(self, c)`

Alias for `set_facecolor`.

`set_figure(self, fig)`

Set the `Figure` instance the artist belongs to.

**Parameters****fig** [*Figure*]`set_gid(self, gid)`

Set the (group) id for the artist.

**Parameters****gid** [str]`set_hatch(self, hatch)`

Set the hatching pattern

*hatch* can be one of:

```

/ - diagonal hatching
\ - back diagonal
| - vertical
- - horizontal
+ - crossed
x - crossed diagonal
o - small circle
O - large circle
. - dots
* - stars

```

Letters can be combined, in which case all the specified hatchings are done. If same letter repeats, it increases the density of hatching of that pattern.

Hatching is supported in the PostScript, PDF, SVG and Agg backends only.

Unlike other properties such as linewidth and colors, hatching can only be specified for the collection as a whole, not separately for each member.

**Parameters****hatch** [{'/', '\', '|', '-', '+', 'x', 'o', 'O', '.', '\*'}]`set_in_layout(self, in_layout)`Set if artist is to be included in layout calculations, E.g. *Constrained Layout Guide*, *Figure.tight\_layout()*, and *fig.savefig(fname, bbox\_inches='tight')*.**Parameters****in\_layout** [bool]`set_joinstyle(self, js)`

Set the joinstyle for the collection (for all its elements).

**Parameters****js** [{'miter', 'round', 'bevel'}] The joinstyle`set_label(self, s)`

Set a label that will be displayed in the legend.

**Parameters****s** [object] *s* will be converted to a string by calling *str*.`set_linestyle(self, ls)`

Set the linestyle(s) for the collection.

linestyle	description
'-' or 'solid'	solid line
'--' or 'dashed'	dashed line
'-.' or 'dashdot'	dash-dotted line
':' or 'dotted'	dotted line

Alternatively a dash tuple of the following form can be provided:

```
(offset, onoffseq),
```

where `onoffseq` is an even length tuple of on and off ink in points.

### Parameters

**ls** [{'-', '-', '-.', ':', ''}, (offset, on-off-seq), ...] The line style.

`set_linestyles(self, ls)`

Alias for `set_linestyle`.

`set_linewidth(self, lw)`

Set the linewidth(s) for the collection. `lw` can be a scalar or a sequence; if it is a sequence the patches will cycle through the sequence

### Parameters

**lw** [float or sequence of floats]

`set_linewidths(self, lw)`

Alias for `set_linewidth`.

`set_ls(self, ls)`

Alias for `set_linestyle`.

`set_lw(self, lw)`

Alias for `set_linewidth`.

`set_norm(self, norm)`

Set the normalization instance.

### Parameters

**norm** [*Normalize*]

### Notes

If there are any colorbars using the mappable for this norm, setting the norm of the mappable will reset the norm, locator, and formatters on the colorbar to default.

`set_offset_position(self, offset_position)`

Set how offsets are applied. If `offset_position` is 'screen' (default) the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If `offset_position` is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

### Parameters

**offset\_position** [{'screen', 'data'}]

`set_offsets(self, offsets)`

Set the offsets for the collection.

**Parameters****offsets** [float or sequence of floats]

`set_path_effects(self, path_effects)`  
 Set the path effects.

**Parameters****path\_effects** [*AbstractPathEffect*]

`set_paths(self, verts, closed=True)`  
 This allows one to delay initialization of the vertices.

`set_picker(self, picker)`  
 Define the picking behavior of the artist.

**Parameters****picker** [None or bool or float or callable] This can be one of the following:

- *None*: Picking is disabled for this artist (default).
- A boolean: If *True* then picking will be enabled and the artist will fire a pick event if the mouse event is over the artist.
- A float: If picker is a number it is interpreted as an epsilon tolerance in points and the artist will fire off an event if it's data is within epsilon of the mouse event. For some artists like lines and patch collections, the artist may provide additional data to the pick event that is generated, e.g., the indices of the data within epsilon of the pick event
- A function: If picker is callable, it is a user supplied function which determines whether the artist is hit by the mouse event:

```
hit, props = picker(artist, mouseevent)
```

to determine the hit test. if the mouse event is over the artist, return *hit=True* and props is a dictionary of properties you want added to the PickEvent attributes.

`set_pickradius(self, pr)`  
 Set the pick radius used for containment tests.

**Parameters****d** [float] Pick radius, in points.

`set_rasterized(self, rasterized)`  
 Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

**Parameters****rasterized** [bool or None]

`set_sizes(self, sizes, dpi=72.0)`  
 Set the sizes of each member of the collection.

**Parameters**

**sizes** [ndarray or None] The size to set for each element of the collection.  
 The value is the 'area' of the element.

**dpi** [float] The dpi of the canvas. Defaults to 72.0.

`set_sketch_params(self, scale=None, length=None, randomness=None)`  
Sets the sketch parameters.

#### Parameters

**scale** [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

**length** [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

**randomness** [float, optional] The scale factor by which the length is shrunk or expanded (default 16.0)

`set_snap(self, snap)`  
Set the snapping behavior.

Snapping aligns positions with the pixel grid, which results in clearer images. For example, if a black line of 1px width was defined at a position in between two pixels, the resulting image would contain the interpolated value of that line in the pixel grid, which would be a grey value on both adjacent pixel positions. In contrast, snapping will move the line to the nearest integer pixel value, so that the resulting image will really contain a 1px wide black line.

Snapping is currently only supported by the Agg and MacOSX backends.

#### Parameters

**snap** [bool or None] Possible values:

- `True`: Snap vertices to the nearest pixel center.
- `False`: Do not modify vertex positions.
- `None`: (auto) If the path contains only rectilinear line segments, round to the nearest pixel center.

`set_transform(self, t)`  
Set the artist transform.

#### Parameters

**t** [*Transform*]

`set_url(self, url)`  
Set the url for the artist.

#### Parameters

**url** [str]

`set_urls(self, urls)`

#### Parameters

**urls** [List[str] or None]

`set_verts(self, verts, closed=True)`  
This allows one to delay initialization of the vertices.

`set_verts_and_codes(self, verts, codes)`  
This allows one to initialize vertices with path codes.

`set_visible(self, b)`  
Set the artist's visibility.

### Parameters

**b** [bool]

`set_zorder(self, level)`  
Set the zorder for the artist. Artists with lower zorder values are drawn first.

### Parameters

**level** [float]

`static span_where(x, ymin, ymax, where, **kwargs)`  
Create a `BrokenBarHCollection` to plot horizontal bars from over the regions in `x` where `where` is `True`. The bars range on the `y`-axis from `ymin` to `ymax`

A `BrokenBarHCollection` is returned. `kwargs` are passed on to the collection.

`stale`  
Whether the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

`sticky_edges`  
`x` and `y` sticky edge lists for autoscaling.

When performing autoscaling, if a data limit coincides with a value in the corresponding `sticky_edges` list, then no margin will be added—the view limit "sticks" to the edge. A typical use case is histograms, where one usually expects no margin on the bottom edge (0) of the histogram.

This attribute cannot be assigned to; however, the `x` and `y` lists can be modified in place as needed.

### Examples

```
>>> artist.sticky_edges.x[:] = (xmin, xmax)
>>> artist.sticky_edges.y[:] = (ymin, ymax)
```

`to_rgba(self, x, alpha=None, bytes=False, norm=True)`  
Return a normalized rgba array corresponding to `x`.

In the normal case, `x` is a 1-D or 2-D sequence of scalars, and the corresponding ndarray of rgba values will be returned, based on the `norm` and `colormap` set for this `ScalarMappable`.

There is one special case, for handling images that are already `rgb` or `rgba`, such as might have been read from an image file. If `x` is an ndarray with 3 dimensions, and the last dimension is either 3 or 4, then it will be treated as an `rgb` or `rgba` array, and no mapping will be done. The array can be `uint8`, or it can be floating point with values in the 0-1 range; otherwise a `ValueError` will be raised. If it is a masked array, the mask will be ignored. If the last dimension is 3, the `alpha` kwarg (defaulting to 1) will be used to fill in the transparency. If the last dimension is 4, the `alpha` kwarg is ignored; it does not replace the pre-existing alpha. A `ValueError` will be raised if the third dimension is other than 3 or 4.

In either case, if `bytes` is `False` (default), the rgba array will be floats in the 0-1 range; if it is `True`, the returned rgba array will be `uint8` in the 0 to 255 range.

If `norm` is `False`, no normalization of the input data is performed, and it is assumed to be in the range (0-1).

`update(self, props)`

Update this artist's properties from the dictionary `props`.

`update_from(self, other)`

copy properties from `other` to `self`

`update_scalarmappable(self)`

Update colors from the scalar mappable array, if it is not `None`.

`zorder = 0`

```
class matplotlib.collections.CircleCollection(sizes, **kwargs)
```

Bases: `matplotlib.collections._CollectionWithSizes`

A collection of circles, drawn using splines.

`sizes` Gives the area of the circle in `points^2`

Valid Collection keyword arguments:

- `edgecolors`: `None`
- `facecolors`: `None`
- `linewidths`: `None`
- `antialiaseds`: `None`
- `offsets`: `None`
- `transOffset`: `transforms.IdentityTransform()`
- `norm`: `None` (optional for `matplotlib.cm.ScalarMappable`)
- `cmap`: `None` (optional for `matplotlib.cm.ScalarMappable`)

`offsets` and `transOffset` are used to translate the patch after rendering (default no offsets)

If any of `edgecolors`, `facecolors`, `linewidths`, `antialiaseds` are `None`, they default to their `matplotlib.rcParams` patch setting, in sequence form.

`add_callback(self, func)`

Add a callback function that will be called whenever one of the *Artist's* properties changes.

### Parameters

**func** [callable] The callback function. It must have the signature:

```
def func(artist: Artist) -> Any
```

where `artist` is the calling *Artist*. Return values may exist but are ignored.

### Returns

**oid** [int] The observer id associated with the callback. This id can be used for removing the callback with `remove_callback` later.

### See also:

`remove_callback`

`add_checker(self, checker)`  
 Add an entry to a dictionary of boolean flags that are set to True when the mappable is changed.

`aname`

`autoscale(self)`  
 Autoscale the scalar limits on the norm instance using the current array

`autoscale_None(self)`  
 Autoscale the scalar limits on the norm instance using the current array, changing only limits that are None

`axes`  
 The *Axes* instance the artist resides in, or *None*.

`changed(self)`  
 Call this whenever the mappable is changed to notify all the callbackSM listeners to the 'changed' signal

`check_update(self, checker)`  
 If mappable has changed since the last check, return True; else return False

`contains(self, mouseevent)`  
 Test whether the mouse event occurred in the collection.  
 Returns bool, dict(ind=itemlist), where every item in itemlist contains the event.

`convert_xunits(self, x)`  
 Convert x using the unit type of the xaxis.  
 If the artist is not in contained in an Axes or if the xaxis does not have units, x itself is returned.

`convert_yunits(self, y)`  
 Convert y using the unit type of the yaxis.  
 If the artist is not in contained in an Axes or if the yaxis does not have units, y itself is returned.

`draw(self, renderer)`  
 Draw the Artist using the given renderer.  
 This method will be overridden in the Artist subclasses. Typically, it is implemented to not have any effect if the Artist is not visible (*Artist.get\_visible* is *False*).

### Parameters

**renderer** [*RendererBase* subclass.]

`findobj(self, match=None, include_self=True)`  
 Find artist objects.

Recursively find all *Artist* instances contained in the artist.

### Parameters

**match** A filter criterion for the matches. This can be

- *None*: Return all objects contained in artist.
- A function with signature `def match(artist: Artist) -> bool`. The result will only contain artists for which the function returns *True*.

- A class instance: e.g., *Line2D*. The result will only contain artists of this class or its subclasses (instance check).

**include\_self** [bool] Include *self* in the list to be checked for a match.

### Returns

**artists** [list of *Artist*]

`format_cursor_data(self, data)`

Return a string representation of *data*.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

The default implementation converts ints and floats and arrays of ints and floats into a comma-separated string enclosed in square brackets.

### See also:

`get_cursor_data`

`get_agg_filter(self)`

Return filter function to be used for agg filter.

`get_alpha(self)`

Return the alpha value used for blending - not supported on all backends

`get_animated(self)`

Return the animated state.

`get_array(self)`

Return the array

`get_capstyle(self)`

`get_children(self)`

Return a list of the child *Artists* of this *Artist*.

`get_clim(self)`

return the min, max of the color limits for image scaling

`get_clip_box(self)`

Return the clipbox.

`get_clip_on(self)`

Return whether the artist uses clipping.

`get_clip_path(self)`

Return the clip path.

`get_cmap(self)`

return the colormap

`get_contains(self)`

Return the custom contains function of the artist if set, or *None*.

### See also:

`set_contains`

`get_cursor_data(self, event)`  
Return the cursor data for a given event.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

Cursor data can be used by Artists to provide additional context information for a given event. The default implementation just returns *None*.

Subclasses can override the method and return arbitrary data. However, when doing so, they must ensure that `format_cursor_data` can convert the data to a string representation.

The only current use case is displaying the z-value of an *AxesImage* in the status bar of a plot window, while moving the mouse.

### Parameters

**event** [`matplotlib.backend_bases.MouseEvent`]

### See also:

`format_cursor_data`

`get_dashes(self)`  
Alias for `get_linestyle`.

`get_dataLim(self, transData)`

`get_ec(self)`  
Alias for `get_edgecolor`.

`get_edgecolor(self)`

`get_edgecolors(self)`  
Alias for `get_edgecolor`.

`get_facecolor(self)`

`get_facecolors(self)`  
Alias for `get_facecolor`.

`get_fc(self)`  
Alias for `get_facecolor`.

`get_figure(self)`  
Return the *Figure* instance the artist belongs to.

`get_fill(self)`  
return whether fill is set

`get_gid(self)`  
Return the group id.

`get_hatch(self)`  
Return the current hatching pattern.

`get_in_layout(self)`  
Return boolean flag, True if artist is included in layout calculations.

E.g. *Constrained Layout Guide*, `Figure.tight_layout()`, and `fig.savefig(fname, bbox_inches='tight')`.

`get_joinstyle(self)`

`get_label(self)`

Return the label used for this artist in the legend.

`get_linestyle(self)`

`get_linestyles(self)`

Alias for `get_linestyle`.

`get_linewidth(self)`

`get_linewidths(self)`

Alias for `get_linewidth`.

`get_ls(self)`

Alias for `get_linestyle`.

`get_lw(self)`

Alias for `get_linewidth`.

`get_offset_position(self)`

Returns how offsets are applied for the collection. If `offset_position` is 'screen', the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If `offset_position` is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

`get_offset_transform(self)`

`get_offsets(self)`

Return the offsets for the collection.

`get_path_effects(self)`

`get_paths(self)`

`get_picker(self)`

Return the picking behavior of the artist.

The possible values are described in `set_picker`.

**See also:**

`set_picker`, `pickable`, `pick`

`get_pickradius(self)`

`get_rasterized(self)`

Return whether the artist is to be rasterized.

`get_sizes(self)`

Returns the sizes of the elements in the collection. The value represents the 'area' of the element.

**Returns**

**sizes** [array] The 'area' of each element.

`get_sketch_params(self)`

Returns the sketch parameters for the artist.

**Returns**

**sketch\_params** [tuple or None] A 3-tuple with the following elements:

- *scale*: The amplitude of the wiggle perpendicular to the source line.
- *length*: The length of the wiggle along the line.
- *randomness*: The scale factor by which the length is shrunken or expanded.

Returns *None* if no sketch parameters were set.

`get_snap(self)`

Returns the snap setting.

See `set_snap` for details.

`get_tightbbox(self, renderer)`

Like `Artist.get_window_extent`, but includes any clipping.

### Parameters

**renderer** [*RendererBase* instance] renderer that will be used to draw the figures (i.e. `fig.canvas.get_renderer()`)

### Returns

**bbox** [*BBox*] The enclosing bounding box (in figure pixel co-ordinates).

`get_transform(self)`

Return the *Transform* instance used by this artist.

`get_transformed_clip_path_and_affine(self)`

Return the clip path with the non-affine part of its transformation applied, and the remaining affine part of its transformation.

`get_transforms(self)`

`get_url(self)`

Return the url.

`get_urls(self)`

`get_visible(self)`

Return the visibility.

`get_window_extent(self, renderer)`

Get the axes bounding box in display space.

The bounding box' width and height are nonnegative.

Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

`get_zorder(self)`

Return the artist's zorder.

`have_units(self)`

Return *True* if units are set on the x or y axes.

`is_transform_set(self)`

Return whether the Artist has an explicitly set transform.

This is *True* after *set\_transform* has been called.

`mouseover`

`pchanged(self)`

Call all of the registered callbacks.

This function is triggered internally when a property is changed.

**See also:**

`add_callback`

`remove_callback`

`pick(self, mouseevent)`

Process a pick event.

Each child artist will fire a pick event if *mouseevent* is over the artist and the artist has picker set.

**See also:**

`set_picker, get_picker, pickable`

`pickable(self)`

Return whether the artist is pickable.

**See also:**

`set_picker, get_picker, pick`

`properties(self)`

Return a dictionary of all the properties of the artist.

`remove(self)`

Remove the artist from the figure if possible.

The effect will not be visible until the figure is redrawn, e.g., with *FigureCanvasBase.draw\_idle*. Call *relim* to update the axes limits if desired.

Note: *relim* will not see collections even if the collection was added to the axes with *autolim = True*.

Note: there is no support for removing the artist's legend entry.

`remove_callback(self, oid)`

Remove a callback based on its observer id.

**See also:**

`add_callback`

`set(self, **kwargs)`

A property batch setter. Pass *kwargs* to set properties.

`set_aa(self, aa)`

Alias for *set\_antialiased*.

`set_agg_filter(self, filter_func)`

Set the agg filter.

**Parameters**

**filter\_func** [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

`set_alpha(self, alpha)`

Set the alpha transparencies of the collection.

**Parameters**

**alpha** [float or None]

`set_animated(self, b)`

Set the artist's animation state.

**Parameters**

**b** [bool]

`set_antialiased(self, aa)`

Set the antialiasing state for rendering.

**Parameters**

**aa** [bool or sequence of bools]

`set_antialiaseds(self, aa)`

Alias for `set_antialiased`.

`set_array(self, A)`

Set the image array from numpy array *A*.

**Parameters**

**A** [ndarray]

`set_capstyle(self, cs)`

Set the capstyle for the collection (for all its elements).

**Parameters**

**cs** [{'butt', 'round', 'projecting'}] The capstyle

`set_clim(self, vmin=None, vmax=None)`

set the norm limits for image scaling; if *vmin* is a length2 sequence, interpret it as (*vmin*, *vmax*) which is used to support `setp`

ACCEPTS: a length 2 sequence of floats; may be overridden in methods that have *vmin* and *vmax* kwargs.

`set_clip_box(self, clipbox)`

Set the artist's clip *Bbox*.

**Parameters**

**clipbox** [*Bbox*]

`set_clip_on(self, b)`

Set whether the artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

**Parameters**

**b** [bool]

`set_clip_path(self, path, transform=None)`

Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- *None*, to remove a previously set clipping path.

For efficiency, if the path happens to be an axis-aligned rectangle, this method will set the clipping box to the corresponding rectangle and set the clipping path to *None*.

ACCEPTS: [(*Path*, *Transform*) | *Patch* | *None*]

`set_cmap(self, cmap)`

set the colormap for luminance data

#### Parameters

**cmap** [colormap or registered colormap name]

`set_color(self, c)`

Set both the edgecolor and the facecolor.

#### Parameters

**c** [color or sequence of rgba tuples]

#### See also:

*Collection.set\_facecolor*, *Collection.set\_edgecolor* For setting the edge or face color individually.

`set_contains(self, picker)`

Define a custom contains test for the artist.

The provided callable replaces the default *contains* method of the artist.

#### Parameters

**picker** [callable] A custom picker function to evaluate if an event is within the artist. The function must have the signature:

```
def contains(artist: Artist, event: MouseEvent) -> bool, dict
```

that returns:

- a *bool* indicating if the event is within the artist
- a *dict* of additional information. The dict should at least return the same information as the default *contains()* implementation of the respective artist, but may provide additional information.

`set_dashes(self, ls)`

Alias for *set\_linestyle*.

`set_ec(self, c)`

Alias for *set\_edgecolor*.

`set_edgecolor(self, c)`

Set the edgecolor(s) of the collection.

#### Parameters

**c** [color or sequence of colors or 'face'] The collection edgecolor(s). If a sequence, the patches cycle through it. If 'face', match the facecolor.

`set_edgecolors(self, c)`  
Alias for `set_edgecolor`.

`set_facecolor(self, c)`  
Set the facecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; if it is a sequence the patches will cycle through the sequence.

If *c* is 'none', the patch will not be filled.

#### Parameters

**c** [color or sequence of colors]

`set_facecolors(self, c)`  
Alias for `set_facecolor`.

`set_fc(self, c)`  
Alias for `set_facecolor`.

`set_figure(self, fig)`  
Set the *Figure* instance the artist belongs to.

#### Parameters

**fig** [*Figure*]

`set_gid(self, gid)`  
Set the (group) id for the artist.

#### Parameters

**gid** [str]

`set_hatch(self, hatch)`  
Set the hatching pattern

*hatch* can be one of:

/	- diagonal hatching
\	- back diagonal
	- vertical
-	- horizontal
+	- crossed
x	- crossed diagonal
o	- small circle
O	- large circle
.	- dots
*	- stars

Letters can be combined, in which case all the specified hatchings are done. If same letter repeats, it increases the density of hatching of that pattern.

Hatching is supported in the PostScript, PDF, SVG and Agg backends only.

Unlike other properties such as linewidth and colors, hatching can only be specified for the collection as a whole, not separately for each member.

#### Parameters

**hatch** [{'/', '\\', '|', '-', '+', 'x', 'o', 'O', '.', '\*'}]

`set_in_layout(self, in_layout)`

Set if artist is to be included in layout calculations, E.g. *Constrained Layout Guide*, *Figure.tight\_layout()*, and *fig.savefig(fname, bbox\_inches='tight')*.

#### Parameters

**in\_layout** [bool]

`set_joinstyle(self, js)`

Set the joinstyle for the collection (for all its elements).

#### Parameters

**js** [{'miter', 'round', 'bevel'}] The joinstyle

`set_label(self, s)`

Set a label that will be displayed in the legend.

#### Parameters

**s** [object] *s* will be converted to a string by calling *str*.

`set_linestyle(self, ls)`

Set the linestyle(s) for the collection.

linestyle	description
'-' or 'solid'	solid line
'--' or 'dashed'	dashed line
'-.' or 'dashdot'	dash-dotted line
':' or 'dotted'	dotted line

Alternatively a dash tuple of the following form can be provided:

```
(offset, onoffseq),
```

where *onoffseq* is an even length tuple of on and off ink in points.

#### Parameters

**ls** [{'-', '-', '-.', ':', "", (offset, on-off-seq), ...}] The line style.

`set_linestyles(self, ls)`

Alias for *set\_linestyle*.

`set_linewidth(self, lw)`

Set the linewidth(s) for the collection. *lw* can be a scalar or a sequence; if it is a sequence the patches will cycle through the sequence

#### Parameters

**lw** [float or sequence of floats]

`set_linewidths(self, lw)`

Alias for *set\_linewidth*.

`set_ls(self, ls)`

Alias for *set\_linestyle*.

`set_lw(self, lw)`

Alias for *set\_linewidth*.

`set_norm(self, norm)`

Set the normalization instance.

**Parameters****norm** [*Normalize*]**Notes**

If there are any colorbars using the mappable for this norm, setting the norm of the mappable will reset the norm, locator, and formatters on the colorbar to default.

**set\_offset\_position**(*self*, *offset\_position*)

Set how offsets are applied. If *offset\_position* is 'screen' (default) the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If *offset\_position* is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

**Parameters****offset\_position** [{'screen', 'data'}]**set\_offsets**(*self*, *offsets*)

Set the offsets for the collection.

**Parameters****offsets** [float or sequence of floats]**set\_path\_effects**(*self*, *path\_effects*)

Set the path effects.

**Parameters****path\_effects** [*AbstractPathEffect*]**set\_paths**(*self*)**set\_picker**(*self*, *picker*)

Define the picking behavior of the artist.

**Parameters****picker** [None or bool or float or callable] This can be one of the following:

- *None*: Picking is disabled for this artist (default).
- A boolean: If *True* then picking will be enabled and the artist will fire a pick event if the mouse event is over the artist.
- A float: If *picker* is a number it is interpreted as an epsilon tolerance in points and the artist will fire off an event if it's data is within epsilon of the mouse event. For some artists like lines and patch collections, the artist may provide additional data to the pick event that is generated, e.g., the indices of the data within epsilon of the pick event
- A function: If *picker* is callable, it is a user supplied function which determines whether the artist is hit by the mouse event:

```
hit, props = picker(artist, mouseevent)
```

to determine the hit test. if the mouse event is over the artist, return *hit=True* and *props* is a dictionary of properties you want added to the *PickEvent* attributes.

`set_pickradius(self, pr)`

Set the pick radius used for containment tests.

**Parameters**

**d** [float] Pick radius, in points.

`set_rasterized(self, rasterized)`

Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

**Parameters**

**rasterized** [bool or None]

`set_sizes(self, sizes, dpi=72.0)`

Set the sizes of each member of the collection.

**Parameters**

**sizes** [ndarray or None] The size to set for each element of the collection. The value is the 'area' of the element.

**dpi** [float] The dpi of the canvas. Defaults to 72.0.

`set_sketch_params(self, scale=None, length=None, randomness=None)`

Sets the sketch parameters.

**Parameters**

**scale** [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

**length** [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

**randomness** [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

`set_snap(self, snap)`

Set the snapping behavior.

Snapping aligns positions with the pixel grid, which results in clearer images. For example, if a black line of 1px width was defined at a position in between two pixels, the resulting image would contain the interpolated value of that line in the pixel grid, which would be a grey value on both adjacent pixel positions. In contrast, snapping will move the line to the nearest integer pixel value, so that the resulting image will really contain a 1px wide black line.

Snapping is currently only supported by the Agg and MacOSX backends.

**Parameters**

**snap** [bool or None] Possible values:

- *True*: Snap vertices to the nearest pixel center.
- *False*: Do not modify vertex positions.
- *None*: (auto) If the path contains only rectilinear line segments, round to the nearest pixel center.

`set_transform(self, t)`

Set the artist transform.

**Parameters****t** [*Transform*]`set_url(self, url)`

Set the url for the artist.

**Parameters****url** [str]`set_urls(self, urls)`**Parameters****urls** [List[str] or None]`set_visible(self, b)`

Set the artist's visibility.

**Parameters****b** [bool]`set_zorder(self, level)`

Set the zorder for the artist. Artists with lower zorder values are drawn first.

**Parameters****level** [float]`stale`

Whether the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

`sticky_edges`

x and y sticky edge lists for autoscaling.

When performing autoscaling, if a data limit coincides with a value in the corresponding `sticky_edges` list, then no margin will be added—the view limit “sticks” to the edge. A typical use case is histograms, where one usually expects no margin on the bottom edge (0) of the histogram.

This attribute cannot be assigned to; however, the x and y lists can be modified in place as needed.

**Examples**

```
>>> artist.sticky_edges.x[:] = (xmin, xmax)
>>> artist.sticky_edges.y[:] = (ymin, ymax)
```

`to_rgba(self, x, alpha=None, bytes=False, norm=True)`

Return a normalized rgba array corresponding to x.

In the normal case, x is a 1-D or 2-D sequence of scalars, and the corresponding ndarray of rgba values will be returned, based on the norm and colormap set for this `ScalarMappable`.

There is one special case, for handling images that are already rgb or rgba, such as might have been read from an image file. If x is an ndarray with 3 dimensions, and the last dimension is either 3 or 4, then it will be treated as an rgb or rgba array, and no mapping will be done. The array can be uint8, or it can be floating point with

values in the 0-1 range; otherwise a `ValueError` will be raised. If it is a masked array, the mask will be ignored. If the last dimension is 3, the `alpha` kwarg (defaulting to 1) will be used to fill in the transparency. If the last dimension is 4, the `alpha` kwarg is ignored; it does not replace the pre-existing alpha. A `ValueError` will be raised if the third dimension is other than 3 or 4.

In either case, if `bytes` is `False` (default), the `rgba` array will be floats in the 0-1 range; if it is `True`, the returned `rgba` array will be `uint8` in the 0 to 255 range.

If `norm` is `False`, no normalization of the input data is performed, and it is assumed to be in the range (0-1).

`update(self, props)`

Update this artist's properties from the dictionary `props`.

`update_from(self, other)`

copy properties from `other` to `self`

`update_scalarmappable(self)`

Update colors from the scalar mappable array, if it is not `None`.

`zorder = 0`

```
class matplotlib.collections.Collection(edgecolors=None,          facecolors=None,
                                       linewidths=None,         linestyle='solid',
                                       capstyle=None,          jointstyle=None,    antialiaseds=None,
                                       offsets=None, transOffset=None, norm=None, cmap=None, pickradius=5.0,
                                       hatch=None, urls=None, offset_position='screen', zorder=1, **kwargs)
```

Bases: `matplotlib.artist.Artist`, `matplotlib.cm.ScalarMappable`

Base class for Collections. Must be subclassed to be usable.

All properties in a collection must be sequences or scalars; if scalars, they will be converted to sequences. The property of the `i`th element of the collection is:

```
prop[i % len(props)]
```

Exceptions are `capstyle` and `jointstyle` properties, these can only be set globally for the whole collection.

Keyword arguments and default values:

- `edgecolors`: `None`
- `facecolors`: `None`
- `linewidths`: `None`
- `capstyle`: `None`
- `jointstyle`: `None`
- `antialiaseds`: `None`
- `offsets`: `None`
- `transOffset`: `transforms.IdentityTransform()`
- `offset_position`: `'screen'` (default) or `'data'`
- `norm`: `None` (optional for `matplotlib.cm.ScalarMappable`)
- `cmap`: `None` (optional for `matplotlib.cm.ScalarMappable`)

- *hatch*: None
- *zorder*: 1

*offsets* and *transOffset* are used to translate the patch after rendering (default no offsets). If *offset\_position* is 'screen' (default) the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If *offset\_position* is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

If any of *edgecolors*, *facecolors*, *linewidths*, *antialiaseds* are None, they default to their *matplotlib.rcParams* patch setting, in sequence form.

The use of *ScalarMappable* is optional. If the *ScalarMappable* matrix *\_A* is not None (i.e., a call to *set\_array* has been made), at draw time a call to scalar mappable will be made to set the face colors.

Create a Collection

%(Collection)s

`add_callback(self, func)`

Add a callback function that will be called whenever one of the *Artist*'s properties changes.

### Parameters

**func** [callable] The callback function. It must have the signature:

```
def func(artist: Artist) -> Any
```

where *artist* is the calling *Artist*. Return values may exist but are ignored.

### Returns

**oid** [int] The observer id associated with the callback. This id can be used for removing the callback with *remove\_callback* later.

### See also:

*remove\_callback*

`add_checker(self, checker)`

Add an entry to a dictionary of boolean flags that are set to True when the mappable is changed.

*aname*

`autoscale(self)`

Autoscale the scalar limits on the norm instance using the current array

`autoscale_None(self)`

Autoscale the scalar limits on the norm instance using the current array, changing only limits that are None

*axes*

The *Axes* instance the artist resides in, or *None*.

`changed(self)`

Call this whenever the mappable is changed to notify all the callbackSM listeners to the 'changed' signal

`check_update(self, checker)`

If mappable has changed since the last check, return True; else return False

`contains(self, mouseevent)`

Test whether the mouse event occurred in the collection.

Returns bool, dict(ind=itemlist), where every item in itemlist contains the event.

`convert_xunits(self, x)`

Convert x using the unit type of the xaxis.

If the artist is not in contained in an Axes or if the xaxis does not have units, x itself is returned.

`convert_yunits(self, y)`

Convert y using the unit type of the yaxis.

If the artist is not in contained in an Axes or if the yaxis does not have units, y itself is returned.

`draw(self, renderer)`

Draw the Artist using the given renderer.

This method will be overridden in the Artist subclasses. Typically, it is implemented to not have any effect if the Artist is not visible (*Artist.get\_visible* is *False*).

#### Parameters

**renderer** [*RendererBase* subclass.]

`findobj(self, match=None, include_self=True)`

Find artist objects.

Recursively find all *Artist* instances contained in the artist.

#### Parameters

**match** A filter criterion for the matches. This can be

- *None*: Return all objects contained in artist.
- A function with signature `def match(artist: Artist) -> bool`. The result will only contain artists for which the function returns *True*.
- A class instance: e.g., *Line2D*. The result will only contain artists of this class or its subclasses (*isinstance* check).

**include\_self** [bool] Include *self* in the list to be checked for a match.

#### Returns

**artists** [list of *Artist*]

`format_cursor_data(self, data)`

Return a string representation of *data*.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

The default implementation converts ints and floats and arrays of ints and floats into a comma-separated string enclosed in square brackets.

**See also:**

`get_cursor_data`

`get_agg_filter(self)`  
Return filter function to be used for agg filter.

`get_alpha(self)`  
Return the alpha value used for blending - not supported on all backends

`get_animated(self)`  
Return the animated state.

`get_array(self)`  
Return the array

`get_capstyle(self)`

`get_children(self)`  
Return a list of the child *Artists* of this *Artist*.

`get_clim(self)`  
return the min, max of the color limits for image scaling

`get_clip_box(self)`  
Return the clipbox.

`get_clip_on(self)`  
Return whether the artist uses clipping.

`get_clip_path(self)`  
Return the clip path.

`get_cmap(self)`  
return the colormap

`get_contains(self)`  
Return the custom contains function of the artist if set, or *None*.

**See also:**

`set_contains`

`get_cursor_data(self, event)`  
Return the cursor data for a given event.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

Cursor data can be used by Artists to provide additional context information for a given event. The default implementation just returns *None*.

Subclasses can override the method and return arbitrary data. However, when doing so, they must ensure that `format_cursor_data` can convert the data to a string representation.

The only current use case is displaying the z-value of an *AxesImage* in the status bar of a plot window, while moving the mouse.

### Parameters

**event** [`matplotlib.backend_bases.MouseEvent`]

**See also:**

`format_cursor_data`

`get_dashes(self)`  
Alias for `get_linestyle`.

`get_datalim(self, transData)`

`get_ec(self)`  
Alias for `get_edgecolor`.

`get_edgecolor(self)`

`get_edgecolors(self)`  
Alias for `get_edgecolor`.

`get_facecolor(self)`

`get_facecolors(self)`  
Alias for `get_facecolor`.

`get_fc(self)`  
Alias for `get_facecolor`.

`get_figure(self)`  
Return the *Figure* instance the artist belongs to.

`get_fill(self)`  
return whether fill is set

`get_gid(self)`  
Return the group id.

`get_hatch(self)`  
Return the current hatching pattern.

`get_in_layout(self)`  
Return boolean flag, True if artist is included in layout calculations.  
  
E.g. *Constrained Layout Guide*, `Figure.tight_layout()`, and `fig.savefig(fname, bbox_inches='tight')`.

`get_joinstyle(self)`

`get_label(self)`  
Return the label used for this artist in the legend.

`get_linestyle(self)`

`get_linestyles(self)`  
Alias for `get_linestyle`.

`get_linewidth(self)`

`get_linewidths(self)`  
Alias for `get_linewidth`.

`get_ls(self)`  
Alias for `get_linestyle`.

`get_lw(self)`  
Alias for `get_linewidth`.

`get_offset_position(self)`

Returns how offsets are applied for the collection. If *offset\_position* is 'screen', the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If *offset\_position* is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

`get_offset_transform(self)`

`get_offsets(self)`

Return the offsets for the collection.

`get_path_effects(self)`

`get_paths(self)`

`get_picker(self)`

Return the picking behavior of the artist.

The possible values are described in *set\_picker*.

**See also:**

*set\_picker, pickable, pick*

`get_pickradius(self)`

`get_rasterized(self)`

Return whether the artist is to be rasterized.

`get_sketch_params(self)`

Returns the sketch parameters for the artist.

**Returns**

**sketch\_params** [tuple or None] A 3-tuple with the following elements:

- *scale*: The amplitude of the wiggle perpendicular to the source line.
- *length*: The length of the wiggle along the line.
- *randomness*: The scale factor by which the length is shrunken or expanded.

Returns *None* if no sketch parameters were set.

`get_snap(self)`

Returns the snap setting.

See *set\_snap* for details.

`get_tightbbox(self, renderer)`

Like `Artist.get_window_extent`, but includes any clipping.

**Parameters**

**renderer** [*RendererBase* instance] renderer that will be used to draw the figures (i.e. `fig.canvas.get_renderer()`)

**Returns**

**bbox** [*BBox*] The enclosing bounding box (in figure pixel co-ordinates).

`get_transform(self)`

Return the *Transform* instance used by this artist.

`get_transformed_clip_path_and_affine(self)`  
Return the clip path with the non-affine part of its transformation applied, and the remaining affine part of its transformation.

`get_transforms(self)`

`get_url(self)`  
Return the url.

`get_urls(self)`

`get_visible(self)`  
Return the visibility.

`get_window_extent(self, renderer)`  
Get the axes bounding box in display space.  
  
The bounding box' width and height are nonnegative.  
  
Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.  
  
Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

`get_zorder(self)`  
Return the artist's zorder.

`have_units(self)`  
Return *True* if units are set on the x or y axes.

`is_transform_set(self)`  
Return whether the Artist has an explicitly set transform.  
  
This is *True* after `set_transform` has been called.

`mouseover`

`pchanged(self)`  
Call all of the registered callbacks.  
  
This function is triggered internally when a property is changed.  
  
**See also:**  
  
`add_callback`  
`remove_callback`

`pick(self, mouseevent)`  
Process a pick event.  
  
Each child artist will fire a pick event if *mouseevent* is over the artist and the artist has picker set.  
  
**See also:**  
  
`set_picker`, `get_picker`, `pickable`

`pickable(self)`

Return whether the artist is pickable.

**See also:**

`set_picker`, `get_picker`, `pick`

`properties(self)`

Return a dictionary of all the properties of the artist.

`remove(self)`

Remove the artist from the figure if possible.

The effect will not be visible until the figure is redrawn, e.g., with `FigureCanvasBase.draw_idle`. Call `relim` to update the axes limits if desired.

Note: `relim` will not see collections even if the collection was added to the axes with `autolim = True`.

Note: there is no support for removing the artist's legend entry.

`remove_callback(self, oid)`

Remove a callback based on its observer id.

**See also:**

`add_callback`

`set(self, **kwargs)`

A property batch setter. Pass `kwargs` to set properties.

`set_aa(self, aa)`

Alias for `set_antialiased`.

`set_agg_filter(self, filter_func)`

Set the agg filter.

**Parameters**

**filter\_func** [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

`set_alpha(self, alpha)`

Set the alpha transparencies of the collection.

**Parameters**

**alpha** [float or None]

`set_animated(self, b)`

Set the artist's animation state.

**Parameters**

**b** [bool]

`set_antialiased(self, aa)`

Set the antialiasing state for rendering.

**Parameters**

**aa** [bool or sequence of bools]

`set_antialiaseds(self, aa)`  
Alias for `set_antialiased`.

`set_array(self, A)`  
Set the image array from numpy array *A*.

**Parameters**

**A** [ndarray]

`set_capstyle(self, cs)`  
Set the capstyle for the collection (for all its elements).

**Parameters**

**cs** [{'butt', 'round', 'projecting'}] The capstyle

`set_clim(self, vmin=None, vmax=None)`  
set the norm limits for image scaling; if *vmin* is a length2 sequence, interpret it as (*vmin*, *vmax*) which is used to support setp

ACCEPTS: a length 2 sequence of floats; may be overridden in methods that have *vmin* and *vmax* kwargs.

`set_clip_box(self, clipbox)`  
Set the artist's clip *Bbox*.

**Parameters**

**clipbox** [*Bbox*]

`set_clip_on(self, b)`  
Set whether the artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

**Parameters**

**b** [bool]

`set_clip_path(self, path, transform=None)`  
Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- None, to remove a previously set clipping path.

For efficiency, if the path happens to be an axis-aligned rectangle, this method will set the clipping box to the corresponding rectangle and set the clipping path to None.

ACCEPTS: [(*Path*, *Transform*) | *Patch* | None]

`set_cmap(self, cmap)`  
set the colormap for luminance data

**Parameters**

**cmap** [colormap or registered colormap name]

`set_color(self, c)`  
Set both the edgecolor and the facecolor.

**Parameters**

**c** [color or sequence of rgba tuples]

**See also:**

`Collection.set_facecolor`, `Collection.set_edgecolor` For setting the edge or face color individually.

`set_contains(self, picker)`

Define a custom contains test for the artist.

The provided callable replaces the default `contains` method of the artist.

**Parameters**

**picker** [callable] A custom picker function to evaluate if an event is within the artist. The function must have the signature:

```
def contains(artist: Artist, event: MouseEvent) -> bool, dict
```

that returns:

- a bool indicating if the event is within the artist
- a dict of additional information. The dict should at least return the same information as the default `contains()` implementation of the respective artist, but may provide additional information.

`set_dashes(self, ls)`

Alias for `set_linestyle`.

`set_ec(self, c)`

Alias for `set_edgecolor`.

`set_edgecolor(self, c)`

Set the edgecolor(s) of the collection.

**Parameters**

**c** [color or sequence of colors or 'face'] The collection edgecolor(s). If a sequence, the patches cycle through it. If 'face', match the facecolor.

`set_edgecolors(self, c)`

Alias for `set_edgecolor`.

`set_facecolor(self, c)`

Set the facecolor(s) of the collection. `c` can be a matplotlib color spec (all patches have same color), or a sequence of specs; if it is a sequence the patches will cycle through the sequence.

If `c` is 'none', the patch will not be filled.

**Parameters**

**c** [color or sequence of colors]

`set_facecolors(self, c)`

Alias for `set_facecolor`.

`set_fc(self, c)`

Alias for `set_facecolor`.

`set_figure(self, fig)`

Set the `Figure` instance the artist belongs to.

**Parameters****fig** [*Figure*]`set_gid(self, gid)`

Set the (group) id for the artist.

**Parameters****gid** [str]`set_hatch(self, hatch)`

Set the hatching pattern

*hatch* can be one of:

```

/ - diagonal hatching
\ - back diagonal
| - vertical
- - horizontal
+ - crossed
x - crossed diagonal
o - small circle
O - large circle
. - dots
* - stars

```

Letters can be combined, in which case all the specified hatchings are done. If same letter repeats, it increases the density of hatching of that pattern.

Hatching is supported in the PostScript, PDF, SVG and Agg backends only.

Unlike other properties such as linewidth and colors, hatching can only be specified for the collection as a whole, not separately for each member.

**Parameters****hatch** [{'/', '\', '|', '-', '+', 'x', 'o', 'O', '.', '\*'}]`set_in_layout(self, in_layout)`Set if artist is to be included in layout calculations, E.g. *Constrained Layout Guide*, `Figure.tight_layout()`, and `fig.savefig(fname, bbox_inches='tight')`.**Parameters****in\_layout** [bool]`set_joinstyle(self, js)`

Set the joinstyle for the collection (for all its elements).

**Parameters****js** [{'miter', 'round', 'bevel'}] The joinstyle`set_label(self, s)`

Set a label that will be displayed in the legend.

**Parameters****s** [object] *s* will be converted to a string by calling `str`.`set_linestyle(self, ls)`

Set the linestyle(s) for the collection.

linestyle	description
'-' or 'solid'	solid line
'--' or 'dashed'	dashed line
'-.' or 'dashdot'	dash-dotted line
':' or 'dotted'	dotted line

Alternatively a dash tuple of the following form can be provided:

```
(offset, onoffseq),
```

where `onoffseq` is an even length tuple of on and off ink in points.

### Parameters

**ls** [{'-', '-', '-.', ':', ', ', (offset, on-off-seq), ...}] The line style.

`set_linestyles(self, ls)`

Alias for `set_linestyle`.

`set_linewidth(self, lw)`

Set the linewidth(s) for the collection. `lw` can be a scalar or a sequence; if it is a sequence the patches will cycle through the sequence

### Parameters

**lw** [float or sequence of floats]

`set_linewidths(self, lw)`

Alias for `set_linewidth`.

`set_ls(self, ls)`

Alias for `set_linestyle`.

`set_lw(self, lw)`

Alias for `set_linewidth`.

`set_norm(self, norm)`

Set the normalization instance.

### Parameters

**norm** [*Normalize*]

### Notes

If there are any colorbars using the mappable for this norm, setting the norm of the mappable will reset the norm, locator, and formatters on the colorbar to default.

`set_offset_position(self, offset_position)`

Set how offsets are applied. If `offset_position` is 'screen' (default) the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If `offset_position` is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

### Parameters

**offset\_position** [{'screen', 'data'}]

`set_offsets(self, offsets)`

Set the offsets for the collection.

**Parameters****offsets** [float or sequence of floats]`set_path_effects(self, path_effects)`  
Set the path effects.**Parameters****path\_effects** [*AbstractPathEffect*]`set_paths(self)``set_picker(self, picker)`  
Define the picking behavior of the artist.**Parameters****picker** [None or bool or float or callable] This can be one of the following:

- *None*: Picking is disabled for this artist (default).
- A boolean: If *True* then picking will be enabled and the artist will fire a pick event if the mouse event is over the artist.
- A float: If picker is a number it is interpreted as an epsilon tolerance in points and the artist will fire off an event if it's data is within epsilon of the mouse event. For some artists like lines and patch collections, the artist may provide additional data to the pick event that is generated, e.g., the indices of the data within epsilon of the pick event
- A function: If picker is callable, it is a user supplied function which determines whether the artist is hit by the mouse event:

```
hit, props = picker(artist, mouseevent)
```

to determine the hit test. if the mouse event is over the artist, return *hit=True* and props is a dictionary of properties you want added to the PickEvent attributes.

`set_pickradius(self, pr)`  
Set the pick radius used for containment tests.**Parameters****d** [float] Pick radius, in points.`set_rasterized(self, rasterized)`  
Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

**Parameters****rasterized** [bool or None]`set_sketch_params(self, scale=None, length=None, randomness=None)`  
Sets the sketch parameters.**Parameters****scale** [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is *None*, or not provided, no sketch filter will be provided.

**length** [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

**randomness** [float, optional] The scale factor by which the length is shrunk or expanded (default 16.0)

`set_snap(self, snap)`

Set the snapping behavior.

Snapping aligns positions with the pixel grid, which results in clearer images. For example, if a black line of 1px width was defined at a position in between two pixels, the resulting image would contain the interpolated value of that line in the pixel grid, which would be a grey value on both adjacent pixel positions. In contrast, snapping will move the line to the nearest integer pixel value, so that the resulting image will really contain a 1px wide black line.

Snapping is currently only supported by the Agg and MacOSX backends.

#### Parameters

**snap** [bool or None] Possible values:

- *True*: Snap vertices to the nearest pixel center.
- *False*: Do not modify vertex positions.
- *None*: (auto) If the path contains only rectilinear line segments, round to the nearest pixel center.

`set_transform(self, t)`

Set the artist transform.

#### Parameters

**t** [*Transform*]

`set_url(self, url)`

Set the url for the artist.

#### Parameters

**url** [str]

`set_urls(self, urls)`

#### Parameters

**urls** [List[str] or None]

`set_visible(self, b)`

Set the artist's visibility.

#### Parameters

**b** [bool]

`set_zorder(self, level)`

Set the zorder for the artist. Artists with lower zorder values are drawn first.

#### Parameters

**level** [float]

`stale`

Whether the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

**sticky\_edges**

x and y sticky edge lists for autoscaling.

When performing autoscaling, if a data limit coincides with a value in the corresponding `sticky_edges` list, then no margin will be added—the view limit “sticks” to the edge. A typical use case is histograms, where one usually expects no margin on the bottom edge (0) of the histogram.

This attribute cannot be assigned to; however, the x and y lists can be modified in place as needed.

**Examples**

```
>>> artist.sticky_edges.x[:] = (xmin, xmax)
>>> artist.sticky_edges.y[:] = (ymin, ymax)
```

**to\_rgba(*self*, x, alpha=None, bytes=False, norm=True)**

Return a normalized rgba array corresponding to x.

In the normal case, x is a 1-D or 2-D sequence of scalars, and the corresponding ndarray of rgba values will be returned, based on the norm and colormap set for this `ScalarMappable`.

There is one special case, for handling images that are already rgb or rgba, such as might have been read from an image file. If x is an ndarray with 3 dimensions, and the last dimension is either 3 or 4, then it will be treated as an rgb or rgba array, and no mapping will be done. The array can be uint8, or it can be floating point with values in the 0-1 range; otherwise a `ValueError` will be raised. If it is a masked array, the mask will be ignored. If the last dimension is 3, the *alpha* kwarg (defaulting to 1) will be used to fill in the transparency. If the last dimension is 4, the *alpha* kwarg is ignored; it does not replace the pre-existing alpha. A `ValueError` will be raised if the third dimension is other than 3 or 4.

In either case, if *bytes* is *False* (default), the rgba array will be floats in the 0-1 range; if it is *True*, the returned rgba array will be uint8 in the 0 to 255 range.

If *norm* is *False*, no normalization of the input data is performed, and it is assumed to be in the range (0-1).

**update(*self*, props)**

Update this artist’s properties from the dictionary *props*.

**update\_from(*self*, other)**

copy properties from other to self

**update\_scalarmappable(*self*)**

Update colors from the scalar mappable array, if it is not None.

`zorder = 0`

```
class matplotlib.collections.EllipseCollection(widths, heights, angles, units='points',
                                             **kwargs)
```

Bases: `matplotlib.collections.Collection`

A collection of ellipses, drawn using splines.

**Parameters**

**widths** [array-like] The lengths of the first axes (e.g., major axis lengths).

**heights** [array-like] The lengths of second axes.

**angles** [array-like] The angles of the first axes, degrees CCW from the x-axis.

**units** [{'points', 'inches', 'dots', 'width', 'height', 'x', 'y', 'xy'}] The units in which majors and minors are given; 'width' and 'height' refer to the dimensions of the axes, while 'x' and 'y' refer to the *offsets* data units. 'xy' differs from all others in that the angle as plotted varies with the aspect ratio, and equals the specified angle only when the aspect ratio is unity. Hence it behaves the same as the *Ellipse* with `axes.transData` as its transform.

### Other Parameters

**\*\*kwargs** Additional kwargs inherited from the base *Collection*.

Valid Collection keyword arguments:

- *edgecolors*: None
- *facecolors*: None
- *linewidths*: None
- *antialiaseds*: None
- *offsets*: None
- *transOffset*: `transforms.IdentityTransform()`
- *norm*: None (optional for *matplotlib.cm.ScalarMappable*)
- *cmap*: None (optional for *matplotlib.cm.ScalarMappable*)

*offsets* and *transOffset* are used to translate the patch after rendering (default no offsets)

If any of *edgecolors*, *facecolors*, *linewidths*, *antialiaseds* are None, they default to their *matplotlib.rcParams* patch setting, in sequence form.

`add_callback(self, func)`

Add a callback function that will be called whenever one of the *Artist*'s properties changes.

### Parameters

**func** [callable] The callback function. It must have the signature:

```
def func(artist: Artist) -> Any
```

where *artist* is the calling *Artist*. Return values may exist but are ignored.

### Returns

**oid** [int] The observer id associated with the callback. This id can be used for removing the callback with *remove\_callback* later.

### See also:

*remove\_callback*

`add_checker(self, checker)`

Add an entry to a dictionary of boolean flags that are set to True when the mappable is changed.

`aname`

`autoscale(self)`

Autoscale the scalar limits on the norm instance using the current array

`autoscale_None(self)`

Autoscale the scalar limits on the norm instance using the current array, changing only limits that are None

`axes`

The *Axes* instance the artist resides in, or *None*.

`changed(self)`

Call this whenever the mappable is changed to notify all the callbackSM listeners to the 'changed' signal

`check_update(self, checker)`

If mappable has changed since the last check, return True; else return False

`contains(self, mouseevent)`

Test whether the mouse event occurred in the collection.

Returns bool, dict(ind=itemlist), where every item in itemlist contains the event.

`convert_xunits(self, x)`

Convert x using the unit type of the xaxis.

If the artist is not in contained in an Axes or if the xaxis does not have units, x itself is returned.

`convert_yunits(self, y)`

Convert y using the unit type of the yaxis.

If the artist is not in contained in an Axes or if the yaxis does not have units, y itself is returned.

`draw(self, renderer)`

Draw the Artist using the given renderer.

This method will be overridden in the Artist subclasses. Typically, it is implemented to not have any effect if the Artist is not visible (*Artist.get\_visible* is *False*).

### Parameters

**renderer** [*RendererBase* subclass.]

`findobj(self, match=None, include_self=True)`

Find artist objects.

Recursively find all *Artist* instances contained in the artist.

### Parameters

**match** A filter criterion for the matches. This can be

- *None*: Return all objects contained in artist.
- A function with signature `def match(artist: Artist) -> bool`. The result will only contain artists for which the function returns *True*.

- A class instance: e.g., *Line2D*. The result will only contain artists of this class or its subclasses (instance check).

**include\_self** [bool] Include *self* in the list to be checked for a match.

### Returns

**artists** [list of *Artist*]

`format_cursor_data(self, data)`

Return a string representation of *data*.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

The default implementation converts ints and floats and arrays of ints and floats into a comma-separated string enclosed in square brackets.

### See also:

`get_cursor_data`

`get_agg_filter(self)`

Return filter function to be used for agg filter.

`get_alpha(self)`

Return the alpha value used for blending - not supported on all backends

`get_animated(self)`

Return the animated state.

`get_array(self)`

Return the array

`get_capstyle(self)`

`get_children(self)`

Return a list of the child *Artists* of this *Artist*.

`get_clim(self)`

return the min, max of the color limits for image scaling

`get_clip_box(self)`

Return the clipbox.

`get_clip_on(self)`

Return whether the artist uses clipping.

`get_clip_path(self)`

Return the clip path.

`get_cmap(self)`

return the colormap

`get_contains(self)`

Return the custom contains function of the artist if set, or *None*.

### See also:

`set_contains`

`get_cursor_data(self, event)`  
Return the cursor data for a given event.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

Cursor data can be used by Artists to provide additional context information for a given event. The default implementation just returns *None*.

Subclasses can override the method and return arbitrary data. However, when doing so, they must ensure that `format_cursor_data` can convert the data to a string representation.

The only current use case is displaying the z-value of an *AxesImage* in the status bar of a plot window, while moving the mouse.

### Parameters

**event** [`matplotlib.backend_bases.MouseEvent`]

### See also:

`format_cursor_data`

`get_dashes(self)`  
Alias for `get_linestyle`.

`get_dataLim(self, transData)`

`get_ec(self)`  
Alias for `get_edgecolor`.

`get_edgecolor(self)`

`get_edgecolors(self)`  
Alias for `get_edgecolor`.

`get_facecolor(self)`

`get_facecolors(self)`  
Alias for `get_facecolor`.

`get_fc(self)`  
Alias for `get_facecolor`.

`get_figure(self)`  
Return the *Figure* instance the artist belongs to.

`get_fill(self)`  
return whether fill is set

`get_gid(self)`  
Return the group id.

`get_hatch(self)`  
Return the current hatching pattern.

`get_in_layout(self)`  
Return boolean flag, True if artist is included in layout calculations.

E.g. *Constrained Layout Guide*, `Figure.tight_layout()`, and `fig.savefig(fname, bbox_inches='tight')`.

`get_joinstyle(self)`

`get_label(self)`

Return the label used for this artist in the legend.

`get_linestyle(self)`

`get_linestyles(self)`

Alias for `get_linestyle`.

`get_linewidth(self)`

`get_linewidths(self)`

Alias for `get_linewidth`.

`get_ls(self)`

Alias for `get_linestyle`.

`get_lw(self)`

Alias for `get_linewidth`.

`get_offset_position(self)`

Returns how offsets are applied for the collection. If `offset_position` is 'screen', the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If `offset_position` is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

`get_offset_transform(self)`

`get_offsets(self)`

Return the offsets for the collection.

`get_path_effects(self)`

`get_paths(self)`

`get_picker(self)`

Return the picking behavior of the artist.

The possible values are described in `set_picker`.

**See also:**

`set_picker`, `pickable`, `pick`

`get_pickradius(self)`

`get_rasterized(self)`

Return whether the artist is to be rasterized.

`get_sketch_params(self)`

Returns the sketch parameters for the artist.

**Returns**

**sketch\_params** [tuple or None] A 3-tuple with the following elements:

- *scale*: The amplitude of the wiggle perpendicular to the source line.
- *length*: The length of the wiggle along the line.
- *randomness*: The scale factor by which the length is shrunken or expanded.

Returns *None* if no sketch parameters were set.

`get_snap(self)`  
Returns the snap setting.

See `set_snap` for details.

`get_tightbbox(self, renderer)`  
Like `Artist.get_window_extent`, but includes any clipping.

#### Parameters

**renderer** [*RendererBase* instance] renderer that will be used to draw the figures (i.e. `fig.canvas.get_renderer()`)

#### Returns

**bbox** [*BBox*] The enclosing bounding box (in figure pixel co-ordinates).

`get_transform(self)`  
Return the *Transform* instance used by this artist.

`get_transformed_clip_path_and_affine(self)`  
Return the clip path with the non-affine part of its transformation applied, and the remaining affine part of its transformation.

`get_transforms(self)`

`get_url(self)`  
Return the url.

`get_urls(self)`

`get_visible(self)`  
Return the visibility.

`get_window_extent(self, renderer)`  
Get the axes bounding box in display space.

The bounding box' width and height are nonnegative.

Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

`get_zorder(self)`  
Return the artist's zorder.

`have_units(self)`  
Return *True* if units are set on the x or y axes.

`is_transform_set(self)`  
Return whether the Artist has an explicitly set transform.

This is *True* after `set_transform` has been called.

`mouseover`

`pchanged(self)`  
Call all of the registered callbacks.

This function is triggered internally when a property is changed.

**See also:**

`add_callback`  
`remove_callback`

`pick(self, mouseevent)`

Process a pick event.

Each child artist will fire a pick event if *mouseevent* is over the artist and the artist has picker set.

**See also:**

`set_picker`, `get_picker`, `pickable`

`pickable(self)`

Return whether the artist is pickable.

**See also:**

`set_picker`, `get_picker`, `pick`

`properties(self)`

Return a dictionary of all the properties of the artist.

`remove(self)`

Remove the artist from the figure if possible.

The effect will not be visible until the figure is redrawn, e.g., with *FigureCanvasBase.draw\_idle*. Call *relim* to update the axes limits if desired.

Note: *relim* will not see collections even if the collection was added to the axes with *autolim = True*.

Note: there is no support for removing the artist's legend entry.

`remove_callback(self, oid)`

Remove a callback based on its observer id.

**See also:**

`add_callback`

`set(self, **kwargs)`

A property batch setter. Pass *kwargs* to set properties.

`set_aa(self, aa)`

Alias for *set\_antialiased*.

`set_agg_filter(self, filter_func)`

Set the agg filter.

**Parameters**

**filter\_func** [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

`set_alpha(self, alpha)`

Set the alpha transparencies of the collection.

**Parameters**

**alpha** [float or None]

`set_animated(self, b)`  
Set the artist's animation state.

**Parameters**

**b** [bool]

`set_antialiased(self, aa)`  
Set the antialiasing state for rendering.

**Parameters**

**aa** [bool or sequence of bools]

`set_antialiaseds(self, aa)`  
Alias for `set_antialiased`.

`set_array(self, A)`  
Set the image array from numpy array *A*.

**Parameters**

**A** [ndarray]

`set_capstyle(self, cs)`  
Set the capstyle for the collection (for all its elements).

**Parameters**

**cs** [{'butt', 'round', 'projecting'}] The capstyle

`set_clim(self, vmin=None, vmax=None)`  
set the norm limits for image scaling; if *vmin* is a length2 sequence, interpret it as (*vmin*, *vmax*) which is used to support `setp`

ACCEPTS: a length 2 sequence of floats; may be overridden in methods that have *vmin* and *vmax* kwargs.

`set_clip_box(self, clipbox)`  
Set the artist's clip *Bbox*.

**Parameters**

**clipbox** [*Bbox*]

`set_clip_on(self, b)`  
Set whether the artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

**Parameters**

**b** [bool]

`set_clip_path(self, path, transform=None)`  
Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- None, to remove a previously set clipping path.

For efficiency, if the path happens to be an axis-aligned rectangle, this method will set the clipping box to the corresponding rectangle and set the clipping path to `None`.

ACCEPTS: [(*Path*, *Transform*) | *Patch* | *None*]

`set_cmap(self, cmap)`  
set the colormap for luminance data

#### Parameters

**cmap** [colormap or registered colormap name]

`set_color(self, c)`  
Set both the edgecolor and the facecolor.

#### Parameters

**c** [color or sequence of rgba tuples]

#### See also:

`Collection.set_facecolor`, `Collection.set_edgecolor` For setting the edge or face color individually.

`set_contains(self, picker)`  
Define a custom contains test for the artist.

The provided callable replaces the default `contains` method of the artist.

#### Parameters

**picker** [callable] A custom picker function to evaluate if an event is within the artist. The function must have the signature:

```
def contains(artist: Artist, event: MouseEvent) -> bool, dict
```

that returns:

- a bool indicating if the event is within the artist
- a dict of additional information. The dict should at least return the same information as the default `contains()` implementation of the respective artist, but may provide additional information.

`set_dashes(self, ls)`  
Alias for `set_linestyle`.

`set_ec(self, c)`  
Alias for `set_edgecolor`.

`set_edgecolor(self, c)`  
Set the edgecolor(s) of the collection.

#### Parameters

**c** [color or sequence of colors or 'face'] The collection edgecolor(s). If a sequence, the patches cycle through it. If 'face', match the facecolor.

`set_edgecolors(self, c)`  
Alias for `set_edgecolor`.

`set_facecolor(self, c)`  
Set the facecolor(s) of the collection. `c` can be a matplotlib color spec (all patches

have same color), or a sequence of specs; if it is a sequence the patches will cycle through the sequence.

If *c* is 'none', the patch will not be filled.

#### Parameters

**c** [color or sequence of colors]

`set_facecolors(self, c)`  
Alias for `set_facecolor`.

`set_fc(self, c)`  
Alias for `set_facecolor`.

`set_figure(self, fig)`  
Set the *Figure* instance the artist belongs to.

#### Parameters

**fig** [*Figure*]

`set_gid(self, gid)`  
Set the (group) id for the artist.

#### Parameters

**gid** [str]

`set_hatch(self, hatch)`  
Set the hatching pattern

*hatch* can be one of:

```

/ - diagonal hatching
\ - back diagonal
| - vertical
- - horizontal
+ - crossed
x - crossed diagonal
o - small circle
O - large circle
. - dots
* - stars

```

Letters can be combined, in which case all the specified hatchings are done. If same letter repeats, it increases the density of hatching of that pattern.

Hatching is supported in the PostScript, PDF, SVG and Agg backends only.

Unlike other properties such as linewidth and colors, hatching can only be specified for the collection as a whole, not separately for each member.

#### Parameters

**hatch** [{'/', '\\', '|', '-', '+', 'x', 'o', 'O', '.', '\*'}]

`set_in_layout(self, in_layout)`  
Set if artist is to be included in layout calculations, E.g. *Constrained Layout Guide*, `Figure.tight_layout()`, and `fig.savefig(fname, bbox_inches='tight')`.

#### Parameters

**in\_layout** [bool]

`set_joinstyle(self, js)`  
Set the joinstyle for the collection (for all its elements).

**Parameters**

**js** [{'miter', 'round', 'bevel'}] The joinstyle

`set_label(self, s)`  
Set a label that will be displayed in the legend.

**Parameters**

**s** [object] *s* will be converted to a string by calling `str`.

`set_linestyle(self, ls)`  
Set the linestyle(s) for the collection.

linestyle	description
'-' or 'solid'	solid line
'--' or 'dashed'	dashed line
'-.' or 'dashdot'	dash-dotted line
':' or 'dotted'	dotted line

Alternatively a dash tuple of the following form can be provided:

```
(offset, onoffseq),
```

where `onoffseq` is an even length tuple of on and off ink in points.

**Parameters**

**ls** [{'-', '-', '-.', ':', ", (offset, on-off-seq), ...}] The line style.

`set_linestyles(self, ls)`  
Alias for `set_linestyle`.

`set_linewidth(self, lw)`  
Set the linewidth(s) for the collection. *lw* can be a scalar or a sequence; if it is a sequence the patches will cycle through the sequence

**Parameters**

**lw** [float or sequence of floats]

`set_linewidths(self, lw)`  
Alias for `set_linewidth`.

`set_ls(self, ls)`  
Alias for `set_linestyle`.

`set_lw(self, lw)`  
Alias for `set_linewidth`.

`set_norm(self, norm)`  
Set the normalization instance.

**Parameters**

**norm** [*Normalize*]

## Notes

If there are any colorbars using the mappable for this norm, setting the norm of the mappable will reset the norm, locator, and formatters on the colorbar to default.

`set_offset_position(self, offset_position)`

Set how offsets are applied. If `offset_position` is 'screen' (default) the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If `offset_position` is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

### Parameters

**offset\_position** [{'screen', 'data'}]

`set_offsets(self, offsets)`

Set the offsets for the collection.

### Parameters

**offsets** [float or sequence of floats]

`set_path_effects(self, path_effects)`

Set the path effects.

### Parameters

**path\_effects** [*AbstractPathEffect*]

`set_paths(self)`

`set_picker(self, picker)`

Define the picking behavior of the artist.

### Parameters

**picker** [None or bool or float or callable] This can be one of the following:

- *None*: Picking is disabled for this artist (default).
- A boolean: If *True* then picking will be enabled and the artist will fire a pick event if the mouse event is over the artist.
- A float: If `picker` is a number it is interpreted as an epsilon tolerance in points and the artist will fire off an event if it's data is within epsilon of the mouse event. For some artists like lines and patch collections, the artist may provide additional data to the pick event that is generated, e.g., the indices of the data within epsilon of the pick event
- A function: If `picker` is callable, it is a user supplied function which determines whether the artist is hit by the mouse event:

```
hit, props = picker(artist, mouseevent)
```

to determine the hit test. if the mouse event is over the artist, return `hit=True` and `props` is a dictionary of properties you want added to the `PickEvent` attributes.

`set_pickradius(self, pr)`

Set the pick radius used for containment tests.

### Parameters

**d** [float] Pick radius, in points.

`set_rasterized(self, rasterized)`

Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

#### Parameters

**rasterized** [bool or None]

`set_sketch_params(self, scale=None, length=None, randomness=None)`

Sets the sketch parameters.

#### Parameters

**scale** [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

**length** [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

**randomness** [float, optional] The scale factor by which the length is shrunk or expanded (default 16.0)

`set_snap(self, snap)`

Set the snapping behavior.

Snapping aligns positions with the pixel grid, which results in clearer images. For example, if a black line of 1px width was defined at a position in between two pixels, the resulting image would contain the interpolated value of that line in the pixel grid, which would be a grey value on both adjacent pixel positions. In contrast, snapping will move the line to the nearest integer pixel value, so that the resulting image will really contain a 1px wide black line.

Snapping is currently only supported by the Agg and MacOSX backends.

#### Parameters

**snap** [bool or None] Possible values:

- *True*: Snap vertices to the nearest pixel center.
- *False*: Do not modify vertex positions.
- *None*: (auto) If the path contains only rectilinear line segments, round to the nearest pixel center.

`set_transform(self, t)`

Set the artist transform.

#### Parameters

**t** [*Transform*]

`set_url(self, url)`

Set the url for the artist.

#### Parameters

**url** [str]

`set_urls(self, urls)`

#### Parameters

**urls** [List[str] or None]

`set_visible(self, b)`  
Set the artist's visibility.

**Parameters**

**b** [bool]

`set_zorder(self, level)`  
Set the zorder for the artist. Artists with lower zorder values are drawn first.

**Parameters**

**level** [float]

**stale**  
Whether the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

**sticky\_edges**  
x and y sticky edge lists for autoscaling.

When performing autoscaling, if a data limit coincides with a value in the corresponding sticky\_edges list, then no margin will be added—the view limit “sticks” to the edge. A typical use case is histograms, where one usually expects no margin on the bottom edge (0) of the histogram.

This attribute cannot be assigned to; however, the x and y lists can be modified in place as needed.

**Examples**

```
>>> artist.sticky_edges.x[:] = (xmin, xmax)
>>> artist.sticky_edges.y[:] = (ymin, ymax)
```

`to_rgba(self, x, alpha=None, bytes=False, norm=True)`  
Return a normalized rgba array corresponding to x.

In the normal case, x is a 1-D or 2-D sequence of scalars, and the corresponding ndarray of rgba values will be returned, based on the norm and colormap set for this ScalarMappable.

There is one special case, for handling images that are already rgb or rgba, such as might have been read from an image file. If x is an ndarray with 3 dimensions, and the last dimension is either 3 or 4, then it will be treated as an rgb or rgba array, and no mapping will be done. The array can be uint8, or it can be floating point with values in the 0-1 range; otherwise a ValueError will be raised. If it is a masked array, the mask will be ignored. If the last dimension is 3, the *alpha* kwarg (defaulting to 1) will be used to fill in the transparency. If the last dimension is 4, the *alpha* kwarg is ignored; it does not replace the pre-existing alpha. A ValueError will be raised if the third dimension is other than 3 or 4.

In either case, if *bytes* is *False* (default), the rgba array will be floats in the 0-1 range; if it is *True*, the returned rgba array will be uint8 in the 0 to 255 range.

If *norm* is *False*, no normalization of the input data is performed, and it is assumed to be in the range (0-1).

`update(self, props)`

Update this artist's properties from the dictionary *props*.

`update_from(self, other)`

copy properties from other to self

`update_scalarmappable(self)`

Update colors from the scalar mappable array, if it is not None.

`zorder = 0`

```
class matplotlib.collections.EventCollection(positions, orientation=None, lineoffset=0,
                                             linelength=1, linewidth=None,
                                             color=None, linestyle='solid',
                                             antialiased=None, **kwargs)
```

Bases: `matplotlib.collections.LineCollection`

A collection of discrete events.

The events are given by a 1-dimensional array, usually the position of something along an axis, such as time or length. They do not have an amplitude and are displayed as vertical or horizontal parallel bars.

### Parameters

**positions** [1D array-like object] Each value is an event.

**orientation** [{None, 'horizontal', 'vertical'}, optional] The orientation of the **collection** (the event bars are along the orthogonal direction). Defaults to 'horizontal' if not specified or None.

**lineoffset** [scalar, optional, default: 0] The offset of the center of the markers from the origin, in the direction orthogonal to *orientation*.

**linelength** [scalar, optional, default: 1] The total height of the marker (i.e. the marker stretches from `lineoffset - linelength/2` to `lineoffset + linelength/2`).

**linewidth** [scalar or None, optional, default: None] If it is None, defaults to its rcParams setting, in sequence form.

**color** [color, sequence of colors or None, optional, default: None] If it is None, defaults to its rcParams setting, in sequence form.

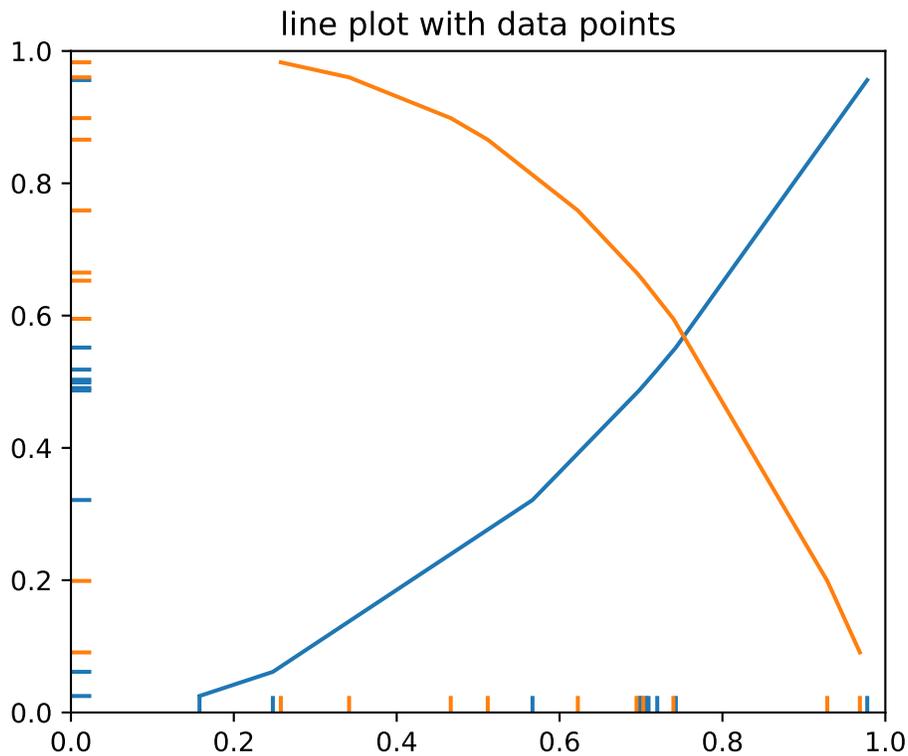
**linestyle** [str or tuple, optional, default: 'solid'] Valid strings are ['solid', 'dashed', 'dashdot', 'dotted', '-', '-.-', ':']. Dash tuples should be of the form:

```
(offset, onoffseq),
```

where *onoffseq* is an even length tuple of on and off ink in points.

**antialiased** [{None, 1, 2}, optional] If it is None, defaults to its rcParams setting, in sequence form.

**\*\*kwargs** [optional] Other keyword arguments are line collection properties. See *LineCollection* for a list of the valid properties.



## Examples

`add_callback(self, func)`

Add a callback function that will be called whenever one of the *Artist's* properties changes.

### Parameters

**func** [callable] The callback function. It must have the signature:

```
def func(artist: Artist) -> Any
```

where *artist* is the calling *Artist*. Return values may exist but are ignored.

### Returns

**oid** [int] The observer id associated with the callback. This id can be used for removing the callback with `remove_callback` later.

### See also:

`remove_callback`

`add_checker(self, checker)`

Add an entry to a dictionary of boolean flags that are set to True when the mappable is changed.

`add_positions(self, position)`  
 add one or more events at the specified positions

`aname`

`append_positions(self, position)`  
 add one or more events at the specified positions

`autoscale(self)`  
 Autoscale the scalar limits on the norm instance using the current array

`autoscale_None(self)`  
 Autoscale the scalar limits on the norm instance using the current array, changing only limits that are None

`axes`  
 The *Axes* instance the artist resides in, or *None*.

`changed(self)`  
 Call this whenever the mappable is changed to notify all the callbackSM listeners to the 'changed' signal

`check_update(self, checker)`  
 If mappable has changed since the last check, return True; else return False

`contains(self, mouseevent)`  
 Test whether the mouse event occurred in the collection.  
 Returns bool, dict(ind=itemlist), where every item in itemlist contains the event.

`convert_xunits(self, x)`  
 Convert *x* using the unit type of the xaxis.  
 If the artist is not in contained in an Axes or if the xaxis does not have units, *x* itself is returned.

`convert_yunits(self, y)`  
 Convert *y* using the unit type of the yaxis.  
 If the artist is not in contained in an Axes or if the yaxis does not have units, *y* itself is returned.

`draw(self, renderer)`  
 Draw the Artist using the given renderer.  
 This method will be overridden in the Artist subclasses. Typically, it is implemented to not have any effect if the Artist is not visible (*Artist.get\_visible* is *False*).

### Parameters

**renderer** [*RendererBase* subclass.]

`extend_positions(self, position)`  
 add one or more events at the specified positions

`findobj(self, match=None, include_self=True)`  
 Find artist objects.  
 Recursively find all *Artist* instances contained in the artist.

### Parameters

**match** A filter criterion for the matches. This can be

- *None*: Return all objects contained in artist.

- A function with signature `def match(artist: Artist) -> bool`. The result will only contain artists for which the function returns *True*.
- A class instance: e.g., *Line2D*. The result will only contain artists of this class or its subclasses (instance check).

**include\_self** [bool] Include *self* in the list to be checked for a match.

### Returns

**artists** [list of *Artist*]

`format_cursor_data(self, data)`

Return a string representation of *data*.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

The default implementation converts ints and floats and arrays of ints and floats into a comma-separated string enclosed in square brackets.

### See also:

`get_cursor_data`

`get_agg_filter(self)`

Return filter function to be used for agg filter.

`get_alpha(self)`

Return the alpha value used for blending - not supported on all backends

`get_animated(self)`

Return the animated state.

`get_array(self)`

Return the array

`get_capstyle(self)`

`get_children(self)`

Return a list of the child *Artists* of this *Artist*.

`get_clim(self)`

return the min, max of the color limits for image scaling

`get_clip_box(self)`

Return the clipbox.

`get_clip_on(self)`

Return whether the artist uses clipping.

`get_clip_path(self)`

Return the clip path.

`get_cmap(self)`

return the colormap

`get_color(self)`

get the color of the lines used to mark each event

`get_colors(self)`

`get_contains(self)`

Return the custom contains function of the artist if set, or *None*.

**See also:**

`set_contains`

`get_cursor_data(self, event)`

Return the cursor data for a given event.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

Cursor data can be used by Artists to provide additional context information for a given event. The default implementation just returns *None*.

Subclasses can override the method and return arbitrary data. However, when doing so, they must ensure that `format_cursor_data` can convert the data to a string representation.

The only current use case is displaying the z-value of an *AxesImage* in the status bar of a plot window, while moving the mouse.

**Parameters**

**event** [`matplotlib.backend_bases.MouseEvent`]

**See also:**

`format_cursor_data`

`get_dashes(self)`

Alias for `get_linestyle`.

`get_dataLim(self, transData)`

`get_ec(self)`

Alias for `get_edgecolor`.

`get_edgecolor(self)`

`get_edgecolors(self)`

Alias for `get_edgecolor`.

`get_facecolor(self)`

`get_facecolors(self)`

Alias for `get_facecolor`.

`get_fc(self)`

Alias for `get_facecolor`.

`get_figure(self)`

Return the *Figure* instance the artist belongs to.

`get_fill(self)`

return whether fill is set

`get_gid(self)`

Return the group id.

`get_hatch(self)`  
Return the current hatching pattern.

`get_in_layout(self)`  
Return boolean flag, True if artist is included in layout calculations.  
E.g. *Constrained Layout Guide*, `Figure.tight_layout()`, and `fig.savefig(fname, bbox_inches='tight')`.

`get_joinstyle(self)`

`get_label(self)`  
Return the label used for this artist in the legend.

`get_linelength(self)`  
get the length of the lines used to mark each event

`get_lineoffset(self)`  
get the offset of the lines used to mark each event

`get_linestyle(self)`

`get_linestyles(self)`  
Alias for `get_linestyle`.

`get_linewidth(self)`  
Get the width of the lines used to mark each event.

`get_linewidths(self)`  
Alias for `get_linewidth`.

`get_ls(self)`  
Alias for `get_linestyle`.

`get_lw(self)`  
Alias for `get_linewidth`.

`get_offset_position(self)`  
Returns how offsets are applied for the collection. If `offset_position` is 'screen', the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If `offset_position` is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

`get_offset_transform(self)`

`get_offsets(self)`  
Return the offsets for the collection.

`get_orientation(self)`  
get the orientation of the event line, may be: [ 'horizontal' | 'vertical' ]

`get_path_effects(self)`

`get_paths(self)`

`get_picker(self)`  
Return the picking behavior of the artist.  
The possible values are described in `set_picker`.

**See also:**  
`set_picker`, `pickable`, `pick`

`get_pickradius(self)`

`get_positions(self)`

return an array containing the floating-point values of the positions

`get_rasterized(self)`

Return whether the artist is to be rasterized.

`get_segments(self)`

#### Returns

**segments** [list] List of segments in the LineCollection. Each list item contains an array of vertices.

`get_sketch_params(self)`

Returns the sketch parameters for the artist.

#### Returns

**sketch\_params** [tuple or None] A 3-tuple with the following elements:

- *scale*: The amplitude of the wiggle perpendicular to the source line.
- *length*: The length of the wiggle along the line.
- *randomness*: The scale factor by which the length is shrunken or expanded.

Returns *None* if no sketch parameters were set.

`get_snap(self)`

Returns the snap setting.

See `set_snap` for details.

`get_tightbbox(self, renderer)`

Like `Artist.get_window_extent`, but includes any clipping.

#### Parameters

**renderer** [*RendererBase* instance] renderer that will be used to draw the figures (i.e. `fig.canvas.get_renderer()`)

#### Returns

**bbbox** [BBox] The enclosing bounding box (in figure pixel co-ordinates).

`get_transform(self)`

Return the *Transform* instance used by this artist.

`get_transformed_clip_path_and_affine(self)`

Return the clip path with the non-affine part of its transformation applied, and the remaining affine part of its transformation.

`get_transforms(self)`

`get_url(self)`

Return the url.

`get_urls(self)`

`get_visible(self)`

Return the visibility.

`get_window_extent(self, renderer)`

Get the axes bounding box in display space.

The bounding box' width and height are nonnegative.

Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

`get_zorder(self)`

Return the artist's zorder.

`have_units(self)`

Return *True* if units are set on the x or y axes.

`is_horizontal(self)`

True if the eventcollection is horizontal, False if vertical

`is_transform_set(self)`

Return whether the Artist has an explicitly set transform.

This is *True* after *set\_transform* has been called.

`mouseover`

`pchanged(self)`

Call all of the registered callbacks.

This function is triggered internally when a property is changed.

**See also:**

*add\_callback*

*remove\_callback*

`pick(self, mouseevent)`

Process a pick event.

Each child artist will fire a pick event if *mouseevent* is over the artist and the artist has picker set.

**See also:**

*set\_picker, get\_picker, pickable*

`pickable(self)`

Return whether the artist is pickable.

**See also:**

*set\_picker, get\_picker, pick*

`properties(self)`

Return a dictionary of all the properties of the artist.

`remove(self)`

Remove the artist from the figure if possible.

The effect will not be visible until the figure is redrawn, e.g., with `FigureCanvasBase.draw_idle`. Call `relim` to update the axes limits if desired.

Note: `relim` will not see collections even if the collection was added to the axes with `autolim = True`.

Note: there is no support for removing the artist's legend entry.

`remove_callback(self, oid)`

Remove a callback based on its observer id.

**See also:**

`add_callback`

`set(self, **kwargs)`

A property batch setter. Pass `kwargs` to set properties.

`set_aa(self, aa)`

Alias for `set_antialiased`.

`set_agg_filter(self, filter_func)`

Set the agg filter.

**Parameters**

**filter\_func** [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

`set_alpha(self, alpha)`

Set the alpha transparencies of the collection.

**Parameters**

**alpha** [float or None]

`set_animated(self, b)`

Set the artist's animation state.

**Parameters**

**b** [bool]

`set_antialiased(self, aa)`

Set the antialiasing state for rendering.

**Parameters**

**aa** [bool or sequence of bools]

`set_antialiaseds(self, aa)`

Alias for `set_antialiased`.

`set_array(self, A)`

Set the image array from numpy array `A`.

**Parameters**

**A** [ndarray]

`set_capstyle(self, cs)`

Set the capstyle for the collection (for all its elements).

**Parameters**

**cs** [{'butt', 'round', 'projecting'}] The capstyle

`set_clim(self, vmin=None, vmax=None)`

set the norm limits for image scaling; if *vmin* is a length2 sequence, interpret it as (*vmin*, *vmax*) which is used to support `setp`

ACCEPTS: a length 2 sequence of floats; may be overridden in methods that have *vmin* and *vmax* kwargs.

`set_clip_box(self, clipbox)`

Set the artist's clip *Bbox*.

**Parameters**

**clipbox** [*Bbox*]

`set_clip_on(self, b)`

Set whether the artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

**Parameters**

**b** [bool]

`set_clip_path(self, path, transform=None)`

Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- None, to remove a previously set clipping path.

For efficiency, if the path happens to be an axis-aligned rectangle, this method will set the clipping box to the corresponding rectangle and set the clipping path to None.

ACCEPTS: [(*Path*, *Transform*) | *Patch* | None]

`set_cmap(self, cmap)`

set the colormap for luminance data

**Parameters**

**cmap** [colormap or registered colormap name]

`set_color(self, c)`

Set the color(s) of the LineCollection.

**Parameters**

**c** [color or list of colors] Matplotlib color argument (all patches have same color), or a sequence or rgba tuples; if it is a sequence the patches will cycle through the sequence.

`set_contains(self, picker)`

Define a custom contains test for the artist.

The provided callable replaces the default *contains* method of the artist.

**Parameters**

**picker** [callable] A custom picker function to evaluate if an event is within the artist. The function must have the signature:

```
def contains(artist: Artist, event: MouseEvent) -> bool, dict
```

that returns:

- a bool indicating if the event is within the artist
- a dict of additional information. The dict should at least return the same information as the default `contains()` implementation of the respective artist, but may provide additional information.

`set_dashes(self, ls)`

Alias for `set_linestyle`.

`set_ec(self, c)`

Alias for `set_edgecolor`.

`set_edgecolor(self, c)`

Set the edgecolor(s) of the collection.

#### Parameters

**c** [color or sequence of colors or 'face'] The collection edgecolor(s). If a sequence, the patches cycle through it. If 'face', match the facecolor.

`set_edgecolors(self, c)`

Alias for `set_edgecolor`.

`set_facecolor(self, c)`

Set the facecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; if it is a sequence the patches will cycle through the sequence.

If *c* is 'none', the patch will not be filled.

#### Parameters

**c** [color or sequence of colors]

`set_facecolors(self, c)`

Alias for `set_facecolor`.

`set_fc(self, c)`

Alias for `set_facecolor`.

`set_figure(self, fig)`

Set the *Figure* instance the artist belongs to.

#### Parameters

**fig** [*Figure*]

`set_gid(self, gid)`

Set the (group) id for the artist.

#### Parameters

**gid** [str]

`set_hatch(self, hatch)`

Set the hatching pattern

*hatch* can be one of:

```

/ - diagonal hatching
\ - back diagonal
| - vertical
- - horizontal
+ - crossed
x - crossed diagonal
o - small circle
O - large circle
. - dots
* - stars

```

Letters can be combined, in which case all the specified hatchings are done. If same letter repeats, it increases the density of hatching of that pattern.

Hatching is supported in the PostScript, PDF, SVG and Agg backends only.

Unlike other properties such as linewidth and colors, hatching can only be specified for the collection as a whole, not separately for each member.

**Parameters**

**hatch** [{'/', '\\', '|', '-', '+', 'x', 'o', 'O', '.', '\*'}]

`set_in_layout(self, in_layout)`

Set if artist is to be included in layout calculations, E.g. *Constrained Layout Guide*, *Figure.tight\_layout()*, and `fig.savefig(fname, bbox_inches='tight')`.

**Parameters**

**in\_layout** [bool]

`set_joinstyle(self, js)`

Set the joinstyle for the collection (for all its elements).

**Parameters**

**js** [{'miter', 'round', 'bevel'}] The joinstyle

`set_label(self, s)`

Set a label that will be displayed in the legend.

**Parameters**

**s** [object] *s* will be converted to a string by calling `str`.

`set_linelength(self, linelength)`

set the length of the lines used to mark each event

`set_lineoffset(self, lineoffset)`

set the offset of the lines used to mark each event

`set_linestyle(self, ls)`

Set the linestyle(s) for the collection.

linestyle	description
'-' or 'solid'	solid line
'--' or 'dashed'	dashed line
'-.' or 'dashdot'	dash-dotted line
':' or 'dotted'	dotted line

Alternatively a dash tuple of the following form can be provided:

(offset, onoffseq),

where `onoffseq` is an even length tuple of `on` and `off` ink in points.

### Parameters

**ls** [`'-'`, `'-'`, `'-.'`, `':'`, `''`, (offset, on-off-seq), ...] The line style.

`set_linestyles(self, ls)`

Alias for `set_linestyle`.

`set_linewidth(self, lw)`

Set the linewidth(s) for the collection. `lw` can be a scalar or a sequence; if it is a sequence the patches will cycle through the sequence

### Parameters

**lw** [float or sequence of floats]

`set_linewidths(self, lw)`

Alias for `set_linewidth`.

`set_ls(self, ls)`

Alias for `set_linestyle`.

`set_lw(self, lw)`

Alias for `set_linewidth`.

`set_norm(self, norm)`

Set the normalization instance.

### Parameters

**norm** [*Normalize*]

### Notes

If there are any colorbars using the mappable for this norm, setting the norm of the mappable will reset the norm, locator, and formatters on the colorbar to default.

`set_offset_position(self, offset_position)`

Set how offsets are applied. If `offset_position` is `'screen'` (default) the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If `offset_position` is `'data'`, the offset is applied before the master transform, i.e., the offsets are in data coordinates.

### Parameters

**offset\_position** [`'screen'`, `'data'`]

`set_offsets(self, offsets)`

Set the offsets for the collection.

### Parameters

**offsets** [float or sequence of floats]

`set_orientation(self, orientation=None)`

set the orientation of the event line [ `'horizontal'` | `'vertical'` | `None` ] defaults to `'horizontal'` if not specified or `None`

`set_path_effects(self, path_effects)`  
Set the path effects.

**Parameters**

**path\_effects** [*AbstractPathEffect*]

`set_paths(self, segments)`

`set_picker(self, picker)`  
Define the picking behavior of the artist.

**Parameters**

**picker** [None or bool or float or callable] This can be one of the following:

- *None*: Picking is disabled for this artist (default).
- A boolean: If *True* then picking will be enabled and the artist will fire a pick event if the mouse event is over the artist.
- A float: If *picker* is a number it is interpreted as an epsilon tolerance in points and the artist will fire off an event if it's data is within epsilon of the mouse event. For some artists like lines and patch collections, the artist may provide additional data to the pick event that is generated, e.g., the indices of the data within epsilon of the pick event
- A function: If *picker* is callable, it is a user supplied function which determines whether the artist is hit by the mouse event:

```
hit, props = picker(artist, mouseevent)
```

to determine the hit test. if the mouse event is over the artist, return *hit=True* and *props* is a dictionary of properties you want added to the *PickEvent* attributes.

`set_pickradius(self, pr)`  
Set the pick radius used for containment tests.

**Parameters**

**d** [float] Pick radius, in points.

`set_positions(self, positions)`  
set the positions of the events to the specified value

`set_rasterized(self, rasterized)`  
Force rasterized (bitmap) drawing in vector backend output.  
Defaults to *None*, which implies the backend's default behavior.

**Parameters**

**rasterized** [bool or *None*]

`set_segments(self, segments)`

`set_sketch_params(self, scale=None, length=None, randomness=None)`  
Sets the sketch parameters.

**Parameters**

**scale** [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

**length** [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

**randomness** [float, optional] The scale factor by which the length is shrunk or expanded (default 16.0)

`set_snap(self, snap)`

Set the snapping behavior.

Snapping aligns positions with the pixel grid, which results in clearer images. For example, if a black line of 1px width was defined at a position in between two pixels, the resulting image would contain the interpolated value of that line in the pixel grid, which would be a grey value on both adjacent pixel positions. In contrast, snapping will move the line to the nearest integer pixel value, so that the resulting image will really contain a 1px wide black line.

Snapping is currently only supported by the Agg and MacOSX backends.

#### Parameters

**snap** [bool or None] Possible values:

- *True*: Snap vertices to the nearest pixel center.
- *False*: Do not modify vertex positions.
- *None*: (auto) If the path contains only rectilinear line segments, round to the nearest pixel center.

`set_transform(self, t)`

Set the artist transform.

#### Parameters

**t** [*Transform*]

`set_url(self, url)`

Set the url for the artist.

#### Parameters

**url** [str]

`set_urls(self, urls)`

#### Parameters

**urls** [List[str] or None]

`set_verts(self, segments)`

`set_visible(self, b)`

Set the artist's visibility.

#### Parameters

**b** [bool]

`set_zorder(self, level)`

Set the zorder for the artist. Artists with lower zorder values are drawn first.

#### Parameters

**level** [float]**stale**

Whether the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

**sticky\_edges**

x and y sticky edge lists for autoscaling.

When performing autoscaling, if a data limit coincides with a value in the corresponding sticky\_edges list, then no margin will be added—the view limit “sticks” to the edge. A typical use case is histograms, where one usually expects no margin on the bottom edge (0) of the histogram.

This attribute cannot be assigned to; however, the x and y lists can be modified in place as needed.

**Examples**

```
>>> artist.sticky_edges.x[:] = (xmin, xmax)
>>> artist.sticky_edges.y[:] = (ymin, ymax)
```

**switch\_orientation(*self*)**

switch the orientation of the event line, either from vertical to horizontal or vice versus

**to\_rgba(*self*, *x*, *alpha=None*, *bytes=False*, *norm=True*)**

Return a normalized rgba array corresponding to *x*.

In the normal case, *x* is a 1-D or 2-D sequence of scalars, and the corresponding ndarray of rgba values will be returned, based on the norm and colormap set for this ScalarMappable.

There is one special case, for handling images that are already rgb or rgba, such as might have been read from an image file. If *x* is an ndarray with 3 dimensions, and the last dimension is either 3 or 4, then it will be treated as an rgb or rgba array, and no mapping will be done. The array can be uint8, or it can be floating point with values in the 0-1 range; otherwise a ValueError will be raised. If it is a masked array, the mask will be ignored. If the last dimension is 3, the *alpha* kwarg (defaulting to 1) will be used to fill in the transparency. If the last dimension is 4, the *alpha* kwarg is ignored; it does not replace the pre-existing alpha. A ValueError will be raised if the third dimension is other than 3 or 4.

In either case, if *bytes* is *False* (default), the rgba array will be floats in the 0-1 range; if it is *True*, the returned rgba array will be uint8 in the 0 to 255 range.

If *norm* is *False*, no normalization of the input data is performed, and it is assumed to be in the range (0-1).

**update(*self*, *props*)**

Update this artist's properties from the dictionary *props*.

**update\_from(*self*, *other*)**

copy properties from other to self

**update\_scalarmappable(*self*)**

Update colors from the scalar mappable array, if it is not None.

**zorder** = 0

```
class matplotlib.collections.LineCollection(segments, linewidths=None, col-
ors=None, antialiaseds=None,
linestyles='solid', offsets=None, trans-
sOffset=None, norm=None, cmap=None,
pickradius=5, zorder=2, facecol-
ors='none', **kwargs)
```

Bases: `matplotlib.collections.Collection`

All parameters must be sequences or scalars; if scalars, they will be converted to sequences. The property of the *i*th line segment is:

```
prop[i % len(props)]
```

i.e., the properties cycle if the `len` of `props` is less than the number of segments.

### Parameters

**segments** A sequence of (*line0*, *line1*, *line2*), where:

```
linen = (x0, y0), (x1, y1), ... (xm, ym)
```

or the equivalent numpy array with two columns. Each line can be a different length.

**colors** [sequence, optional] A sequence of RGBA tuples (e.g., arbitrary color strings, etc, not allowed).

**antialiaseds** [sequence, optional] A sequence of ones or zeros.

**linestyles** [string, tuple, optional] Either one of [ 'solid' | 'dashed' | 'dash-dot' | 'dotted' ], or a dash tuple. The dash tuple is:

```
(offset, onoffseq)
```

where `onoffseq` is an even length tuple of on and off ink in points.

**norm** [Normalize, optional] *Normalize* instance.

**cmap** [string or Colormap, optional] Colormap name or *Colormap* instance.

**pickradius** [float, optional] The tolerance in points for mouse clicks picking a line. Default is 5 pt.

**zorder** [int, optional] zorder of the LineCollection. Default is 2.

**facecolors** [optional] The facecolors of the LineCollection. Default is 'none'. Setting to a value other than 'none' will lead to a filled polygon being drawn between points on each line.

### Notes

If *linewidths*, *colors*, or *antialiaseds* is None, they default to their rcParams setting, in sequence form.

If *offsets* and *transOffset* are not None, then *offsets* are transformed by *transOffset* and applied after the segments have been transformed to display coordinates.

If *offsets* is not None but *transOffset* is None, then the *offsets* are added to the segments before any transformation. In this case, a single offset can be specified as:

```
offsets=(x0,y0)
```

and this value will be added cumulatively to each successive segment, so as to produce a set of successively offset curves.

The use of *ScalarMappable* is optional. If the *ScalarMappable* array *\_A* is not *None* (i.e., a call to *set\_array()* has been made), at draw time a call to scalar mappable will be made to set the colors.

`add_callback(self, func)`

Add a callback function that will be called whenever one of the *Artist*'s properties changes.

### Parameters

**func** [callable] The callback function. It must have the signature:

```
def func(artist: Artist) -> Any
```

where *artist* is the calling *Artist*. Return values may exist but are ignored.

### Returns

**oid** [int] The observer id associated with the callback. This id can be used for removing the callback with *remove\_callback* later.

### See also:

*remove\_callback*

`add_checker(self, checker)`

Add an entry to a dictionary of boolean flags that are set to *True* when the mappable is changed.

`aname`

`autoscale(self)`

Autoscale the scalar limits on the norm instance using the current array

`autoscale_None(self)`

Autoscale the scalar limits on the norm instance using the current array, changing only limits that are *None*

`axes`

The *Axes* instance the artist resides in, or *None*.

`changed(self)`

Call this whenever the mappable is changed to notify all the callbackSM listeners to the 'changed' signal

`check_update(self, checker)`

If mappable has changed since the last check, return *True*; else return *False*

`contains(self, mouseevent)`

Test whether the mouse event occurred in the collection.

Returns *bool*, *dict*(*ind*=*itemlist*), where every item in *itemlist* contains the event.

`convert_xunits(self, x)`

Convert *x* using the unit type of the xaxis.

If the artist is not contained in an Axes or if the xaxis does not have units, `x` itself is returned.

`convert_yunits(self, y)`

Convert `y` using the unit type of the yaxis.

If the artist is not contained in an Axes or if the yaxis does not have units, `y` itself is returned.

`draw(self, renderer)`

Draw the Artist using the given renderer.

This method will be overridden in the Artist subclasses. Typically, it is implemented to not have any effect if the Artist is not visible (`Artist.get_visible` is `False`).

### Parameters

**renderer** [`RendererBase` subclass.]

`findobj(self, match=None, include_self=True)`

Find artist objects.

Recursively find all `Artist` instances contained in the artist.

### Parameters

**match** A filter criterion for the matches. This can be

- `None`: Return all objects contained in artist.
- A function with signature `def match(artist: Artist) -> bool`. The result will only contain artists for which the function returns `True`.
- A class instance: e.g., `Line2D`. The result will only contain artists of this class or its subclasses (`isinstance` check).

**include\_self** [bool] Include `self` in the list to be checked for a match.

### Returns

**artists** [list of `Artist`]

`format_cursor_data(self, data)`

Return a string representation of `data`.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

The default implementation converts ints and floats and arrays of ints and floats into a comma-separated string enclosed in square brackets.

### See also:

`get_cursor_data`

`get_agg_filter(self)`

Return filter function to be used for agg filter.

`get_alpha(self)`

Return the alpha value used for blending - not supported on all backends

`get_animated(self)`

Return the animated state.

`get_array(self)`  
Return the array

`get_capstyle(self)`

`get_children(self)`  
Return a list of the child *Artists* of this *Artist*.

`get_clim(self)`  
return the min, max of the color limits for image scaling

`get_clip_box(self)`  
Return the clipbox.

`get_clip_on(self)`  
Return whether the artist uses clipping.

`get_clip_path(self)`  
Return the clip path.

`get_cmap(self)`  
return the colormap

`get_color(self)`

`get_colors(self)`

`get_contains(self)`  
Return the custom contains function of the artist if set, or *None*.

**See also:**

`set_contains`

`get_cursor_data(self, event)`  
Return the cursor data for a given event.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

Cursor data can be used by Artists to provide additional context information for a given event. The default implementation just returns *None*.

Subclasses can override the method and return arbitrary data. However, when doing so, they must ensure that `format_cursor_data` can convert the data to a string representation.

The only current use case is displaying the z-value of an *AxesImage* in the status bar of a plot window, while moving the mouse.

#### Parameters

**event** [`matplotlib.backend_bases.MouseEvent`]

#### See also:

`format_cursor_data`

`get_dashes(self)`  
Alias for `get_linestyle`.

---

```
get_datalim(self, transData)
get_ec(self)
    Alias for get_edgecolor.
get_edgecolor(self)
get_edgecolors(self)
    Alias for get_edgecolor.
get_facecolor(self)
get_facecolors(self)
    Alias for get_facecolor.
get_fc(self)
    Alias for get_facecolor.
get_figure(self)
    Return the Figure instance the artist belongs to.
get_fill(self)
    return whether fill is set
get_gid(self)
    Return the group id.
get_hatch(self)
    Return the current hatching pattern.
get_in_layout(self)
    Return boolean flag, True if artist is included in layout calculations.
    E.g. Constrained Layout Guide, Figure.tight_layout(), and fig.savefig(fname,
    bbox_inches='tight').
get_joinstyle(self)
get_label(self)
    Return the label used for this artist in the legend.
get_linestyle(self)
get_linestyles(self)
    Alias for get_linestyle.
get_linewidth(self)
get_linewidths(self)
    Alias for get_linewidth.
get_ls(self)
    Alias for get_linestyle.
get_lw(self)
    Alias for get_linewidth.
get_offset_position(self)
    Returns how offsets are applied for the collection. If offset_position is 'screen', the
    offset is applied after the master transform has been applied, that is, the offsets are
    in screen coordinates. If offset_position is 'data', the offset is applied before the
    master transform, i.e., the offsets are in data coordinates.
get_offset_transform(self)
```

`get_offsets(self)`  
Return the offsets for the collection.

`get_path_effects(self)`

`get_paths(self)`

`get_picker(self)`  
Return the picking behavior of the artist.

The possible values are described in `set_picker`.

**See also:**

`set_picker`, `pickable`, `pick`

`get_pickradius(self)`

`get_rasterized(self)`  
Return whether the artist is to be rasterized.

`get_segments(self)`

**Returns**

**segments** [list] List of segments in the LineCollection. Each list item contains an array of vertices.

`get_sketch_params(self)`  
Returns the sketch parameters for the artist.

**Returns**

**sketch\_params** [tuple or None] A 3-tuple with the following elements:

- *scale*: The amplitude of the wiggle perpendicular to the source line.
- *length*: The length of the wiggle along the line.
- *randomness*: The scale factor by which the length is shrunken or expanded.

Returns *None* if no sketch parameters were set.

`get_snap(self)`  
Returns the snap setting.

See `set_snap` for details.

`get_tightbbox(self, renderer)`  
Like `Artist.get_window_extent`, but includes any clipping.

**Parameters**

**renderer** [*RendererBase* instance] renderer that will be used to draw the figures (i.e. `fig.canvas.get_renderer()`)

**Returns**

**bbbox** [BBox] The enclosing bounding box (in figure pixel co-ordinates).

`get_transform(self)`  
Return the *Transform* instance used by this artist.

`get_transformed_clip_path_and_affine(self)`  
 Return the clip path with the non-affine part of its transformation applied, and the remaining affine part of its transformation.

`get_transforms(self)`

`get_url(self)`  
 Return the url.

`get_urls(self)`

`get_visible(self)`  
 Return the visibility.

`get_window_extent(self, renderer)`  
 Get the axes bounding box in display space.  
 The bounding box' width and height are nonnegative.  
 Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.  
 Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

`get_zorder(self)`  
 Return the artist's zorder.

`have_units(self)`  
 Return *True* if units are set on the x or y axes.

`is_transform_set(self)`  
 Return whether the Artist has an explicitly set transform.  
 This is *True* after `set_transform` has been called.

`mouseover`

`pchanged(self)`  
 Call all of the registered callbacks.  
 This function is triggered internally when a property is changed.  
**See also:**  
`add_callback`  
`remove_callback`

`pick(self, mouseevent)`  
 Process a pick event.  
 Each child artist will fire a pick event if *mouseevent* is over the artist and the artist has picker set.  
**See also:**  
`set_picker`, `get_picker`, `pickable`

`pickable(self)`

Return whether the artist is pickable.

**See also:**

`set_picker`, `get_picker`, `pick`

`properties(self)`

Return a dictionary of all the properties of the artist.

`remove(self)`

Remove the artist from the figure if possible.

The effect will not be visible until the figure is redrawn, e.g., with `FigureCanvasBase.draw_idle`. Call `relim` to update the axes limits if desired.

Note: `relim` will not see collections even if the collection was added to the axes with `autolim = True`.

Note: there is no support for removing the artist's legend entry.

`remove_callback(self, oid)`

Remove a callback based on its observer id.

**See also:**

`add_callback`

`set(self, **kwargs)`

A property batch setter. Pass `kwargs` to set properties.

`set_aa(self, aa)`

Alias for `set_antialiased`.

`set_agg_filter(self, filter_func)`

Set the agg filter.

**Parameters**

**filter\_func** [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

`set_alpha(self, alpha)`

Set the alpha transparencies of the collection.

**Parameters**

**alpha** [float or None]

`set_animated(self, b)`

Set the artist's animation state.

**Parameters**

**b** [bool]

`set_antialiased(self, aa)`

Set the antialiasing state for rendering.

**Parameters**

**aa** [bool or sequence of bools]

`set_antialiaseds(self, aa)`  
Alias for `set_antialiased`.

`set_array(self, A)`  
Set the image array from numpy array *A*.

**Parameters**

**A** [ndarray]

`set_capstyle(self, cs)`  
Set the capstyle for the collection (for all its elements).

**Parameters**

**cs** [{'butt', 'round', 'projecting'}] The capstyle

`set_clim(self, vmin=None, vmax=None)`  
set the norm limits for image scaling; if *vmin* is a length2 sequence, interpret it as (*vmin*, *vmax*) which is used to support setp

ACCEPTS: a length 2 sequence of floats; may be overridden in methods that have *vmin* and *vmax* kwargs.

`set_clip_box(self, clipbox)`  
Set the artist's clip *Bbox*.

**Parameters**

**clipbox** [*Bbox*]

`set_clip_on(self, b)`  
Set whether the artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

**Parameters**

**b** [bool]

`set_clip_path(self, path, transform=None)`  
Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- None, to remove a previously set clipping path.

For efficiency, if the path happens to be an axis-aligned rectangle, this method will set the clipping box to the corresponding rectangle and set the clipping path to None.

ACCEPTS: [(*Path*, *Transform*) | *Patch* | None]

`set_cmap(self, cmap)`  
set the colormap for luminance data

**Parameters**

**cmap** [colormap or registered colormap name]

`set_color(self, c)`  
Set the color(s) of the LineCollection.

**Parameters**

**c** [color or list of colors] Matplotlib color argument (all patches have same color), or a sequence or rgba tuples; if it is a sequence the patches will cycle through the sequence.

`set_contains(self, picker)`

Define a custom contains test for the artist.

The provided callable replaces the default `contains` method of the artist.

### Parameters

**picker** [callable] A custom picker function to evaluate if an event is within the artist. The function must have the signature:

```
def contains(artist: Artist, event: MouseEvent) -> bool, dict
```

that returns:

- a bool indicating if the event is within the artist
- a dict of additional information. The dict should at least return the same information as the default `contains()` implementation of the respective artist, but may provide additional information.

`set_dashes(self, ls)`

Alias for `set_linestyle`.

`set_ec(self, c)`

Alias for `set_edgecolor`.

`set_edgecolor(self, c)`

Set the edgecolor(s) of the collection.

### Parameters

**c** [color or sequence of colors or 'face'] The collection edgecolor(s). If a sequence, the patches cycle through it. If 'face', match the facecolor.

`set_edgecolors(self, c)`

Alias for `set_edgecolor`.

`set_facecolor(self, c)`

Set the facecolor(s) of the collection. `c` can be a matplotlib color spec (all patches have same color), or a sequence of specs; if it is a sequence the patches will cycle through the sequence.

If `c` is 'none', the patch will not be filled.

### Parameters

**c** [color or sequence of colors]

`set_facecolors(self, c)`

Alias for `set_facecolor`.

`set_fc(self, c)`

Alias for `set_facecolor`.

`set_figure(self, fig)`

Set the `Figure` instance the artist belongs to.

### Parameters

**fig** [`Figure`]

`set_gid(self, gid)`  
Set the (group) id for the artist.

**Parameters**

**gid** [str]

`set_hatch(self, hatch)`  
Set the hatching pattern

*hatch* can be one of:

```

/ - diagonal hatching
\ - back diagonal
| - vertical
- - horizontal
+ - crossed
x - crossed diagonal
o - small circle
O - large circle
. - dots
* - stars

```

Letters can be combined, in which case all the specified hatchings are done. If same letter repeats, it increases the density of hatching of that pattern.

Hatching is supported in the PostScript, PDF, SVG and Agg backends only.

Unlike other properties such as linewidth and colors, hatching can only be specified for the collection as a whole, not separately for each member.

**Parameters**

**hatch** [{'/', '\', '|', '-', '+', 'x', 'o', 'O', '.', '\*'}]

`set_in_layout(self, in_layout)`  
Set if artist is to be included in layout calculations, E.g. *Constrained Layout Guide*, *Figure.tight\_layout()*, and *fig.savefig(fname, bbox\_inches='tight')*.

**Parameters**

**in\_layout** [bool]

`set_joinstyle(self, js)`  
Set the joinstyle for the collection (for all its elements).

**Parameters**

**js** [{'miter', 'round', 'bevel'}] The joinstyle

`set_label(self, s)`  
Set a label that will be displayed in the legend.

**Parameters**

**s** [object] *s* will be converted to a string by calling `str`.

`set_linestyle(self, ls)`  
Set the linestyle(s) for the collection.

linestyle	description
'-' or 'solid'	solid line
'--' or 'dashed'	dashed line
'-.' or 'dashdot'	dash-dotted line
':' or 'dotted'	dotted line

Alternatively a dash tuple of the following form can be provided:

```
(offset, onoffseq),
```

where `onoffseq` is an even length tuple of on and off ink in points.

### Parameters

**ls** [{'-', '-', '-.', ':', ', ', (offset, on-off-seq), ...}] The line style.

`set_linestyles(self, ls)`

Alias for `set_linestyle`.

`set_linewidth(self, lw)`

Set the linewidth(s) for the collection. `lw` can be a scalar or a sequence; if it is a sequence the patches will cycle through the sequence

### Parameters

**lw** [float or sequence of floats]

`set_linewidths(self, lw)`

Alias for `set_linewidth`.

`set_ls(self, ls)`

Alias for `set_linestyle`.

`set_lw(self, lw)`

Alias for `set_linewidth`.

`set_norm(self, norm)`

Set the normalization instance.

### Parameters

**norm** [*Normalize*]

### Notes

If there are any colorbars using the mappable for this norm, setting the norm of the mappable will reset the norm, locator, and formatters on the colorbar to default.

`set_offset_position(self, offset_position)`

Set how offsets are applied. If `offset_position` is 'screen' (default) the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If `offset_position` is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

### Parameters

**offset\_position** [{'screen', 'data'}]

`set_offsets(self, offsets)`

Set the offsets for the collection.

**Parameters****offsets** [float or sequence of floats]

`set_path_effects(self, path_effects)`  
 Set the path effects.

**Parameters****path\_effects** [*AbstractPathEffect*]

`set_paths(self, segments)`

`set_picker(self, picker)`  
 Define the picking behavior of the artist.

**Parameters****picker** [None or bool or float or callable] This can be one of the following:

- *None*: Picking is disabled for this artist (default).
- A boolean: If *True* then picking will be enabled and the artist will fire a pick event if the mouse event is over the artist.
- A float: If picker is a number it is interpreted as an epsilon tolerance in points and the artist will fire off an event if it's data is within epsilon of the mouse event. For some artists like lines and patch collections, the artist may provide additional data to the pick event that is generated, e.g., the indices of the data within epsilon of the pick event
- A function: If picker is callable, it is a user supplied function which determines whether the artist is hit by the mouse event:

```
hit, props = picker(artist, mouseevent)
```

to determine the hit test. if the mouse event is over the artist, return *hit=True* and props is a dictionary of properties you want added to the PickEvent attributes.

`set_pickradius(self, pr)`  
 Set the pick radius used for containment tests.

**Parameters****d** [float] Pick radius, in points.

`set_rasterized(self, rasterized)`  
 Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

**Parameters****rasterized** [bool or None]

`set_segments(self, segments)`

`set_sketch_params(self, scale=None, length=None, randomness=None)`  
 Sets the sketch parameters.

**Parameters**

**scale** [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

**length** [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

**randomness** [float, optional] The scale factor by which the length is shrunk or expanded (default 16.0)

`set_snap(self, snap)`

Set the snapping behavior.

Snapping aligns positions with the pixel grid, which results in clearer images. For example, if a black line of 1px width was defined at a position in between two pixels, the resulting image would contain the interpolated value of that line in the pixel grid, which would be a grey value on both adjacent pixel positions. In contrast, snapping will move the line to the nearest integer pixel value, so that the resulting image will really contain a 1px wide black line.

Snapping is currently only supported by the Agg and MacOSX backends.

#### Parameters

**snap** [bool or None] Possible values:

- *True*: Snap vertices to the nearest pixel center.
- *False*: Do not modify vertex positions.
- *None*: (auto) If the path contains only rectilinear line segments, round to the nearest pixel center.

`set_transform(self, t)`

Set the artist transform.

#### Parameters

**t** [*Transform*]

`set_url(self, url)`

Set the url for the artist.

#### Parameters

**url** [str]

`set_urls(self, urls)`

#### Parameters

**urls** [List[str] or None]

`set_verts(self, segments)`

`set_visible(self, b)`

Set the artist's visibility.

#### Parameters

**b** [bool]

`set_zorder(self, level)`

Set the zorder for the artist. Artists with lower zorder values are drawn first.

#### Parameters

**level** [float]**stale**

Whether the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

**sticky\_edges**

x and y sticky edge lists for autoscaling.

When performing autoscaling, if a data limit coincides with a value in the corresponding sticky\_edges list, then no margin will be added—the view limit “sticks” to the edge. A typical use case is histograms, where one usually expects no margin on the bottom edge (0) of the histogram.

This attribute cannot be assigned to; however, the x and y lists can be modified in place as needed.

**Examples**

```
>>> artist.sticky_edges.x[:] = (xmin, xmax)
>>> artist.sticky_edges.y[:] = (ymin, ymax)
```

**to\_rgba(self, x, alpha=None, bytes=False, norm=True)**

Return a normalized rgba array corresponding to x.

In the normal case, x is a 1-D or 2-D sequence of scalars, and the corresponding ndarray of rgba values will be returned, based on the norm and colormap set for this ScalarMappable.

There is one special case, for handling images that are already rgb or rgba, such as might have been read from an image file. If x is an ndarray with 3 dimensions, and the last dimension is either 3 or 4, then it will be treated as an rgb or rgba array, and no mapping will be done. The array can be uint8, or it can be floating point with values in the 0-1 range; otherwise a ValueError will be raised. If it is a masked array, the mask will be ignored. If the last dimension is 3, the *alpha* kwarg (defaulting to 1) will be used to fill in the transparency. If the last dimension is 4, the *alpha* kwarg is ignored; it does not replace the pre-existing alpha. A ValueError will be raised if the third dimension is other than 3 or 4.

In either case, if *bytes* is *False* (default), the rgba array will be floats in the 0-1 range; if it is *True*, the returned rgba array will be uint8 in the 0 to 255 range.

If *norm* is *False*, no normalization of the input data is performed, and it is assumed to be in the range (0-1).

**update(self, props)**

Update this artist's properties from the dictionary *props*.

**update\_from(self, other)**

copy properties from other to self

**update\_scalarmappable(self)**

Update colors from the scalar mappable array, if it is not None.

*zorder* = 0

```
class matplotlib.collections.PatchCollection(patches, match_original=False,
                                             **kwargs)
```

Bases: *matplotlib.collections.Collection*

A generic collection of patches.

This makes it easier to assign a color map to a heterogeneous collection of patches.

This also may improve plotting speed, since PatchCollection will draw faster than a large number of patches.

**patches** a sequence of Patch objects. This list may include a heterogeneous assortment of different patch types.

**match\_original** If True, use the colors and linewidths of the original patches. If False, new colors may be assigned by providing the standard collection arguments, facecolor, edgecolor, linewidths, norm or cmap.

If any of *edgecolors*, *facecolors*, *linewidths*, *antialiaseds* are None, they default to their *matplotlib.rcParams* patch setting, in sequence form.

The use of *ScalarMappable* is optional. If the *ScalarMappable* matrix *\_A* is not None (i.e., a call to *set\_array* has been made), at draw time a call to scalar mappable will be made to set the face colors.

`add_callback(self, func)`

Add a callback function that will be called whenever one of the *Artist*'s properties changes.

#### Parameters

**func** [callable] The callback function. It must have the signature:

```
def func(artist: Artist) -> Any
```

where *artist* is the calling *Artist*. Return values may exist but are ignored.

#### Returns

**oid** [int] The observer id associated with the callback. This id can be used for removing the callback with *remove\_callback* later.

#### See also:

*remove\_callback*

`add_checker(self, checker)`

Add an entry to a dictionary of boolean flags that are set to True when the mappable is changed.

**aname**

`autoscale(self)`

Autoscale the scalar limits on the norm instance using the current array

`autoscale_None(self)`

Autoscale the scalar limits on the norm instance using the current array, changing only limits that are None

**axes**

The *Axes* instance the artist resides in, or *None*.

`changed(self)`

Call this whenever the mappable is changed to notify all the callbackSM listeners to the 'changed' signal

`check_update(self, checker)`

If mappable has changed since the last check, return True; else return False

`contains(self, mouseevent)`

Test whether the mouse event occurred in the collection.

Returns bool, dict(ind=itemlist), where every item in itemlist contains the event.

`convert_xunits(self, x)`

Convert x using the unit type of the xaxis.

If the artist is not in contained in an Axes or if the xaxis does not have units, x itself is returned.

`convert_yunits(self, y)`

Convert y using the unit type of the yaxis.

If the artist is not in contained in an Axes or if the yaxis does not have units, y itself is returned.

`draw(self, renderer)`

Draw the Artist using the given renderer.

This method will be overridden in the Artist subclasses. Typically, it is implemented to not have any effect if the Artist is not visible (*Artist.get\_visible* is *False*).

### Parameters

**renderer** [*RendererBase* subclass.]

`findobj(self, match=None, include_self=True)`

Find artist objects.

Recursively find all *Artist* instances contained in the artist.

### Parameters

**match** A filter criterion for the matches. This can be

- *None*: Return all objects contained in artist.
- A function with signature `def match(artist: Artist) -> bool`. The result will only contain artists for which the function returns *True*.
- A class instance: e.g., *Line2D*. The result will only contain artists of this class or its subclasses (*isinstance* check).

**include\_self** [bool] Include *self* in the list to be checked for a match.

### Returns

**artists** [list of *Artist*]

`format_cursor_data(self, data)`

Return a string representation of *data*.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

The default implementation converts ints and floats and arrays of ints and floats into a comma-separated string enclosed in square brackets.

**See also:**

`get_cursor_data`

`get_agg_filter(self)`  
Return filter function to be used for agg filter.

`get_alpha(self)`  
Return the alpha value used for blending - not supported on all backends

`get_animated(self)`  
Return the animated state.

`get_array(self)`  
Return the array

`get_capstyle(self)`

`get_children(self)`  
Return a list of the child *Artists* of this *Artist*.

`get_clim(self)`  
return the min, max of the color limits for image scaling

`get_clip_box(self)`  
Return the clipbox.

`get_clip_on(self)`  
Return whether the artist uses clipping.

`get_clip_path(self)`  
Return the clip path.

`get_cmap(self)`  
return the colormap

`get_contains(self)`  
Return the custom contains function of the artist if set, or *None*.

**See also:**

`set_contains`

`get_cursor_data(self, event)`  
Return the cursor data for a given event.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

Cursor data can be used by Artists to provide additional context information for a given event. The default implementation just returns *None*.

Subclasses can override the method and return arbitrary data. However, when doing so, they must ensure that `format_cursor_data` can convert the data to a string representation.

The only current use case is displaying the z-value of an *AxesImage* in the status bar of a plot window, while moving the mouse.

### Parameters

**event** [`matplotlib.backend_bases.MouseEvent`]

**See also:**

`format_cursor_data`

`get_dashes(self)`  
Alias for `get_linestyle`.

`get_datalim(self, transData)`

`get_ec(self)`  
Alias for `get_edgecolor`.

`get_edgecolor(self)`

`get_edgecolors(self)`  
Alias for `get_edgecolor`.

`get_facecolor(self)`

`get_facecolors(self)`  
Alias for `get_facecolor`.

`get_fc(self)`  
Alias for `get_facecolor`.

`get_figure(self)`  
Return the *Figure* instance the artist belongs to.

`get_fill(self)`  
return whether fill is set

`get_gid(self)`  
Return the group id.

`get_hatch(self)`  
Return the current hatching pattern.

`get_in_layout(self)`  
Return boolean flag, True if artist is included in layout calculations.  
  
E.g. *Constrained Layout Guide*, `Figure.tight_layout()`, and `fig.savefig(fname, bbox_inches='tight')`.

`get_joinstyle(self)`

`get_label(self)`  
Return the label used for this artist in the legend.

`get_linestyle(self)`

`get_linestyles(self)`  
Alias for `get_linestyle`.

`get_linewidth(self)`

`get_linewidths(self)`  
Alias for `get_linewidth`.

`get_ls(self)`  
Alias for `get_linestyle`.

`get_lw(self)`  
Alias for `get_linewidth`.

`get_offset_position(self)`

Returns how offsets are applied for the collection. If *offset\_position* is 'screen', the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If *offset\_position* is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

`get_offset_transform(self)`

`get_offsets(self)`

Return the offsets for the collection.

`get_path_effects(self)`

`get_paths(self)`

`get_picker(self)`

Return the picking behavior of the artist.

The possible values are described in *set\_picker*.

**See also:**

*set\_picker, pickable, pick*

`get_pickradius(self)`

`get_rasterized(self)`

Return whether the artist is to be rasterized.

`get_sketch_params(self)`

Returns the sketch parameters for the artist.

**Returns**

**sketch\_params** [tuple or None] A 3-tuple with the following elements:

- *scale*: The amplitude of the wiggle perpendicular to the source line.
- *length*: The length of the wiggle along the line.
- *randomness*: The scale factor by which the length is shrunken or expanded.

Returns *None* if no sketch parameters were set.

`get_snap(self)`

Returns the snap setting.

See *set\_snap* for details.

`get_tightbbox(self, renderer)`

Like `Artist.get_window_extent`, but includes any clipping.

**Parameters**

**renderer** [*RendererBase* instance] renderer that will be used to draw the figures (i.e. `fig.canvas.get_renderer()`)

**Returns**

**bbox** [*BBox*] The enclosing bounding box (in figure pixel co-ordinates).

`get_transform(self)`

Return the *Transform* instance used by this artist.

`get_transformed_clip_path_and_affine(self)`  
 Return the clip path with the non-affine part of its transformation applied, and the remaining affine part of its transformation.

`get_transforms(self)`

`get_url(self)`  
 Return the url.

`get_urls(self)`

`get_visible(self)`  
 Return the visibility.

`get_window_extent(self, renderer)`  
 Get the axes bounding box in display space.  
 The bounding box' width and height are nonnegative.  
 Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.  
 Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

`get_zorder(self)`  
 Return the artist's zorder.

`have_units(self)`  
 Return *True* if units are set on the x or y axes.

`is_transform_set(self)`  
 Return whether the Artist has an explicitly set transform.  
 This is *True* after `set_transform` has been called.

`mouseover`

`pchanged(self)`  
 Call all of the registered callbacks.  
 This function is triggered internally when a property is changed.  
**See also:**  
`add_callback`  
`remove_callback`

`pick(self, mouseevent)`  
 Process a pick event.  
 Each child artist will fire a pick event if *mouseevent* is over the artist and the artist has picker set.  
**See also:**  
`set_picker`, `get_picker`, `pickable`

`pickable(self)`

Return whether the artist is pickable.

**See also:**

`set_picker`, `get_picker`, `pick`

`properties(self)`

Return a dictionary of all the properties of the artist.

`remove(self)`

Remove the artist from the figure if possible.

The effect will not be visible until the figure is redrawn, e.g., with `FigureCanvasBase.draw_idle`. Call `relim` to update the axes limits if desired.

Note: `relim` will not see collections even if the collection was added to the axes with `autolim = True`.

Note: there is no support for removing the artist's legend entry.

`remove_callback(self, oid)`

Remove a callback based on its observer id.

**See also:**

`add_callback`

`set(self, **kwargs)`

A property batch setter. Pass `kwargs` to set properties.

`set_aa(self, aa)`

Alias for `set_antialiased`.

`set_agg_filter(self, filter_func)`

Set the agg filter.

**Parameters**

**filter\_func** [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

`set_alpha(self, alpha)`

Set the alpha transparencies of the collection.

**Parameters**

**alpha** [float or None]

`set_animated(self, b)`

Set the artist's animation state.

**Parameters**

**b** [bool]

`set_antialiased(self, aa)`

Set the antialiasing state for rendering.

**Parameters**

**aa** [bool or sequence of bools]

`set_antialiaseds(self, aa)`  
Alias for `set_antialiased`.

`set_array(self, A)`  
Set the image array from numpy array *A*.

**Parameters**

**A** [ndarray]

`set_capstyle(self, cs)`  
Set the capstyle for the collection (for all its elements).

**Parameters**

**cs** [{'butt', 'round', 'projecting'}] The capstyle

`set_clim(self, vmin=None, vmax=None)`  
set the norm limits for image scaling; if *vmin* is a length2 sequence, interpret it as (*vmin*, *vmax*) which is used to support setp

ACCEPTS: a length 2 sequence of floats; may be overridden in methods that have *vmin* and *vmax* kwargs.

`set_clip_box(self, clipbox)`  
Set the artist's clip *Bbox*.

**Parameters**

**clipbox** [*Bbox*]

`set_clip_on(self, b)`  
Set whether the artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

**Parameters**

**b** [bool]

`set_clip_path(self, path, transform=None)`  
Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- None, to remove a previously set clipping path.

For efficiency, if the path happens to be an axis-aligned rectangle, this method will set the clipping box to the corresponding rectangle and set the clipping path to None.

ACCEPTS: [(*Path*, *Transform*) | *Patch* | None]

`set_cmap(self, cmap)`  
set the colormap for luminance data

**Parameters**

**cmap** [colormap or registered colormap name]

`set_color(self, c)`  
Set both the edgecolor and the facecolor.

**Parameters**

**c** [color or sequence of rgba tuples]

**See also:**

`Collection.set_facecolor`, `Collection.set_edgecolor` For setting the edge or face color individually.

`set_contains(self, picker)`

Define a custom contains test for the artist.

The provided callable replaces the default `contains` method of the artist.

**Parameters**

**picker** [callable] A custom picker function to evaluate if an event is within the artist. The function must have the signature:

```
def contains(artist: Artist, event: MouseEvent) -> bool, dict
```

that returns:

- a bool indicating if the event is within the artist
- a dict of additional information. The dict should at least return the same information as the default `contains()` implementation of the respective artist, but may provide additional information.

`set_dashes(self, ls)`

Alias for `set_linestyle`.

`set_ec(self, c)`

Alias for `set_edgecolor`.

`set_edgecolor(self, c)`

Set the edgecolor(s) of the collection.

**Parameters**

**c** [color or sequence of colors or 'face'] The collection edgecolor(s). If a sequence, the patches cycle through it. If 'face', match the facecolor.

`set_edgecolors(self, c)`

Alias for `set_edgecolor`.

`set_facecolor(self, c)`

Set the facecolor(s) of the collection. `c` can be a matplotlib color spec (all patches have same color), or a sequence of specs; if it is a sequence the patches will cycle through the sequence.

If `c` is 'none', the patch will not be filled.

**Parameters**

**c** [color or sequence of colors]

`set_facecolors(self, c)`

Alias for `set_facecolor`.

`set_fc(self, c)`

Alias for `set_facecolor`.

`set_figure(self, fig)`

Set the `Figure` instance the artist belongs to.

**Parameters****fig** [*Figure*]`set_gid(self, gid)`

Set the (group) id for the artist.

**Parameters****gid** [str]`set_hatch(self, hatch)`

Set the hatching pattern

*hatch* can be one of:

```

/ - diagonal hatching
\ - back diagonal
| - vertical
- - horizontal
+ - crossed
x - crossed diagonal
o - small circle
O - large circle
. - dots
* - stars

```

Letters can be combined, in which case all the specified hatchings are done. If same letter repeats, it increases the density of hatching of that pattern.

Hatching is supported in the PostScript, PDF, SVG and Agg backends only.

Unlike other properties such as linewidth and colors, hatching can only be specified for the collection as a whole, not separately for each member.

**Parameters****hatch** [{'/', '\\', '|', '-', '+', 'x', 'o', 'O', '.', '\*'}]`set_in_layout(self, in_layout)`Set if artist is to be included in layout calculations, E.g. *Constrained Layout Guide*, `Figure.tight_layout()`, and `fig.savefig(fname, bbox_inches='tight')`.**Parameters****in\_layout** [bool]`set_joinstyle(self, js)`

Set the joinstyle for the collection (for all its elements).

**Parameters****js** [{'miter', 'round', 'bevel'}] The joinstyle`set_label(self, s)`

Set a label that will be displayed in the legend.

**Parameters****s** [object] *s* will be converted to a string by calling `str`.`set_linestyle(self, ls)`

Set the linestyle(s) for the collection.

linestyle	description
'-' or 'solid'	solid line
'--' or 'dashed'	dashed line
'-.' or 'dashdot'	dash-dotted line
':' or 'dotted'	dotted line

Alternatively a dash tuple of the following form can be provided:

```
(offset, onoffseq),
```

where `onoffseq` is an even length tuple of on and off ink in points.

### Parameters

**ls** [{'-', '-', '-.', ':', "", (offset, on-off-seq), ...}] The line style.

`set_linestyles(self, ls)`

Alias for `set_linestyle`.

`set_linewidth(self, lw)`

Set the linewidth(s) for the collection. `lw` can be a scalar or a sequence; if it is a sequence the patches will cycle through the sequence

### Parameters

**lw** [float or sequence of floats]

`set_linewidths(self, lw)`

Alias for `set_linewidth`.

`set_ls(self, ls)`

Alias for `set_linestyle`.

`set_lw(self, lw)`

Alias for `set_linewidth`.

`set_norm(self, norm)`

Set the normalization instance.

### Parameters

**norm** [*Normalize*]

### Notes

If there are any colorbars using the mappable for this norm, setting the norm of the mappable will reset the norm, locator, and formatters on the colorbar to default.

`set_offset_position(self, offset_position)`

Set how offsets are applied. If `offset_position` is 'screen' (default) the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If `offset_position` is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

### Parameters

**offset\_position** [{'screen', 'data'}]

`set_offsets(self, offsets)`

Set the offsets for the collection.

**Parameters****offsets** [float or sequence of floats]

`set_path_effects(self, path_effects)`  
 Set the path effects.

**Parameters****path\_effects** [*AbstractPathEffect*]

`set_paths(self, patches)`

`set_picker(self, picker)`  
 Define the picking behavior of the artist.

**Parameters****picker** [None or bool or float or callable] This can be one of the following:

- *None*: Picking is disabled for this artist (default).
- A boolean: If *True* then picking will be enabled and the artist will fire a pick event if the mouse event is over the artist.
- A float: If picker is a number it is interpreted as an epsilon tolerance in points and the artist will fire off an event if it's data is within epsilon of the mouse event. For some artists like lines and patch collections, the artist may provide additional data to the pick event that is generated, e.g., the indices of the data within epsilon of the pick event
- A function: If picker is callable, it is a user supplied function which determines whether the artist is hit by the mouse event:

```
hit, props = picker(artist, mouseevent)
```

to determine the hit test. if the mouse event is over the artist, return *hit=True* and props is a dictionary of properties you want added to the PickEvent attributes.

`set_pickradius(self, pr)`  
 Set the pick radius used for containment tests.

**Parameters****d** [float] Pick radius, in points.

`set_rasterized(self, rasterized)`  
 Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

**Parameters****rasterized** [bool or None]

`set_sketch_params(self, scale=None, length=None, randomness=None)`  
 Sets the sketch parameters.

**Parameters**

**scale** [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is *None*, or not provided, no sketch filter will be provided.

**length** [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

**randomness** [float, optional] The scale factor by which the length is shrunk or expanded (default 16.0)

`set_snap(self, snap)`

Set the snapping behavior.

Snapping aligns positions with the pixel grid, which results in clearer images. For example, if a black line of 1px width was defined at a position in between two pixels, the resulting image would contain the interpolated value of that line in the pixel grid, which would be a grey value on both adjacent pixel positions. In contrast, snapping will move the line to the nearest integer pixel value, so that the resulting image will really contain a 1px wide black line.

Snapping is currently only supported by the Agg and MacOSX backends.

#### Parameters

**snap** [bool or None] Possible values:

- *True*: Snap vertices to the nearest pixel center.
- *False*: Do not modify vertex positions.
- *None*: (auto) If the path contains only rectilinear line segments, round to the nearest pixel center.

`set_transform(self, t)`

Set the artist transform.

#### Parameters

**t** [*Transform*]

`set_url(self, url)`

Set the url for the artist.

#### Parameters

**url** [str]

`set_urls(self, urls)`

#### Parameters

**urls** [List[str] or None]

`set_visible(self, b)`

Set the artist's visibility.

#### Parameters

**b** [bool]

`set_zorder(self, level)`

Set the zorder for the artist. Artists with lower zorder values are drawn first.

#### Parameters

**level** [float]

`stale`

Whether the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

**sticky\_edges**

x and y sticky edge lists for autoscaling.

When performing autoscaling, if a data limit coincides with a value in the corresponding `sticky_edges` list, then no margin will be added—the view limit “sticks” to the edge. A typical use case is histograms, where one usually expects no margin on the bottom edge (0) of the histogram.

This attribute cannot be assigned to; however, the x and y lists can be modified in place as needed.

**Examples**

```
>>> artist.sticky_edges.x[:] = (xmin, xmax)
>>> artist.sticky_edges.y[:] = (ymin, ymax)
```

**to\_rgba(self, x, alpha=None, bytes=False, norm=True)**

Return a normalized rgba array corresponding to x.

In the normal case, x is a 1-D or 2-D sequence of scalars, and the corresponding ndarray of rgba values will be returned, based on the norm and colormap set for this `ScalarMappable`.

There is one special case, for handling images that are already rgb or rgba, such as might have been read from an image file. If x is an ndarray with 3 dimensions, and the last dimension is either 3 or 4, then it will be treated as an rgb or rgba array, and no mapping will be done. The array can be uint8, or it can be floating point with values in the 0-1 range; otherwise a `ValueError` will be raised. If it is a masked array, the mask will be ignored. If the last dimension is 3, the `alpha` kwarg (defaulting to 1) will be used to fill in the transparency. If the last dimension is 4, the `alpha` kwarg is ignored; it does not replace the pre-existing alpha. A `ValueError` will be raised if the third dimension is other than 3 or 4.

In either case, if `bytes` is `False` (default), the rgba array will be floats in the 0-1 range; if it is `True`, the returned rgba array will be uint8 in the 0 to 255 range.

If `norm` is `False`, no normalization of the input data is performed, and it is assumed to be in the range (0-1).

**update(self, props)**

Update this artist’s properties from the dictionary `props`.

**update\_from(self, other)**

copy properties from other to self

**update\_scalarmappable(self)**

Update colors from the scalar mappable array, if it is not None.

`zorder = 0`

**class matplotlib.collections.PathCollection(paths, sizes=None, \*\*kwargs)**

Bases: `matplotlib.collections._CollectionWithSizes`

This is the most basic `Collection` subclass. A `PathCollection` is e.g. created by a `scatter()` plot.

`paths` is a sequence of `matplotlib.path.Path` instances.

Valid Collection keyword arguments:

- *edgecolors*: None
- *facecolors*: None
- *linewidths*: None
- *antialiaseds*: None
- *offsets*: None
- *transOffset*: `transforms.IdentityTransform()`
- *norm*: None (optional for `matplotlib.cm.ScalarMappable`)
- *cmap*: None (optional for `matplotlib.cm.ScalarMappable`)

*offsets* and *transOffset* are used to translate the patch after rendering (default no offsets)

If any of *edgecolors*, *facecolors*, *linewidths*, *antialiaseds* are None, they default to their `matplotlib.rcParams` patch setting, in sequence form.

`add_callback(self, func)`

Add a callback function that will be called whenever one of the *Artist*'s properties changes.

#### Parameters

**func** [callable] The callback function. It must have the signature:

```
def func(artist: Artist) -> Any
```

where *artist* is the calling *Artist*. Return values may exist but are ignored.

#### Returns

**oid** [int] The observer id associated with the callback. This id can be used for removing the callback with `remove_callback` later.

#### See also:

`remove_callback`

`add_checker(self, checker)`

Add an entry to a dictionary of boolean flags that are set to True when the mappable is changed.

`aname`

`autoscale(self)`

Autoscale the scalar limits on the norm instance using the current array

`autoscale_None(self)`

Autoscale the scalar limits on the norm instance using the current array, changing only limits that are None

`axes`

The *Axes* instance the artist resides in, or *None*.

`changed(self)`

Call this whenever the mappable is changed to notify all the callbackSM listeners to the 'changed' signal

`check_update(self, checker)`

If mappable has changed since the last check, return True; else return False

`contains(self, mouseevent)`

Test whether the mouse event occurred in the collection.

Returns bool, dict(ind=itemlist), where every item in itemlist contains the event.

`convert_xunits(self, x)`

Convert x using the unit type of the xaxis.

If the artist is not in contained in an Axes or if the xaxis does not have units, x itself is returned.

`convert_yunits(self, y)`

Convert y using the unit type of the yaxis.

If the artist is not in contained in an Axes or if the yaxis does not have units, y itself is returned.

`draw(self, renderer)`

Draw the Artist using the given renderer.

This method will be overridden in the Artist subclasses. Typically, it is implemented to not have any effect if the Artist is not visible (*Artist.get\_visible* is *False*).

### Parameters

**renderer** [*RendererBase* subclass.]

`findobj(self, match=None, include_self=True)`

Find artist objects.

Recursively find all *Artist* instances contained in the artist.

### Parameters

**match** A filter criterion for the matches. This can be

- *None*: Return all objects contained in artist.
- A function with signature `def match(artist: Artist) -> bool`. The result will only contain artists for which the function returns *True*.
- A class instance: e.g., *Line2D*. The result will only contain artists of this class or its subclasses (*isinstance* check).

**include\_self** [bool] Include *self* in the list to be checked for a match.

### Returns

**artists** [list of *Artist*]

`format_cursor_data(self, data)`

Return a string representation of *data*.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

The default implementation converts ints and floats and arrays of ints and floats into a comma-separated string enclosed in square brackets.

**See also:**

`get_cursor_data`

`get_agg_filter(self)`  
Return filter function to be used for agg filter.

`get_alpha(self)`  
Return the alpha value used for blending - not supported on all backends

`get_animated(self)`  
Return the animated state.

`get_array(self)`  
Return the array

`get_capstyle(self)`

`get_children(self)`  
Return a list of the child *Artists* of this *Artist*.

`get_clim(self)`  
return the min, max of the color limits for image scaling

`get_clip_box(self)`  
Return the clipbox.

`get_clip_on(self)`  
Return whether the artist uses clipping.

`get_clip_path(self)`  
Return the clip path.

`get_cmap(self)`  
return the colormap

`get_contains(self)`  
Return the custom contains function of the artist if set, or *None*.

**See also:**

`set_contains`

`get_cursor_data(self, event)`  
Return the cursor data for a given event.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

Cursor data can be used by Artists to provide additional context information for a given event. The default implementation just returns *None*.

Subclasses can override the method and return arbitrary data. However, when doing so, they must ensure that `format_cursor_data` can convert the data to a string representation.

The only current use case is displaying the z-value of an *AxesImage* in the status bar of a plot window, while moving the mouse.

### Parameters

**event** [`matplotlib.backend_bases.MouseEvent`]

**See also:**`format_cursor_data``get_dashes(self)`Alias for `get_linestyle`.`get_dataLim(self, transData)``get_ec(self)`Alias for `get_edgecolor`.`get_edgecolor(self)``get_edgecolors(self)`Alias for `get_edgecolor`.`get_facecolor(self)``get_facecolors(self)`Alias for `get_facecolor`.`get_fc(self)`Alias for `get_facecolor`.`get_figure(self)`Return the *Figure* instance the artist belongs to.`get_fill(self)`

return whether fill is set

`get_gid(self)`

Return the group id.

`get_hatch(self)`

Return the current hatching pattern.

`get_in_layout(self)`

Return boolean flag, True if artist is included in layout calculations.

E.g. *Constrained Layout Guide*, `Figure.tight_layout()`, and `fig.savefig(fname, bbox_inches='tight')`.`get_joinstyle(self)``get_label(self)`

Return the label used for this artist in the legend.

`get_linestyle(self)``get_linestyles(self)`Alias for `get_linestyle`.`get_linewidth(self)``get_linewidths(self)`Alias for `get_linewidth`.`get_ls(self)`Alias for `get_linestyle`.`get_lw(self)`Alias for `get_linewidth`.

`get_offset_position(self)`

Returns how offsets are applied for the collection. If *offset\_position* is 'screen', the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If *offset\_position* is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

`get_offset_transform(self)`

`get_offsets(self)`

Return the offsets for the collection.

`get_path_effects(self)`

`get_paths(self)`

`get_picker(self)`

Return the picking behavior of the artist.

The possible values are described in *set\_picker*.

**See also:**

*set\_picker*, *pickable*, *pick*

`get_pickradius(self)`

`get_rasterized(self)`

Return whether the artist is to be rasterized.

`get_sizes(self)`

Returns the sizes of the elements in the collection. The value represents the 'area' of the element.

**Returns**

**sizes** [array] The 'area' of each element.

`get_sketch_params(self)`

Returns the sketch parameters for the artist.

**Returns**

**sketch\_params** [tuple or None] A 3-tuple with the following elements:

- *scale*: The amplitude of the wiggle perpendicular to the source line.
- *length*: The length of the wiggle along the line.
- *randomness*: The scale factor by which the length is shrunken or expanded.

Returns *None* if no sketch parameters were set.

`get_snap(self)`

Returns the snap setting.

See *set\_snap* for details.

`get_tightbbox(self, renderer)`

Like `Artist.get_window_extent`, but includes any clipping.

**Parameters**

**renderer** [*RendererBase* instance] renderer that will be used to draw the figures (i.e. `fig.canvas.get_renderer()`)

## Returns

**bbox** [BBox] The enclosing bounding box (in figure pixel co-ordinates).

`get_transform(self)`

Return the *Transform* instance used by this artist.

`get_transformed_clip_path_and_affine(self)`

Return the clip path with the non-affine part of its transformation applied, and the remaining affine part of its transformation.

`get_transforms(self)`

`get_url(self)`

Return the url.

`get_urls(self)`

`get_visible(self)`

Return the visibility.

`get_window_extent(self, renderer)`

Get the axes bounding box in display space.

The bounding box' width and height are nonnegative.

Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

`get_zorder(self)`

Return the artist's zorder.

`have_units(self)`

Return *True* if units are set on the x or y axes.

`is_transform_set(self)`

Return whether the Artist has an explicitly set transform.

This is *True* after *set\_transform* has been called.

`legend_elements(self, prop='colors', num='auto', fmt=None, func=<function PathCollection.<lambda> at 0x7f6988bd1378>, **kwargs)`

Creates legend handles and labels for a PathCollection. This is useful for obtaining a legend for a *scatter()* plot. E.g.:

```
scatter = plt.scatter([1,2,3], [4,5,6], c=[7,2,3])
plt.legend(*scatter.legend_elements())
```

Also see the `automatedlegendcreation` example.

## Parameters

**prop** [string, optional, default "colors"] Can be "colors" or "sizes". In case of "colors", the legend handles will show the different colors of the collection. In case of "sizes", the legend will show the different sizes.

**num** [int, None, "auto" (default), array-like, or *Locator*,] optional Target number of elements to create. If None, use all unique elements of the mappable array. If an integer, target to use *num* elements in the normed range. If "auto", try to determine which option better suits the nature of the data. The number of created elements may slightly deviate from *num* due to a *Locator* being used to find useful locations. If a list or array, use exactly those elements for the legend. Finally, a *Locator* can be provided.

**fmt** [string, *Formatter*, or None (default)] The format or formatter to use for the labels. If a string must be a valid input for a *StrMethodFormatter*. If None (the default), use a *ScalarFormatter*.

**func** [function, default *lambda x: x*] Function to calculate the labels. Often the size (or color) argument to *scatter()* will have been pre-processed by the user using a function  $s = f(x)$  to make the markers visible; e.g. *size = np.log10(x)*. Providing the inverse of this function here allows that pre-processing to be inverted, so that the legend labels have the correct values; e.g. *func = np.exp(x, 10)*.

**kwargs** [further parameters] Allowed kwargs are *color* and *size*. E.g. it may be useful to set the color of the markers if *prop="sizes"* is used; similarly to set the size of the markers if *prop="colors"* is used. Any further parameters are passed onto the *Line2D* instance. This may be useful to e.g. specify a different *markeredgecolor* or *alpha* for the legend handles.

### Returns

**tuple (handles, labels)** with *handles* being a list of *Line2D* objects and *labels* a matching list of strings.

`mouseover`

`pchanged(self)`

Call all of the registered callbacks.

This function is triggered internally when a property is changed.

#### See also:

`add_callback`

`remove_callback`

`pick(self, mouseevent)`

Process a pick event.

Each child artist will fire a pick event if *mouseevent* is over the artist and the artist has picker set.

#### See also:

`set_picker`, `get_picker`, `pickable`

`pickable(self)`

Return whether the artist is pickable.

#### See also:

`set_picker, get_picker, pick`

`properties(self)`

Return a dictionary of all the properties of the artist.

`remove(self)`

Remove the artist from the figure if possible.

The effect will not be visible until the figure is redrawn, e.g., with `FigureCanvasBase.draw_idle`. Call `relim` to update the axes limits if desired.

Note: `relim` will not see collections even if the collection was added to the axes with `autolim = True`.

Note: there is no support for removing the artist's legend entry.

`remove_callback(self, oid)`

Remove a callback based on its observer id.

**See also:**

`add_callback`

`set(self, **kwargs)`

A property batch setter. Pass `kwargs` to set properties.

`set_aa(self, aa)`

Alias for `set_antialiased`.

`set_agg_filter(self, filter_func)`

Set the agg filter.

**Parameters**

**filter\_func** [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

`set_alpha(self, alpha)`

Set the alpha transparencies of the collection.

**Parameters**

**alpha** [float or None]

`set_animated(self, b)`

Set the artist's animation state.

**Parameters**

**b** [bool]

`set_antialiased(self, aa)`

Set the antialiasing state for rendering.

**Parameters**

**aa** [bool or sequence of bools]

`set_antialiaseds(self, aa)`

Alias for `set_antialiased`.

`set_array(self, A)`

Set the image array from numpy array `A`.

**Parameters**

**A** [ndarray]

`set_capstyle(self, cs)`

Set the capstyle for the collection (for all its elements).

**Parameters**

**cs** [{*'butt'*, *'round'*, *'projecting'*}] The capstyle

`set_clim(self, vmin=None, vmax=None)`

set the norm limits for image scaling; if *vmin* is a length2 sequence, interpret it as (*vmin*, *vmax*) which is used to support setp

ACCEPTS: a length 2 sequence of floats; may be overridden in methods that have *vmin* and *vmax* kwargs.

`set_clip_box(self, clipbox)`

Set the artist's clip *Bbox*.

**Parameters**

**clipbox** [*Bbox*]

`set_clip_on(self, b)`

Set whether the artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

**Parameters**

**b** [bool]

`set_clip_path(self, path, transform=None)`

Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- None, to remove a previously set clipping path.

For efficiency, if the path happens to be an axis-aligned rectangle, this method will set the clipping box to the corresponding rectangle and set the clipping path to None.

ACCEPTS: [(*Path*, *Transform*) | *Patch* | None]

`set_cmap(self, cmap)`

set the colormap for luminance data

**Parameters**

**cmap** [colormap or registered colormap name]

`set_color(self, c)`

Set both the edgecolor and the facecolor.

**Parameters**

**c** [color or sequence of rgba tuples]

**See also:**

*Collection.set\_facecolor*, *Collection.set\_edgecolor* For setting the edge or face color individually.

`set_contains(self, picker)`

Define a custom contains test for the artist.

The provided callable replaces the default `contains` method of the artist.

### Parameters

**picker** [callable] A custom picker function to evaluate if an event is within the artist. The function must have the signature:

```
def contains(artist: Artist, event: MouseEvent) -> bool, dict
```

that returns:

- a bool indicating if the event is within the artist
- a dict of additional information. The dict should at least return the same information as the default `contains()` implementation of the respective artist, but may provide additional information.

`set_dashes(self, ls)`

Alias for `set_linestyle`.

`set_ec(self, c)`

Alias for `set_edgecolor`.

`set_edgecolor(self, c)`

Set the edgecolor(s) of the collection.

### Parameters

**c** [color or sequence of colors or 'face'] The collection edgecolor(s). If a sequence, the patches cycle through it. If 'face', match the facecolor.

`set_edgecolors(self, c)`

Alias for `set_edgecolor`.

`set_facecolor(self, c)`

Set the facecolor(s) of the collection. `c` can be a matplotlib color spec (all patches have same color), or a sequence of specs; if it is a sequence the patches will cycle through the sequence.

If `c` is 'none', the patch will not be filled.

### Parameters

**c** [color or sequence of colors]

`set_facecolors(self, c)`

Alias for `set_facecolor`.

`set_fc(self, c)`

Alias for `set_facecolor`.

`set_figure(self, fig)`

Set the `Figure` instance the artist belongs to.

### Parameters

**fig** [`Figure`]

`set_gid(self, gid)`

Set the (group) id for the artist.

### Parameters

**gid** [str]**set\_hatch**(*self*, *hatch*)

Set the hatching pattern

*hatch* can be one of:

```

/ - diagonal hatching
\ - back diagonal
| - vertical
- - horizontal
+ - crossed
x - crossed diagonal
o - small circle
O - large circle
. - dots
* - stars

```

Letters can be combined, in which case all the specified hatchings are done. If same letter repeats, it increases the density of hatching of that pattern.

Hatching is supported in the PostScript, PDF, SVG and Agg backends only.

Unlike other properties such as linewidth and colors, hatching can only be specified for the collection as a whole, not separately for each member.

**Parameters****hatch** [{'/', '\', '|', '-', '+', 'x', 'o', 'O', '.', '\*}']**set\_in\_layout**(*self*, *in\_layout*)Set if artist is to be included in layout calculations, E.g. *Constrained Layout Guide*, *Figure.tight\_layout()*, and *fig.savefig(fname, bbox\_inches='tight')*.**Parameters****in\_layout** [bool]**set\_joinstyle**(*self*, *js*)

Set the joinstyle for the collection (for all its elements).

**Parameters****js** [{'miter', 'round', 'bevel'}] The joinstyle**set\_label**(*self*, *s*)

Set a label that will be displayed in the legend.

**Parameters****s** [object] *s* will be converted to a string by calling *str*.**set\_linestyle**(*self*, *ls*)

Set the linestyle(s) for the collection.

linestyle	description
'-' or 'solid'	solid line
'--' or 'dashed'	dashed line
'-.' or 'dashdot'	dash-dotted line
':' or 'dotted'	dotted line

Alternatively a dash tuple of the following form can be provided:

(offset, onoffseq),

where `onoffseq` is an even length tuple of on and off ink in points.

### Parameters

**ls** [`'-', '-.', ':', ''`, (offset, on-off-seq), ...] The line style.

`set_linestyles(self, ls)`

Alias for `set_linestyle`.

`set_linewidth(self, lw)`

Set the linewidth(s) for the collection. `lw` can be a scalar or a sequence; if it is a sequence the patches will cycle through the sequence

### Parameters

**lw** [float or sequence of floats]

`set_linewidths(self, lw)`

Alias for `set_linewidth`.

`set_ls(self, ls)`

Alias for `set_linestyle`.

`set_lw(self, lw)`

Alias for `set_linewidth`.

`set_norm(self, norm)`

Set the normalization instance.

### Parameters

**norm** [*Normalize*]

### Notes

If there are any colorbars using the mappable for this norm, setting the norm of the mappable will reset the norm, locator, and formatters on the colorbar to default.

`set_offset_position(self, offset_position)`

Set how offsets are applied. If `offset_position` is `'screen'` (default) the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If `offset_position` is `'data'`, the offset is applied before the master transform, i.e., the offsets are in data coordinates.

### Parameters

**offset\_position** [`'screen', 'data'`]

`set_offsets(self, offsets)`

Set the offsets for the collection.

### Parameters

**offsets** [float or sequence of floats]

`set_path_effects(self, path_effects)`

Set the path effects.

### Parameters

**path\_effects** [*AbstractPathEffect*]

`set_paths(self, paths)`

`set_picker(self, picker)`

Define the picking behavior of the artist.

#### Parameters

**picker** [None or bool or float or callable] This can be one of the following:

- *None*: Picking is disabled for this artist (default).
- A boolean: If *True* then picking will be enabled and the artist will fire a pick event if the mouse event is over the artist.
- A float: If *picker* is a number it is interpreted as an epsilon tolerance in points and the artist will fire off an event if it's data is within epsilon of the mouse event. For some artists like lines and patch collections, the artist may provide additional data to the pick event that is generated, e.g., the indices of the data within epsilon of the pick event
- A function: If *picker* is callable, it is a user supplied function which determines whether the artist is hit by the mouse event:

```
hit, props = picker(artist, mouseevent)
```

to determine the hit test. if the mouse event is over the artist, return *hit=True* and *props* is a dictionary of properties you want added to the `PickEvent` attributes.

`set_pickradius(self, pr)`

Set the pick radius used for containment tests.

#### Parameters

**d** [float] Pick radius, in points.

`set_rasterized(self, rasterized)`

Force rasterized (bitmap) drawing in vector backend output.

Defaults to *None*, which implies the backend's default behavior.

#### Parameters

**rasterized** [bool or *None*]

`set_sizes(self, sizes, dpi=72.0)`

Set the sizes of each member of the collection.

#### Parameters

**sizes** [ndarray or *None*] The size to set for each element of the collection. The value is the 'area' of the element.

**dpi** [float] The dpi of the canvas. Defaults to 72.0.

`set_sketch_params(self, scale=None, length=None, randomness=None)`

Sets the sketch parameters.

#### Parameters

**scale** [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If *scale* is *None*, or not provided, no sketch filter will be provided.

**length** [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

**randomness** [float, optional] The scale factor by which the length is shrunk or expanded (default 16.0)

`set_snap(self, snap)`

Set the snapping behavior.

Snapping aligns positions with the pixel grid, which results in clearer images. For example, if a black line of 1px width was defined at a position in between two pixels, the resulting image would contain the interpolated value of that line in the pixel grid, which would be a grey value on both adjacent pixel positions. In contrast, snapping will move the line to the nearest integer pixel value, so that the resulting image will really contain a 1px wide black line.

Snapping is currently only supported by the Agg and MacOSX backends.

#### Parameters

**snap** [bool or None] Possible values:

- *True*: Snap vertices to the nearest pixel center.
- *False*: Do not modify vertex positions.
- *None*: (auto) If the path contains only rectilinear line segments, round to the nearest pixel center.

`set_transform(self, t)`

Set the artist transform.

#### Parameters

**t** [*Transform*]

`set_url(self, url)`

Set the url for the artist.

#### Parameters

**url** [str]

`set_urls(self, urls)`

#### Parameters

**urls** [List[str] or None]

`set_visible(self, b)`

Set the artist's visibility.

#### Parameters

**b** [bool]

`set_zorder(self, level)`

Set the zorder for the artist. Artists with lower zorder values are drawn first.

#### Parameters

**level** [float]

`stale`

Whether the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

**sticky\_edges**

x and y sticky edge lists for autoscaling.

When performing autoscaling, if a data limit coincides with a value in the corresponding `sticky_edges` list, then no margin will be added—the view limit “sticks” to the edge. A typical use case is histograms, where one usually expects no margin on the bottom edge (0) of the histogram.

This attribute cannot be assigned to; however, the x and y lists can be modified in place as needed.

**Examples**

```
>>> artist.sticky_edges.x[:] = (xmin, xmax)
>>> artist.sticky_edges.y[:] = (ymin, ymax)
```

**to\_rgba(self, x, alpha=None, bytes=False, norm=True)**

Return a normalized rgba array corresponding to x.

In the normal case, x is a 1-D or 2-D sequence of scalars, and the corresponding ndarray of rgba values will be returned, based on the norm and colormap set for this `ScalarMappable`.

There is one special case, for handling images that are already rgb or rgba, such as might have been read from an image file. If x is an ndarray with 3 dimensions, and the last dimension is either 3 or 4, then it will be treated as an rgb or rgba array, and no mapping will be done. The array can be uint8, or it can be floating point with values in the 0-1 range; otherwise a `ValueError` will be raised. If it is a masked array, the mask will be ignored. If the last dimension is 3, the *alpha* kwarg (defaulting to 1) will be used to fill in the transparency. If the last dimension is 4, the *alpha* kwarg is ignored; it does not replace the pre-existing alpha. A `ValueError` will be raised if the third dimension is other than 3 or 4.

In either case, if *bytes* is *False* (default), the rgba array will be floats in the 0-1 range; if it is *True*, the returned rgba array will be uint8 in the 0 to 255 range.

If *norm* is *False*, no normalization of the input data is performed, and it is assumed to be in the range (0-1).

**update(self, props)**

Update this artist’s properties from the dictionary *props*.

**update\_from(self, other)**

copy properties from other to self

**update\_scalarmappable(self)**

Update colors from the scalar mappable array, if it is not None.

`zorder = 0`

```
class matplotlib.collections.PolyCollection(verts, sizes=None, closed=True,
                                           **kwargs)
```

Bases: `matplotlib.collections._CollectionWithSizes`

*verts* is a sequence of ( *verts0*, *verts1*, ...) where *verts<sub>i</sub>* is a sequence of xy tuples of vertices, or an equivalent `numpy` array of shape (*nv*, 2).

*sizes* is *None* (default) or a sequence of floats that scale the corresponding *verts<sub>i</sub>*. The scaling is applied before the Artist master transform; if the latter is an identity transform,

then the overall scaling is such that if *verts<sub>i</sub>* specify a unit square, then *sizes<sub>i</sub>* is the area of that square in points<sup>2</sup>. If `len(sizes) < nv`, the additional values will be taken cyclically from the array.

*closed*, when *True*, will explicitly close the polygon.

Valid Collection keyword arguments:

- *edgcolors*: None
- *facecolors*: None
- *linewidths*: None
- *antialiaseds*: None
- *offsets*: None
- *transOffset*: `transforms.IdentityTransform()`
- *norm*: None (optional for `matplotlib.cm.ScalarMappable`)
- *cmap*: None (optional for `matplotlib.cm.ScalarMappable`)

*offsets* and *transOffset* are used to translate the patch after rendering (default no offsets)

If any of *edgcolors*, *facecolors*, *linewidths*, *antialiaseds* are None, they default to their `matplotlib.rcParams` patch setting, in sequence form.

`add_callback(self, func)`

Add a callback function that will be called whenever one of the *Artist*'s properties changes.

#### Parameters

**func** [callable] The callback function. It must have the signature:

```
def func(artist: Artist) -> Any
```

where *artist* is the calling *Artist*. Return values may exist but are ignored.

#### Returns

**oid** [int] The observer id associated with the callback. This id can be used for removing the callback with `remove_callback` later.

#### See also:

`remove_callback`

`add_checker(self, checker)`

Add an entry to a dictionary of boolean flags that are set to True when the mappable is changed.

`aname`

`autoscale(self)`

Autoscale the scalar limits on the norm instance using the current array

`autoscale_None(self)`

Autoscale the scalar limits on the norm instance using the current array, changing only limits that are None

**axes**

The *Axes* instance the artist resides in, or *None*.

**changed(*self*)**

Call this whenever the mappable is changed to notify all the callbackSM listeners to the 'changed' signal

**check\_update(*self*, *checker*)**

If mappable has changed since the last check, return True; else return False

**contains(*self*, *mouseevent*)**

Test whether the mouse event occurred in the collection.

Returns bool, dict(ind=itemlist), where every item in itemlist contains the event.

**convert\_xunits(*self*, *x*)**

Convert *x* using the unit type of the xaxis.

If the artist is not in contained in an Axes or if the xaxis does not have units, *x* itself is returned.

**convert\_yunits(*self*, *y*)**

Convert *y* using the unit type of the yaxis.

If the artist is not in contained in an Axes or if the yaxis does not have units, *y* itself is returned.

**draw(*self*, *renderer*)**

Draw the Artist using the given renderer.

This method will be overridden in the Artist subclasses. Typically, it is implemented to not have any effect if the Artist is not visible (*Artist.get\_visible* is *False*).

### Parameters

**renderer** [*RendererBase* subclass.]

**findobj(*self*, *match*=None, *include\_self*=True)**

Find artist objects.

Recursively find all *Artist* instances contained in the artist.

### Parameters

**match** A filter criterion for the matches. This can be

- *None*: Return all objects contained in artist.
- A function with signature `def match(artist: Artist) -> bool`. The result will only contain artists for which the function returns *True*.
- A class instance: e.g., *Line2D*. The result will only contain artists of this class or its subclasses (instance check).

**include\_self** [bool] Include *self* in the list to be checked for a match.

### Returns

**artists** [list of *Artist*]

**format\_cursor\_data(*self*, *data*)**

Return a string representation of *data*.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

The default implementation converts ints and floats and arrays of ints and floats into a comma-separated string enclosed in square brackets.

**See also:**

*get\_cursor\_data*

`get_agg_filter(self)`

Return filter function to be used for agg filter.

`get_alpha(self)`

Return the alpha value used for blending - not supported on all backends

`get_animated(self)`

Return the animated state.

`get_array(self)`

Return the array

`get_capstyle(self)`

`get_children(self)`

Return a list of the child *Artists* of this *Artist*.

`get_clim(self)`

return the min, max of the color limits for image scaling

`get_clip_box(self)`

Return the clipbox.

`get_clip_on(self)`

Return whether the artist uses clipping.

`get_clip_path(self)`

Return the clip path.

`get_cmap(self)`

return the colormap

`get_contains(self)`

Return the custom contains function of the artist if set, or *None*.

**See also:**

*set\_contains*

`get_cursor_data(self, event)`

Return the cursor data for a given event.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

Cursor data can be used by Artists to provide additional context information for a given event. The default implementation just returns *None*.

Subclasses can override the method and return arbitrary data. However, when doing so, they must ensure that `format_cursor_data` can convert the data to a string representation.

The only current use case is displaying the z-value of an `AxesImage` in the status bar of a plot window, while moving the mouse.

### Parameters

**event** [`matplotlib.backend_bases.MouseEvent`]

### See also:

`format_cursor_data`

`get_dashes(self)`

Alias for `get_linestyle`.

`get_dataLim(self, transData)`

`get_ec(self)`

Alias for `get_edgecolor`.

`get_edgecolor(self)`

`get_edgecolors(self)`

Alias for `get_edgecolor`.

`get_facecolor(self)`

`get_facecolors(self)`

Alias for `get_facecolor`.

`get_fc(self)`

Alias for `get_facecolor`.

`get_figure(self)`

Return the `Figure` instance the artist belongs to.

`get_fill(self)`

return whether fill is set

`get_gid(self)`

Return the group id.

`get_hatch(self)`

Return the current hatching pattern.

`get_in_layout(self)`

Return boolean flag, True if artist is included in layout calculations.

E.g. *Constrained Layout Guide*, `Figure.tight_layout()`, and `fig.savefig(fname, bbox_inches='tight')`.

`get_joinstyle(self)`

`get_label(self)`

Return the label used for this artist in the legend.

`get_linestyle(self)`

`get_linestyles(self)`

Alias for `get_linestyle`.

`get_linewidth(self)`

`get_linewidths(self)`

Alias for `get_linewidth`.

`get_ls(self)`

Alias for `get_linestyle`.

`get_lw(self)`

Alias for `get_linewidth`.

`get_offset_position(self)`

Returns how offsets are applied for the collection. If `offset_position` is 'screen', the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If `offset_position` is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

`get_offset_transform(self)`

`get_offsets(self)`

Return the offsets for the collection.

`get_path_effects(self)`

`get_paths(self)`

`get_picker(self)`

Return the picking behavior of the artist.

The possible values are described in `set_picker`.

**See also:**

`set_picker`, `pickable`, `pick`

`get_pickradius(self)`

`get_rasterized(self)`

Return whether the artist is to be rasterized.

`get_sizes(self)`

Returns the sizes of the elements in the collection. The value represents the 'area' of the element.

**Returns**

**sizes** [array] The 'area' of each element.

`get_sketch_params(self)`

Returns the sketch parameters for the artist.

**Returns**

**sketch\_params** [tuple or None] A 3-tuple with the following elements:

- *scale*: The amplitude of the wiggle perpendicular to the source line.
- *length*: The length of the wiggle along the line.
- *randomness*: The scale factor by which the length is shrunken or expanded.

Returns *None* if no sketch parameters were set.

`get_snap(self)`

Returns the snap setting.

See `set_snap` for details.

`get_tightbbox(self, renderer)`

Like `Artist.get_window_extent`, but includes any clipping.

### Parameters

**renderer** [*RendererBase* instance] renderer that will be used to draw the figures (i.e. `fig.canvas.get_renderer()`)

### Returns

**bbox** [*BBox*] The enclosing bounding box (in figure pixel co-ordinates).

`get_transform(self)`

Return the *Transform* instance used by this artist.

`get_transformed_clip_path_and_affine(self)`

Return the clip path with the non-affine part of its transformation applied, and the remaining affine part of its transformation.

`get_transforms(self)`

`get_url(self)`

Return the url.

`get_urls(self)`

`get_visible(self)`

Return the visibility.

`get_window_extent(self, renderer)`

Get the axes bounding box in display space.

The bounding box' width and height are nonnegative.

Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

`get_zorder(self)`

Return the artist's zorder.

`have_units(self)`

Return *True* if units are set on the x or y axes.

`is_transform_set(self)`

Return whether the Artist has an explicitly set transform.

This is *True* after `set_transform` has been called.

`mouseover`

`pchanged(self)`

Call all of the registered callbacks.

This function is triggered internally when a property is changed.

**See also:**

---

`add_callback`  
`remove_callback`

`pick(self, mouseevent)`  
 Process a pick event.

Each child artist will fire a pick event if *mouseevent* is over the artist and the artist has picker set.

**See also:**

`set_picker`, `get_picker`, `pickable`

`pickable(self)`  
 Return whether the artist is pickable.

**See also:**

`set_picker`, `get_picker`, `pick`

`properties(self)`  
 Return a dictionary of all the properties of the artist.

`remove(self)`  
 Remove the artist from the figure if possible.

The effect will not be visible until the figure is redrawn, e.g., with *FigureCanvasBase.draw\_idle*. Call *relim* to update the axes limits if desired.

Note: *relim* will not see collections even if the collection was added to the axes with *autolim = True*.

Note: there is no support for removing the artist's legend entry.

`remove_callback(self, oid)`  
 Remove a callback based on its observer id.

**See also:**

`add_callback`

`set(self, **kwargs)`  
 A property batch setter. Pass *kwargs* to set properties.

`set_aa(self, aa)`  
 Alias for *set\_antialiased*.

`set_agg_filter(self, filter_func)`  
 Set the agg filter.

**Parameters**

**filter\_func** [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

`set_alpha(self, alpha)`  
 Set the alpha transparencies of the collection.

**Parameters**

**alpha** [float or None]

`set_animated(self, b)`

Set the artist's animation state.

**Parameters**

**b** [bool]

`set_antialiased(self, aa)`

Set the antialiasing state for rendering.

**Parameters**

**aa** [bool or sequence of bools]

`set_antialiaseds(self, aa)`

Alias for `set_antialiased`.

`set_array(self, A)`

Set the image array from numpy array *A*.

**Parameters**

**A** [ndarray]

`set_capstyle(self, cs)`

Set the capstyle for the collection (for all its elements).

**Parameters**

**cs** [{'butt', 'round', 'projecting'}] The capstyle

`set_clim(self, vmin=None, vmax=None)`

set the norm limits for image scaling; if *vmin* is a length2 sequence, interpret it as (*vmin*, *vmax*) which is used to support setp

ACCEPTS: a length 2 sequence of floats; may be overridden in methods that have *vmin* and *vmax* kwargs.

`set_clip_box(self, clipbox)`

Set the artist's clip *Bbox*.

**Parameters**

**clipbox** [*Bbox*]

`set_clip_on(self, b)`

Set whether the artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

**Parameters**

**b** [bool]

`set_clip_path(self, path, transform=None)`

Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- None, to remove a previously set clipping path.

For efficiency, if the path happens to be an axis-aligned rectangle, this method will set the clipping box to the corresponding rectangle and set the clipping path to `None`.

ACCEPTS: [(*Path*, *Transform*) | *Patch* | *None*]

`set_cmap(self, cmap)`  
set the colormap for luminance data

#### Parameters

**cmap** [colormap or registered colormap name]

`set_color(self, c)`  
Set both the edgecolor and the facecolor.

#### Parameters

**c** [color or sequence of rgba tuples]

#### See also:

`Collection.set_facecolor`, `Collection.set_edgecolor` For setting the edge or face color individually.

`set_contains(self, picker)`  
Define a custom contains test for the artist.

The provided callable replaces the default `contains` method of the artist.

#### Parameters

**picker** [callable] A custom picker function to evaluate if an event is within the artist. The function must have the signature:

```
def contains(artist: Artist, event: MouseEvent) -> bool, dict
```

that returns:

- a bool indicating if the event is within the artist
- a dict of additional information. The dict should at least return the same information as the default `contains()` implementation of the respective artist, but may provide additional information.

`set_dashes(self, ls)`  
Alias for `set_linestyle`.

`set_ec(self, c)`  
Alias for `set_edgecolor`.

`set_edgecolor(self, c)`  
Set the edgecolor(s) of the collection.

#### Parameters

**c** [color or sequence of colors or 'face'] The collection edgecolor(s). If a sequence, the patches cycle through it. If 'face', match the facecolor.

`set_edgecolors(self, c)`  
Alias for `set_edgecolor`.

`set_facecolor(self, c)`  
Set the facecolor(s) of the collection. `c` can be a matplotlib color spec (all patches

have same color), or a sequence of specs; if it is a sequence the patches will cycle through the sequence.

If *c* is 'none', the patch will not be filled.

#### Parameters

**c** [color or sequence of colors]

`set_facecolors(self, c)`  
Alias for `set_facecolor`.

`set_fc(self, c)`  
Alias for `set_facecolor`.

`set_figure(self, fig)`  
Set the *Figure* instance the artist belongs to.

#### Parameters

**fig** [*Figure*]

`set_gid(self, gid)`  
Set the (group) id for the artist.

#### Parameters

**gid** [str]

`set_hatch(self, hatch)`  
Set the hatching pattern

*hatch* can be one of:

/	- diagonal hatching
\	- back diagonal
	- vertical
-	- horizontal
+	- crossed
x	- crossed diagonal
o	- small circle
O	- large circle
.	- dots
*	- stars

Letters can be combined, in which case all the specified hatchings are done. If same letter repeats, it increases the density of hatching of that pattern.

Hatching is supported in the PostScript, PDF, SVG and Agg backends only.

Unlike other properties such as linewidth and colors, hatching can only be specified for the collection as a whole, not separately for each member.

#### Parameters

**hatch** [{'/', '\\', '|', '-', '+', 'x', 'o', 'O', '.', '\*'}]

`set_in_layout(self, in_layout)`  
Set if artist is to be included in layout calculations, E.g. *Constrained Layout Guide*, `Figure.tight_layout()`, and `fig.savefig(fname, bbox_inches='tight')`.

#### Parameters

**in\_layout** [bool]

`set_joinstyle(self, js)`  
Set the joinstyle for the collection (for all its elements).

**Parameters**

**js** [{'miter', 'round', 'bevel'}] The joinstyle

`set_label(self, s)`  
Set a label that will be displayed in the legend.

**Parameters**

**s** [object] *s* will be converted to a string by calling `str`.

`set_linestyle(self, ls)`  
Set the linestyle(s) for the collection.

linestyle	description
'-' or 'solid'	solid line
'--' or 'dashed'	dashed line
'-.' or 'dashdot'	dash-dotted line
':' or 'dotted'	dotted line

Alternatively a dash tuple of the following form can be provided:

```
(offset, onoffseq),
```

where `onoffseq` is an even length tuple of on and off ink in points.

**Parameters**

**ls** [{'-', '-', '-.', ':', ', (offset, on-off-seq), ...}] The line style.

`set_linestyles(self, ls)`  
Alias for `set_linestyle`.

`set_linewidth(self, lw)`  
Set the linewidth(s) for the collection. *lw* can be a scalar or a sequence; if it is a sequence the patches will cycle through the sequence

**Parameters**

**lw** [float or sequence of floats]

`set_linewidths(self, lw)`  
Alias for `set_linewidth`.

`set_ls(self, ls)`  
Alias for `set_linestyle`.

`set_lw(self, lw)`  
Alias for `set_linewidth`.

`set_norm(self, norm)`  
Set the normalization instance.

**Parameters**

**norm** [*Normalize*]

## Notes

If there are any colorbars using the mappable for this norm, setting the norm of the mappable will reset the norm, locator, and formatters on the colorbar to default.

`set_offset_position(self, offset_position)`

Set how offsets are applied. If `offset_position` is 'screen' (default) the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If `offset_position` is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

### Parameters

**offset\_position** [{'screen', 'data'}]

`set_offsets(self, offsets)`

Set the offsets for the collection.

### Parameters

**offsets** [float or sequence of floats]

`set_path_effects(self, path_effects)`

Set the path effects.

### Parameters

**path\_effects** [*AbstractPathEffect*]

`set_paths(self, verts, closed=True)`

This allows one to delay initialization of the vertices.

`set_picker(self, picker)`

Define the picking behavior of the artist.

### Parameters

**picker** [None or bool or float or callable] This can be one of the following:

- *None*: Picking is disabled for this artist (default).
- A boolean: If *True* then picking will be enabled and the artist will fire a pick event if the mouse event is over the artist.
- A float: If `picker` is a number it is interpreted as an epsilon tolerance in points and the artist will fire off an event if it's data is within epsilon of the mouse event. For some artists like lines and patch collections, the artist may provide additional data to the pick event that is generated, e.g., the indices of the data within epsilon of the pick event
- A function: If `picker` is callable, it is a user supplied function which determines whether the artist is hit by the mouse event:

```
hit, props = picker(artist, mouseevent)
```

to determine the hit test. if the mouse event is over the artist, return `hit=True` and `props` is a dictionary of properties you want added to the `PickEvent` attributes.

`set_pickradius(self, pr)`

Set the pick radius used for containment tests.

**Parameters**

**d** [float] Pick radius, in points.

`set_rasterized(self, rasterized)`

Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

**Parameters**

**rasterized** [bool or None]

`set_sizes(self, sizes, dpi=72.0)`

Set the sizes of each member of the collection.

**Parameters**

**sizes** [ndarray or None] The size to set for each element of the collection. The value is the 'area' of the element.

**dpi** [float] The dpi of the canvas. Defaults to 72.0.

`set_sketch_params(self, scale=None, length=None, randomness=None)`

Sets the sketch parameters.

**Parameters**

**scale** [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

**length** [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

**randomness** [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

`set_snap(self, snap)`

Set the snapping behavior.

Snapping aligns positions with the pixel grid, which results in clearer images. For example, if a black line of 1px width was defined at a position in between two pixels, the resulting image would contain the interpolated value of that line in the pixel grid, which would be a grey value on both adjacent pixel positions. In contrast, snapping will move the line to the nearest integer pixel value, so that the resulting image will really contain a 1px wide black line.

Snapping is currently only supported by the Agg and MacOSX backends.

**Parameters**

**snap** [bool or None] Possible values:

- *True*: Snap vertices to the nearest pixel center.
- *False*: Do not modify vertex positions.
- *None*: (auto) If the path contains only rectilinear line segments, round to the nearest pixel center.

`set_transform(self, t)`

Set the artist transform.

**Parameters**

**t** [*Transform*]

`set_url(self, url)`  
Set the url for the artist.

**Parameters**

**url** [str]

`set_urls(self, urls)`

**Parameters**

**urls** [List[str] or None]

`set_verts(self, verts, closed=True)`  
This allows one to delay initialization of the vertices.

`set_verts_and_codes(self, verts, codes)`  
This allows one to initialize vertices with path codes.

`set_visible(self, b)`  
Set the artist's visibility.

**Parameters**

**b** [bool]

`set_zorder(self, level)`  
Set the zorder for the artist. Artists with lower zorder values are drawn first.

**Parameters**

**level** [float]

**stale**  
Whether the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

**sticky\_edges**  
x and y sticky edge lists for autoscaling.

When performing autoscaling, if a data limit coincides with a value in the corresponding `sticky_edges` list, then no margin will be added—the view limit “sticks” to the edge. A typical use case is histograms, where one usually expects no margin on the bottom edge (0) of the histogram.

This attribute cannot be assigned to; however, the x and y lists can be modified in place as needed.

**Examples**

```
>>> artist.sticky_edges.x[:] = (xmin, xmax)
>>> artist.sticky_edges.y[:] = (ymin, ymax)
```

`to_rgba(self, x, alpha=None, bytes=False, norm=True)`  
Return a normalized rgba array corresponding to x.

In the normal case, x is a 1-D or 2-D sequence of scalars, and the corresponding ndarray of rgba values will be returned, based on the norm and colormap set for this `ScalarMappable`.

There is one special case, for handling images that are already rgb or rgba, such as might have been read from an image file. If  $x$  is an ndarray with 3 dimensions, and the last dimension is either 3 or 4, then it will be treated as an rgb or rgba array, and no mapping will be done. The array can be uint8, or it can be floating point with values in the 0-1 range; otherwise a `ValueError` will be raised. If it is a masked array, the mask will be ignored. If the last dimension is 3, the `alpha` kwarg (defaulting to 1) will be used to fill in the transparency. If the last dimension is 4, the `alpha` kwarg is ignored; it does not replace the pre-existing alpha. A `ValueError` will be raised if the third dimension is other than 3 or 4.

In either case, if `bytes` is `False` (default), the rgba array will be floats in the 0-1 range; if it is `True`, the returned rgba array will be uint8 in the 0 to 255 range.

If `norm` is `False`, no normalization of the input data is performed, and it is assumed to be in the range (0-1).

`update(self, props)`

Update this artist's properties from the dictionary `props`.

`update_from(self, other)`

copy properties from `other` to self

`update_scalarmappable(self)`

Update colors from the scalar mappable array, if it is not `None`.

`zorder = 0`

```
class matplotlib.collections.QuadMesh(meshWidth, meshHeight, coordinates, an-
    tialiased=True, shading='flat', **kwargs)
```

Bases: `matplotlib.collections.Collection`

Class for the efficient drawing of a quadrilateral mesh.

A quadrilateral mesh consists of a grid of vertices. The dimensions of this array are  $(meshWidth + 1, meshHeight + 1)$ . Each vertex in the mesh has a different set of "mesh coordinates" representing its position in the topology of the mesh. For any values  $(m, n)$  such that  $0 \leq m \leq meshWidth$  and  $0 \leq n \leq meshHeight$ , the vertices at mesh coordinates  $(m, n)$ ,  $(m, n + 1)$ ,  $(m + 1, n + 1)$ , and  $(m + 1, n)$  form one of the quadrilaterals in the mesh. There are thus  $(meshWidth * meshHeight)$  quadrilaterals in the mesh. The mesh need not be regular and the polygons need not be convex.

A quadrilateral mesh is represented by a  $(2 \times ((meshWidth + 1) * (meshHeight + 1)))$  numpy array `coordinates`, where each row is the  $x$  and  $y$  coordinates of one of the vertices. To define the function that maps from a data point to its corresponding color, use the `set_cmap()` method. Each of these arrays is indexed in row-major order by the mesh coordinates of the vertex (or the mesh coordinates of the lower left vertex, in the case of the colors).

For example, the first entry in `coordinates` is the coordinates of the vertex at mesh coordinates  $(0, 0)$ , then the one at  $(0, 1)$ , then at  $(0, 2) \dots (0, meshWidth)$ ,  $(1, 0)$ ,  $(1, 1)$ , and so on.

`shading` may be 'flat', or 'gouraud'

`add_callback(self, func)`

Add a callback function that will be called whenever one of the `Artist's` properties changes.

### Parameters

**func** [callable] The callback function. It must have the signature:

```
def func(artist: Artist) -> Any
```

where *artist* is the calling *Artist*. Return values may exist but are ignored.

### Returns

**oid** [int] The observer id associated with the callback. This id can be used for removing the callback with *remove\_callback* later.

### See also:

*remove\_callback*

*add\_checker(self, checker)*

Add an entry to a dictionary of boolean flags that are set to True when the mappable is changed.

*aname*

*autoscale(self)*

Autoscale the scalar limits on the norm instance using the current array

*autoscale\_None(self)*

Autoscale the scalar limits on the norm instance using the current array, changing only limits that are None

*axes*

The *Axes* instance the artist resides in, or *None*.

*changed(self)*

Call this whenever the mappable is changed to notify all the callbackSM listeners to the 'changed' signal

*check\_update(self, checker)*

If mappable has changed since the last check, return True; else return False

*contains(self, mouseevent)*

Test whether the mouse event occurred in the collection.

Returns bool, dict(ind=itemlist), where every item in itemlist contains the event.

*static convert\_mesh\_to\_paths(meshWidth, meshHeight, coordinates)*

Converts a given mesh into a sequence of *Path* objects.

This function is primarily of use to implementers of backends that do not directly support quadmeshes.

*convert\_mesh\_to\_triangles(self, meshWidth, meshHeight, coordinates)*

Converts a given mesh into a sequence of triangles, each point with its own color. This is useful for experiments using *draw\_gouraud\_triangle*.

*convert\_xunits(self, x)*

Convert *x* using the unit type of the xaxis.

If the artist is not in contained in an *Axes* or if the xaxis does not have units, *x* itself is returned.

*convert\_yunits(self, y)*

Convert *y* using the unit type of the yaxis.

If the artist is not contained in an Axes or if the yaxis does not have units, *y* itself is returned.

`draw(self, renderer)`

Draw the Artist using the given renderer.

This method will be overridden in the Artist subclasses. Typically, it is implemented to not have any effect if the Artist is not visible (`Artist.get_visible` is `False`).

### Parameters

**renderer** [*RendererBase* subclass.]

`findobj(self, match=None, include_self=True)`

Find artist objects.

Recursively find all *Artist* instances contained in the artist.

### Parameters

**match** A filter criterion for the matches. This can be

- *None*: Return all objects contained in artist.
- A function with signature `def match(artist: Artist) -> bool`. The result will only contain artists for which the function returns *True*.
- A class instance: e.g., *Line2D*. The result will only contain artists of this class or its subclasses (`isinstance` check).

**include\_self** [bool] Include *self* in the list to be checked for a match.

### Returns

**artists** [list of *Artist*]

`format_cursor_data(self, data)`

Return a string representation of *data*.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

The default implementation converts ints and floats and arrays of ints and floats into a comma-separated string enclosed in square brackets.

### See also:

`get_cursor_data`

`get_agg_filter(self)`

Return filter function to be used for agg filter.

`get_alpha(self)`

Return the alpha value used for blending - not supported on all backends

`get_animated(self)`

Return the animated state.

`get_array(self)`

Return the array

`get_capstyle(self)`

`get_children(self)`  
Return a list of the child *Artists* of this *Artist*.

`get_clim(self)`  
return the min, max of the color limits for image scaling

`get_clip_box(self)`  
Return the clipbox.

`get_clip_on(self)`  
Return whether the artist uses clipping.

`get_clip_path(self)`  
Return the clip path.

`get_cmap(self)`  
return the colormap

`get_contains(self)`  
Return the custom contains function of the artist if set, or *None*.

**See also:**

`set_contains`

`get_cursor_data(self, event)`  
Return the cursor data for a given event.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

Cursor data can be used by Artists to provide additional context information for a given event. The default implementation just returns *None*.

Subclasses can override the method and return arbitrary data. However, when doing so, they must ensure that `format_cursor_data` can convert the data to a string representation.

The only current use case is displaying the z-value of an *AxesImage* in the status bar of a plot window, while moving the mouse.

#### Parameters

**event** [`matplotlib.backend_bases.MouseEvent`]

#### See also:

`format_cursor_data`

`get_dashes(self)`  
Alias for `get_linestyle`.

`get_datalim(self, transData)`

`get_ec(self)`  
Alias for `get_edgecolor`.

`get_edgecolor(self)`

`get_edgecolors(self)`  
Alias for `get_edgecolor`.

---

```

get_facecolor(self)
get_facecolors(self)
    Alias for get_facecolor.
get_fc(self)
    Alias for get_facecolor.
get_figure(self)
    Return the Figure instance the artist belongs to.
get_fill(self)
    return whether fill is set
get_gid(self)
    Return the group id.
get_hatch(self)
    Return the current hatching pattern.
get_in_layout(self)
    Return boolean flag, True if artist is included in layout calculations.
    E.g. Constrained Layout Guide, Figure.tight_layout(), and fig.savefig(fname,
    bbox_inches='tight').
get_joinstyle(self)
get_label(self)
    Return the label used for this artist in the legend.
get_linestyle(self)
get_linestyles(self)
    Alias for get_linestyle.
get_linewidth(self)
get_linewidths(self)
    Alias for get_linewidth.
get_ls(self)
    Alias for get_linestyle.
get_lw(self)
    Alias for get_linewidth.
get_offset_position(self)
    Returns how offsets are applied for the collection. If offset_position is 'screen', the
    offset is applied after the master transform has been applied, that is, the offsets are
    in screen coordinates. If offset_position is 'data', the offset is applied before the
    master transform, i.e., the offsets are in data coordinates.
get_offset_transform(self)
get_offsets(self)
    Return the offsets for the collection.
get_path_effects(self)
get_paths(self)
get_picker(self)
    Return the picking behavior of the artist.

```

The possible values are described in *set\_picker*.

**See also:**

*set\_picker, pickable, pick*

*get\_pickradius(self)*

*get\_rasterized(self)*

Return whether the artist is to be rasterized.

*get\_sketch\_params(self)*

Returns the sketch parameters for the artist.

**Returns**

**sketch\_params** [tuple or None] A 3-tuple with the following elements:

- *scale*: The amplitude of the wiggle perpendicular to the source line.
- *length*: The length of the wiggle along the line.
- *randomness*: The scale factor by which the length is shrunken or expanded.

Returns *None* if no sketch parameters were set.

*get\_snap(self)*

Returns the snap setting.

See *set\_snap* for details.

*get\_tightbbox(self, renderer)*

Like *Artist.get\_window\_extent*, but includes any clipping.

**Parameters**

**renderer** [*RendererBase* instance] renderer that will be used to draw the figures (i.e. *fig.canvas.get\_renderer()*)

**Returns**

**bbbox** [*BBox*] The enclosing bounding box (in figure pixel co-ordinates).

*get\_transform(self)*

Return the *Transform* instance used by this artist.

*get\_transformed\_clip\_path\_and\_affine(self)*

Return the clip path with the non-affine part of its transformation applied, and the remaining affine part of its transformation.

*get\_transforms(self)*

*get\_url(self)*

Return the url.

*get\_urls(self)*

*get\_visible(self)*

Return the visibility.

*get\_window\_extent(self, renderer)*

Get the axes bounding box in display space.

The bounding box' width and height are nonnegative.

Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

`get_zorder(self)`

Return the artist's zorder.

`have_units(self)`

Return *True* if units are set on the x or y axes.

`is_transform_set(self)`

Return whether the Artist has an explicitly set transform.

This is *True* after *set\_transform* has been called.

`mouseover`

`pchanged(self)`

Call all of the registered callbacks.

This function is triggered internally when a property is changed.

**See also:**

*add\_callback*

*remove\_callback*

`pick(self, mouseevent)`

Process a pick event.

Each child artist will fire a pick event if *mouseevent* is over the artist and the artist has picker set.

**See also:**

*set\_picker, get\_picker, pickable*

`pickable(self)`

Return whether the artist is pickable.

**See also:**

*set\_picker, get\_picker, pick*

`properties(self)`

Return a dictionary of all the properties of the artist.

`remove(self)`

Remove the artist from the figure if possible.

The effect will not be visible until the figure is redrawn, e.g., with *FigureCanvasBase.draw\_idle*. Call *relim* to update the axes limits if desired.

Note: *relim* will not see collections even if the collection was added to the axes with *autolim = True*.

Note: there is no support for removing the artist's legend entry.

`remove_callback(self, oid)`

Remove a callback based on its observer id.

**See also:**

`add_callback`

`set(self, **kwargs)`

A property batch setter. Pass *kwargs* to set properties.

`set_aa(self, aa)`

Alias for `set_antialiased`.

`set_agg_filter(self, filter_func)`

Set the agg filter.

**Parameters**

**filter\_func** [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

`set_alpha(self, alpha)`

Set the alpha transparencies of the collection.

**Parameters**

**alpha** [float or None]

`set_animated(self, b)`

Set the artist's animation state.

**Parameters**

**b** [bool]

`set_antialiased(self, aa)`

Set the antialiasing state for rendering.

**Parameters**

**aa** [bool or sequence of bools]

`set_antialiaseds(self, aa)`

Alias for `set_antialiased`.

`set_array(self, A)`

Set the image array from numpy array *A*.

**Parameters**

**A** [ndarray]

`set_capstyle(self, cs)`

Set the capstyle for the collection (for all its elements).

**Parameters**

**cs** [{'butt', 'round', 'projecting'}] The capstyle

`set_clim(self, vmin=None, vmax=None)`

set the norm limits for image scaling; if *vmin* is a length2 sequence, interpret it as (*vmin*, *vmax*) which is used to support setp

ACCEPTS: a length 2 sequence of floats; may be overridden in methods that have `vmin` and `vmax` kwargs.

`set_clip_box(self, clipbox)`  
Set the artist's clip *Bbox*.

#### Parameters

**clipbox** [*Bbox*]

`set_clip_on(self, b)`  
Set whether the artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

#### Parameters

**b** [bool]

`set_clip_path(self, path, transform=None)`  
Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- None, to remove a previously set clipping path.

For efficiency, if the path happens to be an axis-aligned rectangle, this method will set the clipping box to the corresponding rectangle and set the clipping path to None.

ACCEPTS: [(*Path*, *Transform*) | *Patch* | None]

`set_cmap(self, cmap)`  
set the colormap for luminance data

#### Parameters

**cmap** [colormap or registered colormap name]

`set_color(self, c)`  
Set both the edgecolor and the facecolor.

#### Parameters

**c** [color or sequence of rgba tuples]

#### See also:

`Collection.set_facecolor`, `Collection.set_edgecolor` For setting the edge or face color individually.

`set_contains(self, picker)`  
Define a custom contains test for the artist.

The provided callable replaces the default *contains* method of the artist.

#### Parameters

**picker** [callable] A custom picker function to evaluate if an event is within the artist. The function must have the signature:

```
def contains(artist: Artist, event: MouseEvent) -> bool, dict
```

that returns:

- a bool indicating if the event is within the artist
- a dict of additional information. The dict should at least return the same information as the default `contains()` implementation of the respective artist, but may provide additional information.

`set_dashes(self, ls)`  
Alias for `set_linestyle`.

`set_ec(self, c)`  
Alias for `set_edgecolor`.

`set_edgecolor(self, c)`  
Set the edgecolor(s) of the collection.

#### Parameters

**c** [color or sequence of colors or 'face'] The collection edgecolor(s). If a sequence, the patches cycle through it. If 'face', match the facecolor.

`set_edgecolors(self, c)`  
Alias for `set_edgecolor`.

`set_facecolor(self, c)`  
Set the facecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; if it is a sequence the patches will cycle through the sequence.

If *c* is 'none', the patch will not be filled.

#### Parameters

**c** [color or sequence of colors]

`set_facecolors(self, c)`  
Alias for `set_facecolor`.

`set_fc(self, c)`  
Alias for `set_facecolor`.

`set_figure(self, fig)`  
Set the *Figure* instance the artist belongs to.

#### Parameters

**fig** [*Figure*]

`set_gid(self, gid)`  
Set the (group) id for the artist.

#### Parameters

**gid** [str]

`set_hatch(self, hatch)`  
Set the hatching pattern

*hatch* can be one of:

```

/ - diagonal hatching
\ - back diagonal
| - vertical
- - horizontal
+ - crossed
x - crossed diagonal
o - small circle
O - large circle
. - dots
* - stars

```

Letters can be combined, in which case all the specified hatchings are done. If same letter repeats, it increases the density of hatching of that pattern.

Hatching is supported in the PostScript, PDF, SVG and Agg backends only.

Unlike other properties such as linewidth and colors, hatching can only be specified for the collection as a whole, not separately for each member.

### Parameters

**hatch** [{'/', '\\', '|', '-', '+', 'x', 'o', 'O', '.', '\*'}]

`set_in_layout(self, in_layout)`

Set if artist is to be included in layout calculations, E.g. *Constrained Layout Guide*, *Figure.tight\_layout()*, and `fig.savefig(fname, bbox_inches='tight')`.

### Parameters

**in\_layout** [bool]

`set_joinstyle(self, js)`

Set the joinstyle for the collection (for all its elements).

### Parameters

**js** [{'miter', 'round', 'bevel'}] The joinstyle

`set_label(self, s)`

Set a label that will be displayed in the legend.

### Parameters

**s** [object] *s* will be converted to a string by calling `str`.

`set_linestyle(self, ls)`

Set the linestyle(s) for the collection.

linestyle	description
'-' or 'solid'	solid line
'--' or 'dashed'	dashed line
'-.' or 'dashdot'	dash-dotted line
':' or 'dotted'	dotted line

Alternatively a dash tuple of the following form can be provided:

```
(offset, onoffseq),
```

where `onoffseq` is an even length tuple of on and off ink in points.

**Parameters**

**ls** [{'-', '-', '-.', ':', ', ', (offset, on-off-seq), ...}] The line style.

`set_linestyles(self, ls)`

Alias for `set_linestyle`.

`set_linewidth(self, lw)`

Set the linewidth(s) for the collection. `lw` can be a scalar or a sequence; if it is a sequence the patches will cycle through the sequence

**Parameters**

**lw** [float or sequence of floats]

`set_linewidths(self, lw)`

Alias for `set_linewidth`.

`set_ls(self, ls)`

Alias for `set_linestyle`.

`set_lw(self, lw)`

Alias for `set_linewidth`.

`set_norm(self, norm)`

Set the normalization instance.

**Parameters**

**norm** [*Normalize*]

**Notes**

If there are any colorbars using the mappable for this norm, setting the norm of the mappable will reset the norm, locator, and formatters on the colorbar to default.

`set_offset_position(self, offset_position)`

Set how offsets are applied. If `offset_position` is 'screen' (default) the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If `offset_position` is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

**Parameters**

**offset\_position** [{'screen', 'data'}]

`set_offsets(self, offsets)`

Set the offsets for the collection.

**Parameters**

**offsets** [float or sequence of floats]

`set_path_effects(self, path_effects)`

Set the path effects.

**Parameters**

**path\_effects** [*AbstractPathEffect*]

`set_paths(self)`

`set_picker(self, picker)`

Define the picking behavior of the artist.

**Parameters**

**picker** [None or bool or float or callable] This can be one of the following:

- *None*: Picking is disabled for this artist (default).
- A boolean: If *True* then picking will be enabled and the artist will fire a pick event if the mouse event is over the artist.
- A float: If *picker* is a number it is interpreted as an epsilon tolerance in points and the artist will fire off an event if it's data is within epsilon of the mouse event. For some artists like lines and patch collections, the artist may provide additional data to the pick event that is generated, e.g., the indices of the data within epsilon of the pick event
- A function: If *picker* is callable, it is a user supplied function which determines whether the artist is hit by the mouse event:

```
hit, props = picker(artist, mouseevent)
```

to determine the hit test. if the mouse event is over the artist, return *hit=True* and *props* is a dictionary of properties you want added to the `PickEvent` attributes.

`set_pickradius(self, pr)`

Set the pick radius used for containment tests.

**Parameters**

**d** [float] Pick radius, in points.

`set_rasterized(self, rasterized)`

Force rasterized (bitmap) drawing in vector backend output.

Defaults to *None*, which implies the backend's default behavior.

**Parameters**

**rasterized** [bool or *None*]

`set_sketch_params(self, scale=None, length=None, randomness=None)`

Sets the sketch parameters.

**Parameters**

**scale** [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If *scale* is *None*, or not provided, no sketch filter will be provided.

**length** [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

**randomness** [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

`set_snap(self, snap)`

Set the snapping behavior.

Snapping aligns positions with the pixel grid, which results in clearer images. For example, if a black line of 1px width was defined at a position in between two pixels, the resulting image would contain the interpolated value of that line in the pixel grid, which would be a grey value on both adjacent pixel positions. In contrast, snapping

will move the line to the nearest integer pixel value, so that the resulting image will really contain a 1px wide black line.

Snapping is currently only supported by the Agg and MacOSX backends.

#### Parameters

**snap** [bool or None] Possible values:

- *True*: Snap vertices to the nearest pixel center.
- *False*: Do not modify vertex positions.
- *None*: (auto) If the path contains only rectilinear line segments, round to the nearest pixel center.

`set_transform(self, t)`

Set the artist transform.

#### Parameters

**t** [*Transform*]

`set_url(self, url)`

Set the url for the artist.

#### Parameters

**url** [str]

`set_urls(self, urls)`

#### Parameters

**urls** [List[str] or None]

`set_visible(self, b)`

Set the artist's visibility.

#### Parameters

**b** [bool]

`set_zorder(self, level)`

Set the zorder for the artist. Artists with lower zorder values are drawn first.

#### Parameters

**level** [float]

`stale`

Whether the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

`sticky_edges`

x and y sticky edge lists for autoscaling.

When performing autoscaling, if a data limit coincides with a value in the corresponding `sticky_edges` list, then no margin will be added-the view limit "sticks" to the edge. A typical use case is histograms, where one usually expects no margin on the bottom edge (0) of the histogram.

This attribute cannot be assigned to; however, the x and y lists can be modified in place as needed.

## Examples

```
>>> artist.sticky_edges.x[:] = (xmin, xmax)
>>> artist.sticky_edges.y[:] = (ymin, ymax)
```

`to_rgba(self, x, alpha=None, bytes=False, norm=True)`

Return a normalized rgba array corresponding to *x*.

In the normal case, *x* is a 1-D or 2-D sequence of scalars, and the corresponding ndarray of rgba values will be returned, based on the *norm* and *colormap* set for this *ScalarMappable*.

There is one special case, for handling images that are already rgb or rgba, such as might have been read from an image file. If *x* is an ndarray with 3 dimensions, and the last dimension is either 3 or 4, then it will be treated as an rgb or rgba array, and no mapping will be done. The array can be uint8, or it can be floating point with values in the 0-1 range; otherwise a *ValueError* will be raised. If it is a masked array, the mask will be ignored. If the last dimension is 3, the *alpha* kwarg (defaulting to 1) will be used to fill in the transparency. If the last dimension is 4, the *alpha* kwarg is ignored; it does not replace the pre-existing alpha. A *ValueError* will be raised if the third dimension is other than 3 or 4.

In either case, if *bytes* is *False* (default), the rgba array will be floats in the 0-1 range; if it is *True*, the returned rgba array will be uint8 in the 0 to 255 range.

If *norm* is *False*, no normalization of the input data is performed, and it is assumed to be in the range (0-1).

`update(self, props)`

Update this artist's properties from the dictionary *props*.

`update_from(self, other)`

copy properties from other to self

`update_scalarmappable(self)`

Update colors from the scalar mappable array, if it is not None.

`zorder = 0`

```
class matplotlib.collections.RegularPolyCollection(numsides, rotation=0, sizes=(1, ),
                                                  **kwargs)
```

Bases: `matplotlib.collections._CollectionWithSizes`

Draw a collection of regular polygons with *numsides*.

***numsides*** the number of sides of the polygon

***rotation*** the rotation of the polygon in radians

***sizes*** gives the area of the circle circumscribing the regular polygon in  $\text{points}^2$

Valid Collection keyword arguments:

- *edgecolors*: None
- *facecolors*: None
- *linewidths*: None
- *antialiaseds*: None
- *offsets*: None
- *transOffset*: `transforms.IdentityTransform()`

- *norm*: None (optional for *matplotlib.cm.ScalarMappable*)
- *cmap*: None (optional for *matplotlib.cm.ScalarMappable*)

*offsets* and *transOffset* are used to translate the patch after rendering (default no offsets)

If any of *edgecolors*, *facecolors*, *linewidths*, *antialiaseds* are None, they default to their *matplotlib.rcParams* patch setting, in sequence form.

Example: see `/gallery/event_handling/lasso_demo` for a complete example:

```
offsets = np.random.rand(20,2)
facecolors = [cm.jet(x) for x in np.random.rand(20)]
black = (0,0,0,1)

collection = RegularPolyCollection(
    numsides=5, # a pentagon
    rotation=0, sizes=(50,),
    facecolors=facecolors,
    edgecolors=(black,),
    linewidths=(1,),
    offsets=offsets,
    transOffset=ax.transData,
)
```

`add_callback(self, func)`

Add a callback function that will be called whenever one of the *Artist*'s properties changes.

#### Parameters

**func** [callable] The callback function. It must have the signature:

```
def func(artist: Artist) -> Any
```

where *artist* is the calling *Artist*. Return values may exist but are ignored.

#### Returns

**oid** [int] The observer id associated with the callback. This id can be used for removing the callback with *remove\_callback* later.

#### See also:

*remove\_callback*

`add_checker(self, checker)`

Add an entry to a dictionary of boolean flags that are set to True when the mappable is changed.

*aname*

`autoscale(self)`

Autoscale the scalar limits on the norm instance using the current array

`autoscale_None(self)`

Autoscale the scalar limits on the norm instance using the current array, changing only limits that are None

**axes**

The *Axes* instance the artist resides in, or *None*.

**changed(*self*)**

Call this whenever the mappable is changed to notify all the callbackSM listeners to the 'changed' signal

**check\_update(*self*, *checker*)**

If mappable has changed since the last check, return True; else return False

**contains(*self*, *mouseevent*)**

Test whether the mouse event occurred in the collection.

Returns bool, dict(ind=itemlist), where every item in itemlist contains the event.

**convert\_xunits(*self*, *x*)**

Convert *x* using the unit type of the xaxis.

If the artist is not in contained in an Axes or if the xaxis does not have units, *x* itself is returned.

**convert\_yunits(*self*, *y*)**

Convert *y* using the unit type of the yaxis.

If the artist is not in contained in an Axes or if the yaxis does not have units, *y* itself is returned.

**draw(*self*, *renderer*)**

Draw the Artist using the given renderer.

This method will be overridden in the Artist subclasses. Typically, it is implemented to not have any effect if the Artist is not visible (*Artist.get\_visible* is *False*).

### Parameters

**renderer** [*RendererBase* subclass.]

**findobj(*self*, *match=None*, *include\_self=True*)**

Find artist objects.

Recursively find all *Artist* instances contained in the artist.

### Parameters

**match** A filter criterion for the matches. This can be

- *None*: Return all objects contained in artist.
- A function with signature `def match(artist: Artist) -> bool`. The result will only contain artists for which the function returns *True*.
- A class instance: e.g., *Line2D*. The result will only contain artists of this class or its subclasses (isinstance check).

**include\_self** [bool] Include *self* in the list to be checked for a match.

### Returns

**artists** [list of *Artist*]

**format\_cursor\_data(*self*, *data*)**

Return a string representation of *data*.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

The default implementation converts ints and floats and arrays of ints and floats into a comma-separated string enclosed in square brackets.

**See also:**

*get\_cursor\_data*

`get_agg_filter(self)`

Return filter function to be used for agg filter.

`get_alpha(self)`

Return the alpha value used for blending - not supported on all backends

`get_animated(self)`

Return the animated state.

`get_array(self)`

Return the array

`get_capstyle(self)`

`get_children(self)`

Return a list of the child *Artists* of this *Artist*.

`get_clim(self)`

return the min, max of the color limits for image scaling

`get_clip_box(self)`

Return the clipbox.

`get_clip_on(self)`

Return whether the artist uses clipping.

`get_clip_path(self)`

Return the clip path.

`get_cmap(self)`

return the colormap

`get_contains(self)`

Return the custom contains function of the artist if set, or *None*.

**See also:**

*set\_contains*

`get_cursor_data(self, event)`

Return the cursor data for a given event.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

Cursor data can be used by Artists to provide additional context information for a given event. The default implementation just returns *None*.

Subclasses can override the method and return arbitrary data. However, when doing so, they must ensure that `format_cursor_data` can convert the data to a string representation.

The only current use case is displaying the z-value of an `AxesImage` in the status bar of a plot window, while moving the mouse.

### Parameters

**event** [`matplotlib.backend_bases.MouseEvent`]

### See also:

`format_cursor_data`

`get_dashes(self)`

Alias for `get_linestyle`.

`get_dataLim(self, transData)`

`get_ec(self)`

Alias for `get_edgecolor`.

`get_edgecolor(self)`

`get_edgecolors(self)`

Alias for `get_edgecolor`.

`get_facecolor(self)`

`get_facecolors(self)`

Alias for `get_facecolor`.

`get_fc(self)`

Alias for `get_facecolor`.

`get_figure(self)`

Return the `Figure` instance the artist belongs to.

`get_fill(self)`

return whether fill is set

`get_gid(self)`

Return the group id.

`get_hatch(self)`

Return the current hatching pattern.

`get_in_layout(self)`

Return boolean flag, True if artist is included in layout calculations.

E.g. *Constrained Layout Guide*, `Figure.tight_layout()`, and `fig.savefig(fname, bbox_inches='tight')`.

`get_joinstyle(self)`

`get_label(self)`

Return the label used for this artist in the legend.

`get_linestyle(self)`

`get_linestyles(self)`

Alias for `get_linestyle`.

`get_linewidth(self)`

`get_linewidths(self)`

Alias for `get_linewidth`.

`get_ls(self)`

Alias for `get_linestyle`.

`get_lw(self)`

Alias for `get_linewidth`.

`get_numsides(self)`

`get_offset_position(self)`

Returns how offsets are applied for the collection. If `offset_position` is 'screen', the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If `offset_position` is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

`get_offset_transform(self)`

`get_offsets(self)`

Return the offsets for the collection.

`get_path_effects(self)`

`get_paths(self)`

`get_picker(self)`

Return the picking behavior of the artist.

The possible values are described in `set_picker`.

**See also:**

`set_picker`, `pickable`, `pick`

`get_pickradius(self)`

`get_rasterized(self)`

Return whether the artist is to be rasterized.

`get_rotation(self)`

`get_sizes(self)`

Returns the sizes of the elements in the collection. The value represents the 'area' of the element.

**Returns**

**sizes** [array] The 'area' of each element.

`get_sketch_params(self)`

Returns the sketch parameters for the artist.

**Returns**

**sketch\_params** [tuple or None] A 3-tuple with the following elements:

- *scale*: The amplitude of the wiggle perpendicular to the source line.
- *length*: The length of the wiggle along the line.
- *randomness*: The scale factor by which the length is shrunken or expanded.

Returns *None* if no sketch parameters were set.

`get_snap(self)`

Returns the snap setting.

See `set_snap` for details.

`get_tightbbox(self, renderer)`

Like `Artist.get_window_extent`, but includes any clipping.

### Parameters

**renderer** [*RendererBase* instance] renderer that will be used to draw the figures (i.e. `fig.canvas.get_renderer()`)

### Returns

**bbbox** [*BBox*] The enclosing bounding box (in figure pixel co-ordinates).

`get_transform(self)`

Return the *Transform* instance used by this artist.

`get_transformed_clip_path_and_affine(self)`

Return the clip path with the non-affine part of its transformation applied, and the remaining affine part of its transformation.

`get_transforms(self)`

`get_url(self)`

Return the url.

`get_urls(self)`

`get_visible(self)`

Return the visibility.

`get_window_extent(self, renderer)`

Get the axes bounding box in display space.

The bounding box' width and height are nonnegative.

Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

`get_zorder(self)`

Return the artist's zorder.

`have_units(self)`

Return *True* if units are set on the x or y axes.

`is_transform_set(self)`

Return whether the Artist has an explicitly set transform.

This is *True* after `set_transform` has been called.

`mouseover`

`pchanged(self)`

Call all of the registered callbacks.

This function is triggered internally when a property is changed.

**See also:**

`add_callback`  
`remove_callback`

`pick(self, mouseevent)`

Process a pick event.

Each child artist will fire a pick event if *mouseevent* is over the artist and the artist has picker set.

**See also:**

`set_picker`, `get_picker`, `pickable`

`pickable(self)`

Return whether the artist is pickable.

**See also:**

`set_picker`, `get_picker`, `pick`

`properties(self)`

Return a dictionary of all the properties of the artist.

`remove(self)`

Remove the artist from the figure if possible.

The effect will not be visible until the figure is redrawn, e.g., with *FigureCanvasBase.draw\_idle*. Call *relim* to update the axes limits if desired.

Note: *relim* will not see collections even if the collection was added to the axes with *autolim* = True.

Note: there is no support for removing the artist's legend entry.

`remove_callback(self, oid)`

Remove a callback based on its observer id.

**See also:**

`add_callback`

`set(self, **kwargs)`

A property batch setter. Pass *kwargs* to set properties.

`set_aa(self, aa)`

Alias for *set\_antialiased*.

`set_agg_filter(self, filter_func)`

Set the agg filter.

**Parameters**

**filter\_func** [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

`set_alpha(self, alpha)`

Set the alpha transparencies of the collection.

**Parameters**

**alpha** [float or None]

`set_animated(self, b)`  
Set the artist's animation state.

**Parameters**

**b** [bool]

`set_antialiased(self, aa)`  
Set the antialiasing state for rendering.

**Parameters**

**aa** [bool or sequence of bools]

`set_antialiaseds(self, aa)`  
Alias for `set_antialiased`.

`set_array(self, A)`  
Set the image array from numpy array *A*.

**Parameters**

**A** [ndarray]

`set_capstyle(self, cs)`  
Set the capstyle for the collection (for all its elements).

**Parameters**

**cs** [{'butt', 'round', 'projecting'}] The capstyle

`set_clim(self, vmin=None, vmax=None)`  
set the norm limits for image scaling; if *vmin* is a length2 sequence, interpret it as (*vmin*, *vmax*) which is used to support `setp`

ACCEPTS: a length 2 sequence of floats; may be overridden in methods that have *vmin* and *vmax* kwargs.

`set_clip_box(self, clipbox)`  
Set the artist's clip *Bbox*.

**Parameters**

**clipbox** [*Bbox*]

`set_clip_on(self, b)`  
Set whether the artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

**Parameters**

**b** [bool]

`set_clip_path(self, path, transform=None)`  
Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- None, to remove a previously set clipping path.

For efficiency, if the path happens to be an axis-aligned rectangle, this method will set the clipping box to the corresponding rectangle and set the clipping path to `None`.

ACCEPTS: [(*Path*, *Transform*) | *Patch* | *None*]

`set_cmap(self, cmap)`  
set the colormap for luminance data

#### Parameters

**cmap** [colormap or registered colormap name]

`set_color(self, c)`  
Set both the edgecolor and the facecolor.

#### Parameters

**c** [color or sequence of rgba tuples]

#### See also:

`Collection.set_facecolor`, `Collection.set_edgecolor` For setting the edge or face color individually.

`set_contains(self, picker)`  
Define a custom contains test for the artist.

The provided callable replaces the default `contains` method of the artist.

#### Parameters

**picker** [callable] A custom picker function to evaluate if an event is within the artist. The function must have the signature:

```
def contains(artist: Artist, event: MouseEvent) -> bool, dict
```

that returns:

- a bool indicating if the event is within the artist
- a dict of additional information. The dict should at least return the same information as the default `contains()` implementation of the respective artist, but may provide additional information.

`set_dashes(self, ls)`  
Alias for `set_linestyle`.

`set_ec(self, c)`  
Alias for `set_edgecolor`.

`set_edgecolor(self, c)`  
Set the edgecolor(s) of the collection.

#### Parameters

**c** [color or sequence of colors or 'face'] The collection edgecolor(s). If a sequence, the patches cycle through it. If 'face', match the facecolor.

`set_edgecolors(self, c)`  
Alias for `set_edgecolor`.

`set_facecolor(self, c)`  
Set the facecolor(s) of the collection. `c` can be a matplotlib color spec (all patches

have same color), or a sequence of specs; if it is a sequence the patches will cycle through the sequence.

If *c* is 'none', the patch will not be filled.

#### Parameters

**c** [color or sequence of colors]

`set_facecolors(self, c)`  
Alias for `set_facecolor`.

`set_fc(self, c)`  
Alias for `set_facecolor`.

`set_figure(self, fig)`  
Set the *Figure* instance the artist belongs to.

#### Parameters

**fig** [*Figure*]

`set_gid(self, gid)`  
Set the (group) id for the artist.

#### Parameters

**gid** [str]

`set_hatch(self, hatch)`  
Set the hatching pattern

*hatch* can be one of:

```

/ - diagonal hatching
\ - back diagonal
| - vertical
- - horizontal
+ - crossed
x - crossed diagonal
o - small circle
O - large circle
. - dots
* - stars

```

Letters can be combined, in which case all the specified hatchings are done. If same letter repeats, it increases the density of hatching of that pattern.

Hatching is supported in the PostScript, PDF, SVG and Agg backends only.

Unlike other properties such as linewidth and colors, hatching can only be specified for the collection as a whole, not separately for each member.

#### Parameters

**hatch** [{'/', '\\', '|', '-', '+', 'x', 'o', 'O', '.', '\*'}]

`set_in_layout(self, in_layout)`  
Set if artist is to be included in layout calculations, E.g. *Constrained Layout Guide*, `Figure.tight_layout()`, and `fig.savefig(fname, bbox_inches='tight')`.

#### Parameters

**in\_layout** [bool]

`set_joinstyle(self, js)`  
Set the joinstyle for the collection (for all its elements).

**Parameters**

**js** [{'miter', 'round', 'bevel'}] The joinstyle

`set_label(self, s)`  
Set a label that will be displayed in the legend.

**Parameters**

**s** [object] *s* will be converted to a string by calling `str`.

`set_linestyle(self, ls)`  
Set the linestyle(s) for the collection.

linestyle	description
'-' or 'solid'	solid line
'--' or 'dashed'	dashed line
'-.' or 'dashdot'	dash-dotted line
':' or 'dotted'	dotted line

Alternatively a dash tuple of the following form can be provided:

```
(offset, onoffseq),
```

where `onoffseq` is an even length tuple of on and off ink in points.

**Parameters**

**ls** [{'-', '-', '-.', ':', ', (offset, on-off-seq), ...}] The line style.

`set_linestyles(self, ls)`  
Alias for `set_linestyle`.

`set_linewidth(self, lw)`  
Set the linewidth(s) for the collection. `lw` can be a scalar or a sequence; if it is a sequence the patches will cycle through the sequence

**Parameters**

**lw** [float or sequence of floats]

`set_linewidths(self, lw)`  
Alias for `set_linewidth`.

`set_ls(self, ls)`  
Alias for `set_linestyle`.

`set_lw(self, lw)`  
Alias for `set_linewidth`.

`set_norm(self, norm)`  
Set the normalization instance.

**Parameters**

**norm** [*Normalize*]

**Notes**

If there are any colorbars using the mappable for this norm, setting the norm of the mappable will reset the norm, locator, and formatters on the colorbar to default.

`set_offset_position(self, offset_position)`

Set how offsets are applied. If `offset_position` is 'screen' (default) the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If `offset_position` is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

**Parameters**

**offset\_position** [{'screen', 'data'}]

`set_offsets(self, offsets)`

Set the offsets for the collection.

**Parameters**

**offsets** [float or sequence of floats]

`set_path_effects(self, path_effects)`

Set the path effects.

**Parameters**

**path\_effects** [*AbstractPathEffect*]

`set_paths(self)`

`set_picker(self, picker)`

Define the picking behavior of the artist.

**Parameters**

**picker** [None or bool or float or callable] This can be one of the following:

- *None*: Picking is disabled for this artist (default).
- A boolean: If *True* then picking will be enabled and the artist will fire a pick event if the mouse event is over the artist.
- A float: If `picker` is a number it is interpreted as an epsilon tolerance in points and the artist will fire off an event if it's data is within epsilon of the mouse event. For some artists like lines and patch collections, the artist may provide additional data to the pick event that is generated, e.g., the indices of the data within epsilon of the pick event
- A function: If `picker` is callable, it is a user supplied function which determines whether the artist is hit by the mouse event:

```
hit, props = picker(artist, mouseevent)
```

to determine the hit test. if the mouse event is over the artist, return `hit=True` and `props` is a dictionary of properties you want added to the `PickEvent` attributes.

`set_pickradius(self, pr)`

Set the pick radius used for containment tests.

**Parameters**

**d** [float] Pick radius, in points.

`set_rasterized(self, rasterized)`

Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

#### Parameters

**rasterized** [bool or None]

`set_sizes(self, sizes, dpi=72.0)`

Set the sizes of each member of the collection.

#### Parameters

**sizes** [ndarray or None] The size to set for each element of the collection. The value is the 'area' of the element.

**dpi** [float] The dpi of the canvas. Defaults to 72.0.

`set_sketch_params(self, scale=None, length=None, randomness=None)`

Sets the sketch parameters.

#### Parameters

**scale** [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

**length** [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

**randomness** [float, optional] The scale factor by which the length is shrunk or expanded (default 16.0)

`set_snap(self, snap)`

Set the snapping behavior.

Snapping aligns positions with the pixel grid, which results in clearer images. For example, if a black line of 1px width was defined at a position in between two pixels, the resulting image would contain the interpolated value of that line in the pixel grid, which would be a grey value on both adjacent pixel positions. In contrast, snapping will move the line to the nearest integer pixel value, so that the resulting image will really contain a 1px wide black line.

Snapping is currently only supported by the Agg and MacOSX backends.

#### Parameters

**snap** [bool or None] Possible values:

- *True*: Snap vertices to the nearest pixel center.
- *False*: Do not modify vertex positions.
- *None*: (auto) If the path contains only rectilinear line segments, round to the nearest pixel center.

`set_transform(self, t)`

Set the artist transform.

#### Parameters

**t** [*Transform*]

`set_url(self, url)`  
Set the url for the artist.

**Parameters**

**url** [str]

`set_urls(self, urls)`

**Parameters**

**urls** [List[str] or None]

`set_visible(self, b)`  
Set the artist's visibility.

**Parameters**

**b** [bool]

`set_zorder(self, level)`  
Set the zorder for the artist. Artists with lower zorder values are drawn first.

**Parameters**

**level** [float]

`stale`  
Whether the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

`sticky_edges`  
x and y sticky edge lists for autoscaling.

When performing autoscaling, if a data limit coincides with a value in the corresponding `sticky_edges` list, then no margin will be added—the view limit “sticks” to the edge. A typical use case is histograms, where one usually expects no margin on the bottom edge (0) of the histogram.

This attribute cannot be assigned to; however, the x and y lists can be modified in place as needed.

**Examples**

```
>>> artist.sticky_edges.x[:] = (xmin, xmax)
>>> artist.sticky_edges.y[:] = (ymin, ymax)
```

`to_rgba(self, x, alpha=None, bytes=False, norm=True)`  
Return a normalized rgba array corresponding to x.

In the normal case, x is a 1-D or 2-D sequence of scalars, and the corresponding ndarray of rgba values will be returned, based on the `norm` and `colormap` set for this `ScalarMappable`.

There is one special case, for handling images that are already rgb or rgba, such as might have been read from an image file. If x is an ndarray with 3 dimensions, and the last dimension is either 3 or 4, then it will be treated as an rgb or rgba array, and no mapping will be done. The array can be `uint8`, or it can be floating point with values in the 0-1 range; otherwise a `ValueError` will be raised. If it is a masked array, the mask will be ignored. If the last dimension is 3, the `alpha` kwarg (defaulting to 1) will be used to fill in the transparency. If the last dimension is 4, the `alpha` kwarg

is ignored; it does not replace the pre-existing alpha. A `ValueError` will be raised if the third dimension is other than 3 or 4.

In either case, if `bytes` is `False` (default), the `rgba` array will be floats in the 0-1 range; if it is `True`, the returned `rgba` array will be `uint8` in the 0 to 255 range.

If `norm` is `False`, no normalization of the input data is performed, and it is assumed to be in the range (0-1).

`update(self, props)`

Update this artist's properties from the dictionary `props`.

`update_from(self, other)`

copy properties from `other` to `self`

`update_scalarmappable(self)`

Update colors from the scalar mappable array, if it is not `None`.

`zorder = 0`

```
class matplotlib.collections.StarPolygonCollection(numsides, rotation=0, sizes=(1, ),
                                                  **kwargs)
```

Bases: `matplotlib.collections.RegularPolyCollection`

Draw a collection of regular stars with `numsides` points.

**`numsides`** the number of sides of the polygon

**`rotation`** the rotation of the polygon in radians

**`sizes`** gives the area of the circle circumscribing the regular polygon in `points^2`

Valid Collection keyword arguments:

- `edgecolors`: `None`
- `facecolors`: `None`
- `linewidths`: `None`
- `antialiaseds`: `None`
- `offsets`: `None`
- `transOffset`: `transforms.IdentityTransform()`
- `norm`: `None` (optional for `matplotlib.cm.ScalarMappable`)
- `cmap`: `None` (optional for `matplotlib.cm.ScalarMappable`)

`offsets` and `transOffset` are used to translate the patch after rendering (default no offsets)

If any of `edgecolors`, `facecolors`, `linewidths`, `antialiaseds` are `None`, they default to their `matplotlib.rcParams` patch setting, in sequence form.

Example: see `/gallery/event_handling/lasso_demo` for a complete example:

```
offsets = np.random.rand(20,2)
facecolors = [cm.jet(x) for x in np.random.rand(20)]
black = (0,0,0,1)

collection = RegularPolyCollection(
    numsides=5, # a pentagon
    rotation=0, sizes=(50,)
```

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```

facecolors=facecolors,
edgecolors=(black,),
linewidths=(1,),
offsets=offsets,
transOffset=ax.transData,
)

```

`add_callback(self, func)`

Add a callback function that will be called whenever one of the *Artist*'s properties changes.

### Parameters

**func** [callable] The callback function. It must have the signature:

```
def func(artist: Artist) -> Any
```

where *artist* is the calling *Artist*. Return values may exist but are ignored.

### Returns

**oid** [int] The observer id associated with the callback. This id can be used for removing the callback with `remove_callback` later.

### See also:

`remove_callback`

`add_checker(self, checker)`

Add an entry to a dictionary of boolean flags that are set to True when the mappable is changed.

`aname`

`autoscale(self)`

Autoscale the scalar limits on the norm instance using the current array

`autoscale_None(self)`

Autoscale the scalar limits on the norm instance using the current array, changing only limits that are None

`axes`

The *Axes* instance the artist resides in, or *None*.

`changed(self)`

Call this whenever the mappable is changed to notify all the callbackSM listeners to the 'changed' signal

`check_update(self, checker)`

If mappable has changed since the last check, return True; else return False

`contains(self, mouseevent)`

Test whether the mouse event occurred in the collection.

Returns bool, dict(ind=itemlist), where every item in itemlist contains the event.

`convert_xunits(self, x)`

Convert *x* using the unit type of the xaxis.

If the artist is not contained in an Axes or if the xaxis does not have units, `x` itself is returned.

`convert_yunits(self, y)`

Convert `y` using the unit type of the yaxis.

If the artist is not contained in an Axes or if the yaxis does not have units, `y` itself is returned.

`draw(self, renderer)`

Draw the Artist using the given renderer.

This method will be overridden in the Artist subclasses. Typically, it is implemented to not have any effect if the Artist is not visible (`Artist.get_visible` is `False`).

### Parameters

**renderer** [*RendererBase* subclass.]

`findobj(self, match=None, include_self=True)`

Find artist objects.

Recursively find all *Artist* instances contained in the artist.

### Parameters

**match** A filter criterion for the matches. This can be

- *None*: Return all objects contained in artist.
- A function with signature `def match(artist: Artist) -> bool`. The result will only contain artists for which the function returns *True*.
- A class instance: e.g., *Line2D*. The result will only contain artists of this class or its subclasses (`isinstance` check).

**include\_self** [bool] Include *self* in the list to be checked for a match.

### Returns

**artists** [list of *Artist*]

`format_cursor_data(self, data)`

Return a string representation of *data*.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

The default implementation converts ints and floats and arrays of ints and floats into a comma-separated string enclosed in square brackets.

### See also:

`get_cursor_data`

`get_agg_filter(self)`

Return filter function to be used for agg filter.

`get_alpha(self)`

Return the alpha value used for blending - not supported on all backends

`get_animated(self)`

Return the animated state.

`get_array(self)`  
Return the array

`get_capstyle(self)`

`get_children(self)`  
Return a list of the child *Artists* of this *Artist*.

`get_clim(self)`  
return the min, max of the color limits for image scaling

`get_clip_box(self)`  
Return the clipbox.

`get_clip_on(self)`  
Return whether the artist uses clipping.

`get_clip_path(self)`  
Return the clip path.

`get_cmap(self)`  
return the colormap

`get_contains(self)`  
Return the custom contains function of the artist if set, or *None*.

**See also:**

`set_contains`

`get_cursor_data(self, event)`  
Return the cursor data for a given event.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

Cursor data can be used by Artists to provide additional context information for a given event. The default implementation just returns *None*.

Subclasses can override the method and return arbitrary data. However, when doing so, they must ensure that `format_cursor_data` can convert the data to a string representation.

The only current use case is displaying the z-value of an *AxesImage* in the status bar of a plot window, while moving the mouse.

#### Parameters

**event** [`matplotlib.backend_bases.MouseEvent`]

#### See also:

`format_cursor_data`

`get_dashes(self)`  
Alias for `get_linestyle`.

`get_datalim(self, transData)`

`get_ec(self)`  
Alias for `get_edgecolor`.

`get_edgecolor(self)`

`get_edgecolors(self)`  
Alias for `get_edgecolor`.

`get_facecolor(self)`

`get_facecolors(self)`  
Alias for `get_facecolor`.

`get_fc(self)`  
Alias for `get_facecolor`.

`get_figure(self)`  
Return the *Figure* instance the artist belongs to.

`get_fill(self)`  
return whether fill is set

`get_gid(self)`  
Return the group id.

`get_hatch(self)`  
Return the current hatching pattern.

`get_in_layout(self)`  
Return boolean flag, True if artist is included in layout calculations.  
  
E.g. *Constrained Layout Guide*, `Figure.tight_layout()`, and `fig.savefig(fname, bbox_inches='tight')`.

`get_joinstyle(self)`

`get_label(self)`  
Return the label used for this artist in the legend.

`get_linestyle(self)`

`get_linestyles(self)`  
Alias for `get_linestyle`.

`get_linewidth(self)`

`get_linewidths(self)`  
Alias for `get_linewidth`.

`get_ls(self)`  
Alias for `get_linestyle`.

`get_lw(self)`  
Alias for `get_linewidth`.

`get_numsides(self)`

`get_offset_position(self)`  
Returns how offsets are applied for the collection. If `offset_position` is 'screen', the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If `offset_position` is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

`get_offset_transform(self)`

`get_offsets(self)`  
Return the offsets for the collection.

`get_path_effects(self)`

`get_paths(self)`

`get_picker(self)`

Return the picking behavior of the artist.

The possible values are described in `set_picker`.

**See also:**

`set_picker`, `pickable`, `pick`

`get_pickradius(self)`

`get_rasterized(self)`

Return whether the artist is to be rasterized.

`get_rotation(self)`

`get_sizes(self)`

Returns the sizes of the elements in the collection. The value represents the 'area' of the element.

**Returns**

**sizes** [array] The 'area' of each element.

`get_sketch_params(self)`

Returns the sketch parameters for the artist.

**Returns**

**sketch\_params** [tuple or None] A 3-tuple with the following elements:

- *scale*: The amplitude of the wiggle perpendicular to the source line.
- *length*: The length of the wiggle along the line.
- *randomness*: The scale factor by which the length is shrunken or expanded.

Returns *None* if no sketch parameters were set.

`get_snap(self)`

Returns the snap setting.

See `set_snap` for details.

`get_tightbbox(self, renderer)`

Like `Artist.get_window_extent`, but includes any clipping.

**Parameters**

**renderer** [*RendererBase* instance] renderer that will be used to draw the figures (i.e. `fig.canvas.get_renderer()`)

**Returns**

**bbbox** [BBox] The enclosing bounding box (in figure pixel co-ordinates).

`get_transform(self)`

Return the *Transform* instance used by this artist.

`get_transformed_clip_path_and_affine(self)`  
Return the clip path with the non-affine part of its transformation applied, and the remaining affine part of its transformation.

`get_transforms(self)`

`get_url(self)`  
Return the url.

`get_urls(self)`

`get_visible(self)`  
Return the visibility.

`get_window_extent(self, renderer)`  
Get the axes bounding box in display space.  
  
The bounding box' width and height are nonnegative.  
  
Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.  
  
Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

`get_zorder(self)`  
Return the artist's zorder.

`have_units(self)`  
Return *True* if units are set on the x or y axes.

`is_transform_set(self)`  
Return whether the Artist has an explicitly set transform.  
  
This is *True* after `set_transform` has been called.

`mouseover`

`pchanged(self)`  
Call all of the registered callbacks.  
  
This function is triggered internally when a property is changed.  
  
**See also:**  
  
`add_callback`  
`remove_callback`

`pick(self, mouseevent)`  
Process a pick event.  
  
Each child artist will fire a pick event if *mouseevent* is over the artist and the artist has picker set.  
  
**See also:**  
  
`set_picker`, `get_picker`, `pickable`

`pickable(self)`

Return whether the artist is pickable.

**See also:**

`set_picker`, `get_picker`, `pick`

`properties(self)`

Return a dictionary of all the properties of the artist.

`remove(self)`

Remove the artist from the figure if possible.

The effect will not be visible until the figure is redrawn, e.g., with `FigureCanvasBase.draw_idle`. Call `relim` to update the axes limits if desired.

Note: `relim` will not see collections even if the collection was added to the axes with `autolim = True`.

Note: there is no support for removing the artist's legend entry.

`remove_callback(self, oid)`

Remove a callback based on its observer id.

**See also:**

`add_callback`

`set(self, **kwargs)`

A property batch setter. Pass `kwargs` to set properties.

`set_aa(self, aa)`

Alias for `set_antialiased`.

`set_agg_filter(self, filter_func)`

Set the agg filter.

**Parameters**

**filter\_func** [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

`set_alpha(self, alpha)`

Set the alpha transparencies of the collection.

**Parameters**

**alpha** [float or None]

`set_animated(self, b)`

Set the artist's animation state.

**Parameters**

**b** [bool]

`set_antialiased(self, aa)`

Set the antialiasing state for rendering.

**Parameters**

**aa** [bool or sequence of bools]

`set_antialiaseds(self, aa)`  
Alias for `set_antialiased`.

`set_array(self, A)`  
Set the image array from numpy array *A*.

**Parameters**

**A** [ndarray]

`set_capstyle(self, cs)`  
Set the capstyle for the collection (for all its elements).

**Parameters**

**cs** [{'butt', 'round', 'projecting'}] The capstyle

`set_clim(self, vmin=None, vmax=None)`  
set the norm limits for image scaling; if *vmin* is a length2 sequence, interpret it as (*vmin*, *vmax*) which is used to support `setp`

ACCEPTS: a length 2 sequence of floats; may be overridden in methods that have *vmin* and *vmax* kwargs.

`set_clip_box(self, clipbox)`  
Set the artist's clip *Bbox*.

**Parameters**

**clipbox** [*Bbox*]

`set_clip_on(self, b)`  
Set whether the artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

**Parameters**

**b** [bool]

`set_clip_path(self, path, transform=None)`  
Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- None, to remove a previously set clipping path.

For efficiency, if the path happens to be an axis-aligned rectangle, this method will set the clipping box to the corresponding rectangle and set the clipping path to None.

ACCEPTS: [(*Path*, *Transform*) | *Patch* | None]

`set_cmap(self, cmap)`  
set the colormap for luminance data

**Parameters**

**cmap** [colormap or registered colormap name]

`set_color(self, c)`  
Set both the edgecolor and the facecolor.

**Parameters**

**c** [color or sequence of rgba tuples]

**See also:**

`Collection.set_facecolor`, `Collection.set_edgecolor` For setting the edge or face color individually.

`set_contains(self, picker)`

Define a custom contains test for the artist.

The provided callable replaces the default `contains` method of the artist.

**Parameters**

**picker** [callable] A custom picker function to evaluate if an event is within the artist. The function must have the signature:

```
def contains(artist: Artist, event: MouseEvent) -> bool, dict
```

that returns:

- a bool indicating if the event is within the artist
- a dict of additional information. The dict should at least return the same information as the default `contains()` implementation of the respective artist, but may provide additional information.

`set_dashes(self, ls)`

Alias for `set_linestyle`.

`set_ec(self, c)`

Alias for `set_edgecolor`.

`set_edgecolor(self, c)`

Set the edgecolor(s) of the collection.

**Parameters**

**c** [color or sequence of colors or 'face'] The collection edgecolor(s). If a sequence, the patches cycle through it. If 'face', match the facecolor.

`set_edgecolors(self, c)`

Alias for `set_edgecolor`.

`set_facecolor(self, c)`

Set the facecolor(s) of the collection. `c` can be a matplotlib color spec (all patches have same color), or a sequence of specs; if it is a sequence the patches will cycle through the sequence.

If `c` is 'none', the patch will not be filled.

**Parameters**

**c** [color or sequence of colors]

`set_facecolors(self, c)`

Alias for `set_facecolor`.

`set_fc(self, c)`

Alias for `set_facecolor`.

`set_figure(self, fig)`

Set the `Figure` instance the artist belongs to.

**Parameters****fig** [*Figure*]`set_gid(self, gid)`

Set the (group) id for the artist.

**Parameters****gid** [str]`set_hatch(self, hatch)`

Set the hatching pattern

*hatch* can be one of:

```

/ - diagonal hatching
\ - back diagonal
| - vertical
- - horizontal
+ - crossed
x - crossed diagonal
o - small circle
O - large circle
. - dots
* - stars

```

Letters can be combined, in which case all the specified hatchings are done. If same letter repeats, it increases the density of hatching of that pattern.

Hatching is supported in the PostScript, PDF, SVG and Agg backends only.

Unlike other properties such as linewidth and colors, hatching can only be specified for the collection as a whole, not separately for each member.

**Parameters****hatch** [{'/', '\', '|', '-', '+', 'x', 'o', 'O', '.', '\*'}]`set_in_layout(self, in_layout)`Set if artist is to be included in layout calculations, E.g. *Constrained Layout Guide*, *Figure.tight\_layout()*, and `fig.savefig(fname, bbox_inches='tight')`.**Parameters****in\_layout** [bool]`set_joinstyle(self, js)`

Set the joinstyle for the collection (for all its elements).

**Parameters****js** [{'miter', 'round', 'bevel'}] The joinstyle`set_label(self, s)`

Set a label that will be displayed in the legend.

**Parameters****s** [object] *s* will be converted to a string by calling `str`.`set_linestyle(self, ls)`

Set the linestyle(s) for the collection.

linestyle	description
'-' or 'solid'	solid line
'--' or 'dashed'	dashed line
'-.' or 'dashdot'	dash-dotted line
':' or 'dotted'	dotted line

Alternatively a dash tuple of the following form can be provided:

```
(offset, onoffseq),
```

where `onoffseq` is an even length tuple of on and off ink in points.

### Parameters

**ls** [{'-', '-', '-.', ':', ''}, (offset, on-off-seq), ...] The line style.

`set_linestyles(self, ls)`

Alias for `set_linestyle`.

`set_linewidth(self, lw)`

Set the linewidth(s) for the collection. `lw` can be a scalar or a sequence; if it is a sequence the patches will cycle through the sequence

### Parameters

**lw** [float or sequence of floats]

`set_linewidths(self, lw)`

Alias for `set_linewidth`.

`set_ls(self, ls)`

Alias for `set_linestyle`.

`set_lw(self, lw)`

Alias for `set_linewidth`.

`set_norm(self, norm)`

Set the normalization instance.

### Parameters

**norm** [*Normalize*]

### Notes

If there are any colorbars using the mappable for this norm, setting the norm of the mappable will reset the norm, locator, and formatters on the colorbar to default.

`set_offset_position(self, offset_position)`

Set how offsets are applied. If `offset_position` is 'screen' (default) the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If `offset_position` is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

### Parameters

**offset\_position** [{'screen', 'data'}]

`set_offsets(self, offsets)`

Set the offsets for the collection.

**Parameters****offsets** [float or sequence of floats]`set_path_effects(self, path_effects)`  
Set the path effects.**Parameters****path\_effects** [*AbstractPathEffect*]`set_paths(self)``set_picker(self, picker)`  
Define the picking behavior of the artist.**Parameters****picker** [None or bool or float or callable] This can be one of the following:

- *None*: Picking is disabled for this artist (default).
- A boolean: If *True* then picking will be enabled and the artist will fire a pick event if the mouse event is over the artist.
- A float: If picker is a number it is interpreted as an epsilon tolerance in points and the artist will fire off an event if it's data is within epsilon of the mouse event. For some artists like lines and patch collections, the artist may provide additional data to the pick event that is generated, e.g., the indices of the data within epsilon of the pick event
- A function: If picker is callable, it is a user supplied function which determines whether the artist is hit by the mouse event:

`hit, props = picker(artist, mouseevent)`

to determine the hit test. if the mouse event is over the artist, return *hit=True* and props is a dictionary of properties you want added to the PickEvent attributes.

`set_pickradius(self, pr)`  
Set the pick radius used for containment tests.**Parameters****d** [float] Pick radius, in points.`set_rasterized(self, rasterized)`  
Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

**Parameters****rasterized** [bool or None]`set_sizes(self, sizes, dpi=72.0)`  
Set the sizes of each member of the collection.**Parameters****sizes** [ndarray or None] The size to set for each element of the collection.  
The value is the 'area' of the element.**dpi** [float] The dpi of the canvas. Defaults to 72.0.

`set_sketch_params(self, scale=None, length=None, randomness=None)`  
 Sets the sketch parameters.

#### Parameters

**scale** [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

**length** [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

**randomness** [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

`set_snap(self, snap)`  
 Set the snapping behavior.

Snapping aligns positions with the pixel grid, which results in clearer images. For example, if a black line of 1px width was defined at a position in between two pixels, the resulting image would contain the interpolated value of that line in the pixel grid, which would be a grey value on both adjacent pixel positions. In contrast, snapping will move the line to the nearest integer pixel value, so that the resulting image will really contain a 1px wide black line.

Snapping is currently only supported by the Agg and MacOSX backends.

#### Parameters

**snap** [bool or None] Possible values:

- *True*: Snap vertices to the nearest pixel center.
- *False*: Do not modify vertex positions.
- *None*: (auto) If the path contains only rectilinear line segments, round to the nearest pixel center.

`set_transform(self, t)`  
 Set the artist transform.

#### Parameters

**t** [*Transform*]

`set_url(self, url)`  
 Set the url for the artist.

#### Parameters

**url** [str]

`set_urls(self, urls)`

#### Parameters

**urls** [List[str] or None]

`set_visible(self, b)`  
 Set the artist's visibility.

#### Parameters

**b** [bool]

`set_zorder(self, level)`

Set the zorder for the artist. Artists with lower zorder values are drawn first.

### Parameters

**level** [float]

`stale`

Whether the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

`sticky_edges`

x and y sticky edge lists for autoscaling.

When performing autoscaling, if a data limit coincides with a value in the corresponding `sticky_edges` list, then no margin will be added—the view limit “sticks” to the edge. A typical use case is histograms, where one usually expects no margin on the bottom edge (0) of the histogram.

This attribute cannot be assigned to; however, the x and y lists can be modified in place as needed.

### Examples

```
>>> artist.sticky_edges.x[:] = (xmin, xmax)
>>> artist.sticky_edges.y[:] = (ymin, ymax)
```

`to_rgba(self, x, alpha=None, bytes=False, norm=True)`

Return a normalized rgba array corresponding to x.

In the normal case, x is a 1-D or 2-D sequence of scalars, and the corresponding ndarray of rgba values will be returned, based on the norm and colormap set for this `ScalarMappable`.

There is one special case, for handling images that are already rgb or rgba, such as might have been read from an image file. If x is an ndarray with 3 dimensions, and the last dimension is either 3 or 4, then it will be treated as an rgb or rgba array, and no mapping will be done. The array can be uint8, or it can be floating point with values in the 0-1 range; otherwise a `ValueError` will be raised. If it is a masked array, the mask will be ignored. If the last dimension is 3, the `alpha` kwarg (defaulting to 1) will be used to fill in the transparency. If the last dimension is 4, the `alpha` kwarg is ignored; it does not replace the pre-existing alpha. A `ValueError` will be raised if the third dimension is other than 3 or 4.

In either case, if `bytes` is `False` (default), the rgba array will be floats in the 0-1 range; if it is `True`, the returned rgba array will be uint8 in the 0 to 255 range.

If `norm` is `False`, no normalization of the input data is performed, and it is assumed to be in the range (0-1).

`update(self, props)`

Update this artist's properties from the dictionary `props`.

`update_from(self, other)`

copy properties from other to self

`update_scalarmappable(self)`

Update colors from the scalar mappable array, if it is not None.

`zorder = 0`

```
class matplotlib.collections.TriMesh(triangulation, **kwargs)
```

Bases: *matplotlib.collections.Collection*

Class for the efficient drawing of a triangular mesh using Gouraud shading.

A triangular mesh is a *Triangulation* object.

```
add_callback(self, func)
```

Add a callback function that will be called whenever one of the *Artist's* properties changes.

### Parameters

**func** [callable] The callback function. It must have the signature:

```
def func(artist: Artist) -> Any
```

where *artist* is the calling *Artist*. Return values may exist but are ignored.

### Returns

**oid** [int] The observer id associated with the callback. This id can be used for removing the callback with *remove\_callback* later.

### See also:

*remove\_callback*

```
add_checker(self, checker)
```

Add an entry to a dictionary of boolean flags that are set to True when the mappable is changed.

*aname*

```
autoscale(self)
```

Autoscale the scalar limits on the norm instance using the current array

```
autoscale_None(self)
```

Autoscale the scalar limits on the norm instance using the current array, changing only limits that are None

*axes*

The *Axes* instance the artist resides in, or *None*.

```
changed(self)
```

Call this whenever the mappable is changed to notify all the callbackSM listeners to the 'changed' signal

```
check_update(self, checker)
```

If mappable has changed since the last check, return True; else return False

```
contains(self, mouseevent)
```

Test whether the mouse event occurred in the collection.

Returns bool, dict(ind=itemlist), where every item in itemlist contains the event.

```
static convert_mesh_to_paths(tri)
```

Converts a given mesh into a sequence of *Path* objects.

This function is primarily of use to implementers of backends that do not directly support meshes.

`convert_xunits(self, x)`

Convert *x* using the unit type of the xaxis.

If the artist is not contained in an Axes or if the xaxis does not have units, *x* itself is returned.

`convert_yunits(self, y)`

Convert *y* using the unit type of the yaxis.

If the artist is not contained in an Axes or if the yaxis does not have units, *y* itself is returned.

`draw(self, renderer)`

Draw the Artist using the given renderer.

This method will be overridden in the Artist subclasses. Typically, it is implemented to not have any effect if the Artist is not visible (*Artist.get\_visible* is *False*).

#### Parameters

**renderer** [*RendererBase* subclass.]

`findobj(self, match=None, include_self=True)`

Find artist objects.

Recursively find all *Artist* instances contained in the artist.

#### Parameters

**match** A filter criterion for the matches. This can be

- *None*: Return all objects contained in artist.
- A function with signature `def match(artist: Artist) -> bool`. The result will only contain artists for which the function returns *True*.
- A class instance: e.g., *Line2D*. The result will only contain artists of this class or its subclasses (*isinstance* check).

**include\_self** [bool] Include *self* in the list to be checked for a match.

#### Returns

**artists** [list of *Artist*]

`format_cursor_data(self, data)`

Return a string representation of *data*.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

The default implementation converts ints and floats and arrays of ints and floats into a comma-separated string enclosed in square brackets.

#### See also:

`get_cursor_data`

`get_agg_filter(self)`

Return filter function to be used for agg filter.

`get_alpha(self)`

Return the alpha value used for blending - not supported on all backends

`get_animated(self)`  
Return the animated state.

`get_array(self)`  
Return the array

`get_capstyle(self)`

`get_children(self)`  
Return a list of the child *Artists* of this *Artist*.

`get_clim(self)`  
return the min, max of the color limits for image scaling

`get_clip_box(self)`  
Return the clipbox.

`get_clip_on(self)`  
Return whether the artist uses clipping.

`get_clip_path(self)`  
Return the clip path.

`get_cmap(self)`  
return the colormap

`get_contains(self)`  
Return the custom contains function of the artist if set, or *None*.

**See also:**

`set_contains`

`get_cursor_data(self, event)`  
Return the cursor data for a given event.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

Cursor data can be used by Artists to provide additional context information for a given event. The default implementation just returns *None*.

Subclasses can override the method and return arbitrary data. However, when doing so, they must ensure that `format_cursor_data` can convert the data to a string representation.

The only current use case is displaying the z-value of an *AxesImage* in the status bar of a plot window, while moving the mouse.

#### Parameters

**event** [`matplotlib.backend_bases.MouseEvent`]

#### See also:

`format_cursor_data`

`get_dashes(self)`  
Alias for `get_linestyle`.

`get_datalim(self, transData)`

`get_ec(self)`  
Alias for `get_edgecolor`.

`get_edgecolor(self)`

`get_edgecolors(self)`  
Alias for `get_edgecolor`.

`get_facecolor(self)`

`get_facecolors(self)`  
Alias for `get_facecolor`.

`get_fc(self)`  
Alias for `get_facecolor`.

`get_figure(self)`  
Return the *Figure* instance the artist belongs to.

`get_fill(self)`  
return whether fill is set

`get_gid(self)`  
Return the group id.

`get_hatch(self)`  
Return the current hatching pattern.

`get_in_layout(self)`  
Return boolean flag, True if artist is included in layout calculations.  
  
E.g. *Constrained Layout Guide*, `Figure.tight_layout()`, and `fig.savefig(fname, bbox_inches='tight')`.

`get_joinstyle(self)`

`get_label(self)`  
Return the label used for this artist in the legend.

`get_linestyle(self)`

`get_linestyles(self)`  
Alias for `get_linestyle`.

`get_linewidth(self)`

`get_linewidths(self)`  
Alias for `get_linewidth`.

`get_ls(self)`  
Alias for `get_linestyle`.

`get_lw(self)`  
Alias for `get_linewidth`.

`get_offset_position(self)`  
Returns how offsets are applied for the collection. If `offset_position` is 'screen', the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If `offset_position` is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

`get_offset_transform(self)`

`get_offsets(self)`  
Return the offsets for the collection.

`get_path_effects(self)`

`get_paths(self)`

`get_picker(self)`

Return the picking behavior of the artist.

The possible values are described in `set_picker`.

**See also:**

`set_picker`, `pickable`, `pick`

`get_pickradius(self)`

`get_rasterized(self)`

Return whether the artist is to be rasterized.

`get_sketch_params(self)`

Returns the sketch parameters for the artist.

**Returns**

**sketch\_params** [tuple or None] A 3-tuple with the following elements:

- *scale*: The amplitude of the wiggle perpendicular to the source line.
- *length*: The length of the wiggle along the line.
- *randomness*: The scale factor by which the length is shrunken or expanded.

Returns *None* if no sketch parameters were set.

`get_snap(self)`

Returns the snap setting.

See `set_snap` for details.

`get_tightbbox(self, renderer)`

Like `Artist.get_window_extent`, but includes any clipping.

**Parameters**

**renderer** [`RendererBase` instance] renderer that will be used to draw the figures (i.e. `fig.canvas.get_renderer()`)

**Returns**

**bbbox** [`BBox`] The enclosing bounding box (in figure pixel co-ordinates).

`get_transform(self)`

Return the *Transform* instance used by this artist.

`get_transformed_clip_path_and_affine(self)`

Return the clip path with the non-affine part of its transformation applied, and the remaining affine part of its transformation.

`get_transforms(self)`

`get_url(self)`

Return the url.

`get_urls(self)`

`get_visible(self)`

Return the visibility.

`get_window_extent(self, renderer)`

Get the axes bounding box in display space.

The bounding box' width and height are nonnegative.

Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

`get_zorder(self)`

Return the artist's zorder.

`have_units(self)`

Return *True* if units are set on the x or y axes.

`is_transform_set(self)`

Return whether the Artist has an explicitly set transform.

This is *True* after *set\_transform* has been called.

`mouseover`

`pchanged(self)`

Call all of the registered callbacks.

This function is triggered internally when a property is changed.

**See also:**

*add\_callback*

*remove\_callback*

`pick(self, mouseevent)`

Process a pick event.

Each child artist will fire a pick event if *mouseevent* is over the artist and the artist has picker set.

**See also:**

*set\_picker, get\_picker, pickable*

`pickable(self)`

Return whether the artist is pickable.

**See also:**

*set\_picker, get\_picker, pick*

`properties(self)`

Return a dictionary of all the properties of the artist.

`remove(self)`

Remove the artist from the figure if possible.

The effect will not be visible until the figure is redrawn, e.g., with `FigureCanvasBase.draw_idle`. Call `relim` to update the axes limits if desired.

Note: `relim` will not see collections even if the collection was added to the axes with `autolim = True`.

Note: there is no support for removing the artist's legend entry.

`remove_callback(self, oid)`

Remove a callback based on its observer id.

**See also:**

`add_callback`

`set(self, **kwargs)`

A property batch setter. Pass `kwargs` to set properties.

`set_aa(self, aa)`

Alias for `set_antialiased`.

`set_agg_filter(self, filter_func)`

Set the agg filter.

**Parameters**

**filter\_func** [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

`set_alpha(self, alpha)`

Set the alpha transparencies of the collection.

**Parameters**

**alpha** [float or None]

`set_animated(self, b)`

Set the artist's animation state.

**Parameters**

**b** [bool]

`set_antialiased(self, aa)`

Set the antialiasing state for rendering.

**Parameters**

**aa** [bool or sequence of bools]

`set_antialiaseds(self, aa)`

Alias for `set_antialiased`.

`set_array(self, A)`

Set the image array from numpy array `A`.

**Parameters**

**A** [ndarray]

`set_capstyle(self, cs)`

Set the capstyle for the collection (for all its elements).

**Parameters**

**cs** [{*'butt'*, *'round'*, *'projecting'*}] The capstyle

`set_clim(self, vmin=None, vmax=None)`

set the norm limits for image scaling; if *vmin* is a length2 sequence, interpret it as (*vmin*, *vmax*) which is used to support `setp`

ACCEPTS: a length 2 sequence of floats; may be overridden in methods that have *vmin* and *vmax* kwargs.

`set_clip_box(self, clipbox)`

Set the artist's clip *Bbox*.

**Parameters**

**clipbox** [*Bbox*]

`set_clip_on(self, b)`

Set whether the artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

**Parameters**

**b** [bool]

`set_clip_path(self, path, transform=None)`

Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- None, to remove a previously set clipping path.

For efficiency, if the path happens to be an axis-aligned rectangle, this method will set the clipping box to the corresponding rectangle and set the clipping path to None.

ACCEPTS: [(*Path*, *Transform*) | *Patch* | None]

`set_cmap(self, cmap)`

set the colormap for luminance data

**Parameters**

**cmap** [colormap or registered colormap name]

`set_color(self, c)`

Set both the edgecolor and the facecolor.

**Parameters**

**c** [color or sequence of rgba tuples]

**See also:**

`Collection.set_facecolor`, `Collection.set_edgecolor` For setting the edge or face color individually.

`set_contains(self, picker)`

Define a custom contains test for the artist.

The provided callable replaces the default `contains` method of the artist.

**Parameters**

**picker** [callable] A custom picker function to evaluate if an event is within the artist. The function must have the signature:

```
def contains(artist: Artist, event: MouseEvent) -> bool, dict
```

that returns:

- a bool indicating if the event is within the artist
- a dict of additional information. The dict should at least return the same information as the default `contains()` implementation of the respective artist, but may provide additional information.

`set_dashes(self, ls)`  
Alias for `set_linestyle`.

`set_ec(self, c)`  
Alias for `set_edgecolor`.

`set_edgecolor(self, c)`  
Set the edgecolor(s) of the collection.

**Parameters**

**c** [color or sequence of colors or 'face'] The collection edgecolor(s). If a sequence, the patches cycle through it. If 'face', match the facecolor.

`set_edgecolors(self, c)`  
Alias for `set_edgecolor`.

`set_facecolor(self, c)`  
Set the facecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; if it is a sequence the patches will cycle through the sequence.

If *c* is 'none', the patch will not be filled.

**Parameters**

**c** [color or sequence of colors]

`set_facecolors(self, c)`  
Alias for `set_facecolor`.

`set_fc(self, c)`  
Alias for `set_facecolor`.

`set_figure(self, fig)`  
Set the *Figure* instance the artist belongs to.

**Parameters**

**fig** [*Figure*]

`set_gid(self, gid)`  
Set the (group) id for the artist.

**Parameters**

**gid** [str]

`set_hatch(self, hatch)`  
Set the hatching pattern

*hatch* can be one of:

/	- diagonal hatching
\	- back diagonal
	- vertical
-	- horizontal
+	- crossed
x	- crossed diagonal
o	- small circle
O	- large circle
.	- dots
*	- stars

Letters can be combined, in which case all the specified hatchings are done. If same letter repeats, it increases the density of hatching of that pattern.

Hatching is supported in the PostScript, PDF, SVG and Agg backends only.

Unlike other properties such as linewidth and colors, hatching can only be specified for the collection as a whole, not separately for each member.

#### Parameters

**hatch** [{'/', '\', '|', '-', '+', 'x', 'o', 'O', '.', '\*'}]

`set_in_layout(self, in_layout)`

Set if artist is to be included in layout calculations, E.g. *Constrained Layout Guide*, *Figure.tight\_layout()*, and *fig.savefig(fname, bbox\_inches='tight')*.

#### Parameters

**in\_layout** [bool]

`set_joinstyle(self, js)`

Set the joinstyle for the collection (for all its elements).

#### Parameters

**js** [{'miter', 'round', 'bevel'}] The joinstyle

`set_label(self, s)`

Set a label that will be displayed in the legend.

#### Parameters

**s** [object] *s* will be converted to a string by calling `str`.

`set_linestyle(self, ls)`

Set the linestyle(s) for the collection.

linestyle	description
'-' or 'solid'	solid line
'--' or 'dashed'	dashed line
'-.' or 'dashdot'	dash-dotted line
':' or 'dotted'	dotted line

Alternatively a dash tuple of the following form can be provided:

```
(offset, onoffseq),
```

where `onoffseq` is an even length tuple of on and off ink in points.

### Parameters

**ls** [`'-'`, `'-'`, `'-.'`, `':'`, `''`, (offset, on-off-seq), ...] The line style.

`set_linestyles(self, ls)`

Alias for `set_linestyle`.

`set_linewidth(self, lw)`

Set the linewidth(s) for the collection. `lw` can be a scalar or a sequence; if it is a sequence the patches will cycle through the sequence

### Parameters

**lw** [float or sequence of floats]

`set_linewidths(self, lw)`

Alias for `set_linewidth`.

`set_ls(self, ls)`

Alias for `set_linestyle`.

`set_lw(self, lw)`

Alias for `set_linewidth`.

`set_norm(self, norm)`

Set the normalization instance.

### Parameters

**norm** [*Normalize*]

### Notes

If there are any colorbars using the mappable for this norm, setting the norm of the mappable will reset the norm, locator, and formatters on the colorbar to default.

`set_offset_position(self, offset_position)`

Set how offsets are applied. If `offset_position` is `'screen'` (default) the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If `offset_position` is `'data'`, the offset is applied before the master transform, i.e., the offsets are in data coordinates.

### Parameters

**offset\_position** [`'screen'`, `'data'`]

`set_offsets(self, offsets)`

Set the offsets for the collection.

### Parameters

**offsets** [float or sequence of floats]

`set_path_effects(self, path_effects)`

Set the path effects.

### Parameters

**path\_effects** [*AbstractPathEffect*]

`set_paths(self)`

`set_picker(self, picker)`

Define the picking behavior of the artist.

#### Parameters

**picker** [None or bool or float or callable] This can be one of the following:

- *None*: Picking is disabled for this artist (default).
- A boolean: If *True* then picking will be enabled and the artist will fire a pick event if the mouse event is over the artist.
- A float: If *picker* is a number it is interpreted as an epsilon tolerance in points and the artist will fire off an event if it's data is within epsilon of the mouse event. For some artists like lines and patch collections, the artist may provide additional data to the pick event that is generated, e.g., the indices of the data within epsilon of the pick event
- A function: If *picker* is callable, it is a user supplied function which determines whether the artist is hit by the mouse event:

```
hit, props = picker(artist, mouseevent)
```

to determine the hit test. if the mouse event is over the artist, return *hit=True* and *props* is a dictionary of properties you want added to the `PickEvent` attributes.

`set_pickradius(self, pr)`

Set the pick radius used for containment tests.

#### Parameters

**d** [float] Pick radius, in points.

`set_rasterized(self, rasterized)`

Force rasterized (bitmap) drawing in vector backend output.

Defaults to *None*, which implies the backend's default behavior.

#### Parameters

**rasterized** [bool or *None*]

`set_sketch_params(self, scale=None, length=None, randomness=None)`

Sets the sketch parameters.

#### Parameters

**scale** [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If *scale* is *None*, or not provided, no sketch filter will be provided.

**length** [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

**randomness** [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

`set_snap(self, snap)`

Set the snapping behavior.

Snapping aligns positions with the pixel grid, which results in clearer images. For example, if a black line of 1px width was defined at a position in between two pixels, the resulting image would contain the interpolated value of that line in the pixel grid, which would be a grey value on both adjacent pixel positions. In contrast, snapping will move the line to the nearest integer pixel value, so that the resulting image will really contain a 1px wide black line.

Snapping is currently only supported by the Agg and MacOSX backends.

### Parameters

**snap** [bool or None] Possible values:

- *True*: Snap vertices to the nearest pixel center.
- *False*: Do not modify vertex positions.
- *None*: (auto) If the path contains only rectilinear line segments, round to the nearest pixel center.

`set_transform(self, t)`  
Set the artist transform.

### Parameters

**t** [*Transform*]

`set_url(self, url)`  
Set the url for the artist.

### Parameters

**url** [str]

`set_urls(self, urls)`

### Parameters

**urls** [List[str] or None]

`set_visible(self, b)`  
Set the artist's visibility.

### Parameters

**b** [bool]

`set_zorder(self, level)`  
Set the zorder for the artist. Artists with lower zorder values are drawn first.

### Parameters

**level** [float]

`stale`  
Whether the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

`sticky_edges`  
x and y sticky edge lists for autoscaling.

When performing autoscaling, if a data limit coincides with a value in the corresponding `sticky_edges` list, then no margin will be added—the view limit “sticks” to the edge. A typical use case is histograms, where one usually expects no margin on the bottom edge (0) of the histogram.

This attribute cannot be assigned to; however, the `x` and `y` lists can be modified in place as needed.

### Examples

```
>>> artist.sticky_edges.x[:] = (xmin, xmax)
>>> artist.sticky_edges.y[:] = (ymin, ymax)
```

`to_rgba(self, x, alpha=None, bytes=False, norm=True)`

Return a normalized rgba array corresponding to `x`.

In the normal case, `x` is a 1-D or 2-D sequence of scalars, and the corresponding ndarray of rgba values will be returned, based on the `norm` and `colormap` set for this `ScalarMappable`.

There is one special case, for handling images that are already rgb or rgba, such as might have been read from an image file. If `x` is an ndarray with 3 dimensions, and the last dimension is either 3 or 4, then it will be treated as an rgb or rgba array, and no mapping will be done. The array can be `uint8`, or it can be floating point with values in the 0-1 range; otherwise a `ValueError` will be raised. If it is a masked array, the mask will be ignored. If the last dimension is 3, the `alpha` kwarg (defaulting to 1) will be used to fill in the transparency. If the last dimension is 4, the `alpha` kwarg is ignored; it does not replace the pre-existing alpha. A `ValueError` will be raised if the third dimension is other than 3 or 4.

In either case, if `bytes` is `False` (default), the rgba array will be floats in the 0-1 range; if it is `True`, the returned rgba array will be `uint8` in the 0 to 255 range.

If `norm` is `False`, no normalization of the input data is performed, and it is assumed to be in the range (0-1).

`update(self, props)`

Update this artist's properties from the dictionary `props`.

`update_from(self, other)`

copy properties from `other` to `self`

`update_scalarmappable(self)`

Update colors from the scalar mappable array, if it is not `None`.

`zorder = 0`

## 17.16 matplotlib.colorbar

Colorbar toolkit with two classes and a function:

`ColorbarBase` the base class with full colorbar drawing functionality. It can be used as-is to make a colorbar for a given colormap; a mappable object (e.g., image) is not needed.

`Colorbar` the derived class for use with images or contour plots.

`make_axes()` a function for resizing an axes and adding a second axes suitable for a colorbar

The `colorbar()` method uses `make_axes()` and `Colorbar`; the `colorbar()` function is a thin wrapper over `colorbar()`.

```
class matplotlib.colorbar.Colorbar(ax, mappable, **kw)
```

Bases: `matplotlib.colorbar.ColorbarBase`

This class connects a `ColorbarBase` to a `ScalarMappable` such as a `AxesImage` generated via `imshow()`.

It is not intended to be instantiated directly; instead, use `colorbar()` or `colorbar()` to make your colorbar.

```
add_lines(self, CS, erase=True)
```

Add the lines from a non-filled `ContourSet` to the colorbar.

Set `erase` to `False` if these lines should be added to any pre-existing lines.

```
on_mappable_changed(self, mappable)
```

Updates this colorbar to match the mappable's properties.

Typically this is automatically registered as an event handler by `colorbar_factory()` and should not be called manually.

```
remove(self)
```

Remove this colorbar from the figure. If the colorbar was created with `use_gridspec=True` then restore the `gridspec` to its previous value.

```
update_bruteforce(self, mappable)
```

Destroy and rebuild the colorbar. This is intended to become obsolete, and will probably be deprecated and then removed. It is not called when the `pyplot.colorbar` function or the `Figure.colorbar` method are used to create the colorbar.

```
update_normal(self, mappable)
```

Update solid patches, lines, etc.

Unlike `update_bruteforce`, this does not clear the axes. This is meant to be called when the norm of the image or contour plot to which this colorbar belongs changes.

If the norm on the mappable is different than before, this resets the locator and formatter for the axis, so if these have been customized, they will need to be customized again. However, if the norm only changes values of `vmin`, `vmax` or `cmap` then the old formatter and locator will be preserved.

```
class matplotlib.colorbar.ColorbarBase(ax, cmap=None, norm=None, alpha=None,
                                       values=None, boundaries=None, ori-
                                       entation='vertical', ticklocation='auto',
                                       extend='neither', spacing='uniform',
                                       ticks=None, format=None, drawedges=False,
                                       filled=True, extendfrac=None, exten-
                                       drect=False, label="")
```

Bases: `matplotlib.colorbar._ColorbarMappableDummy`

Draw a colorbar in an existing axes.

This is a base class for the `Colorbar` class, which is the basis for the `colorbar()` function and the `colorbar()` method, which are the usual ways of creating a colorbar.

It is also useful by itself for showing a colormap. If the `cmap` kwarg is given but `boundaries` and `values` are left as `None`, then the colormap will be displayed on a 0-1 scale. To show the under- and over-value colors, specify the `norm` as:

```
colors.Normalize(clip=False)
```

To show the colors versus index instead of on the 0-1 scale, use:

```
norm=colors.NoNorm.
```

Useful public methods are `set_label()` and `add_lines()`.

### Attributes

**ax** [Axes] The Axes instance in which the colorbar is drawn.

**lines** [list] A list of LineCollection if lines were drawn, otherwise an empty list.

**dividers** [LineCollection] A LineCollection if `drawedges` is True, otherwise None.

`add_lines(self, levels, colors, linewidths, erase=True)`

Draw lines on the colorbar.

`colors` and `linewidths` must be scalars or sequences the same length as `levels`.

Set `erase` to False to add lines without first removing any previously added lines.

`ax = None`

The axes that this colorbar lives in.

`config_axis(self)`

`draw_all(self)`

Calculate any free parameters based on the current cmap and norm, and do all the drawing.

`get_ticks(self, minor=False)`

Return the x ticks as a list of locations.

`minorticks_off(self)`

Turns off the minor ticks on the colorbar.

`minorticks_on(self)`

Turns on the minor ticks on the colorbar without extruding into the "extend regions".

`n_rasterize = 50`

`remove(self)`

Remove this colorbar from the figure

`set_alpha(self, alpha)`

`set_label(self, label, **kw)`

Label the long axis of the colorbar.

`set_ticklabels(self, ticklabels, update_ticks=True)`

Set tick labels.

Tick labels are updated immediately unless `update_ticks` is False, in which case one should call `update_ticks` explicitly.

`set_ticks(self, ticks, update_ticks=True)`

Set tick locations.

### Parameters

**ticks** [{None, sequence, *Locator* instance}] If None, a default *Locator* will be used.

**update\_ticks** [{True, False}, optional] If True, tick locations are updated immediately. If False, use *update\_ticks()* to manually update the ticks.

*update\_ticks(self)*

Force the update of the ticks and ticklabels. This must be called whenever the tick locator and/or tick formatter changes.

`class matplotlib.colorbar.ColorbarPatch(ax, mappable, **kw)`

Bases: *matplotlib.colorbar.Colorbar*

A Colorbar which is created using *Patch* rather than the default *pcolor()*.

It uses a list of *Patch* instances instead of a *PatchCollection* because the latter does not allow the hatch pattern to vary among the members of the collection.

`matplotlib.colorbar.colorbar_factory(cax, mappable, **kwargs)`

Creates a colorbar on the given axes for the given mappable.

Typically, for automatic colorbar placement given only a mappable use *colorbar()*.

`matplotlib.colorbar.make_axes(parents, location=None, orientation=None, fraction=0.15, shrink=1.0, aspect=20, **kw)`

Resize and reposition parent axes, and return a child axes suitable for a colorbar.

Keyword arguments may include the following (with defaults):

**location** [[None|'left'|'right'|'top'|'bottom']] The position, relative to **parents**, where the colorbar axes should be created. If None, the value will either come from the given orientation, else it will default to 'right'.

**orientation** [[None|'vertical'|'horizontal']] The orientation of the colorbar. Typically, this keyword shouldn't be used, as it can be derived from the location keyword.

Property	Description
<i>orientation</i>	vertical or horizontal
<i>fraction</i>	0.15; fraction of original axes to use for colorbar
<i>pad</i>	0.05 if vertical, 0.15 if horizontal; fraction of original axes between colorbar and new image axes
<i>shrink</i>	1.0; fraction by which to multiply the size of the colorbar
<i>aspect</i>	20; ratio of long to short dimensions
<i>anchor</i>	(0.0, 0.5) if vertical; (0.5, 1.0) if horizontal; the anchor point of the colorbar axes
<i>panchor</i>	(1.0, 0.5) if vertical; (0.5, 0.0) if horizontal; the anchor point of the colorbar parent axes. If False, the parent axes' anchor will be unchanged

Returns (cax, kw), the child axes and the reduced kw dictionary to be passed when creating the colorbar instance.

`matplotlib.colorbar.make_axes_gridspec(parent, *, fraction=0.15, shrink=1.0, aspect=20, **kw)`

Resize and reposition a parent axes, and return a child axes suitable for a colorbar. This function is similar to `make_axes`. Primary differences are

- `make_axes_gridspec` only handles the `orientation` keyword and cannot handle the "location" keyword.
- `make_axes_gridspec` should only be used with a subplot parent.
- **`make_axes` creates an instance of `Axes`. `make_axes_gridspec` creates an instance of `Subplot`.**
- **`make_axes` updates the position of the parent.** `make_axes_gridspec` replaces the `grid_spec` attribute of the parent with a new one.

While this function is meant to be compatible with `make_axes`, there could be some minor differences.

Keyword arguments may include the following (with defaults):

**`orientation`** 'vertical' or 'horizontal'

Property	Description
<code>orientation</code>	vertical or horizontal
<code>fraction</code>	0.15; fraction of original axes to use for colorbar
<code>pad</code>	0.05 if vertical, 0.15 if horizontal; fraction of original axes between colorbar and new image axes
<code>shrink</code>	1.0; fraction by which to multiply the size of the colorbar
<code>aspect</code>	20; ratio of long to short dimensions
<code>anchor</code>	(0.0, 0.5) if vertical; (0.5, 1.0) if horizontal; the anchor point of the colorbar axes
<code>panchor</code>	(1.0, 0.5) if vertical; (0.5, 0.0) if horizontal; the anchor point of the colorbar parent axes. If False, the parent axes' anchor will be unchanged

All but the first of these are stripped from the input kw set.

Returns (`cax`, `kw`), the child axes and the reduced kw dictionary to be passed when creating the colorbar instance.

## 17.17 matplotlib.colors

For a visual representation of the Matplotlib colormaps, see:

- The `color_examples` examples for examples of controlling color with Matplotlib.
- The `Colors` tutorial for an in-depth guide on controlling color.

A module for converting numbers or color arguments to `RGB` or `RGBA`.

`RGB` and `RGBA` are sequences of, respectively, 3 or 4 floats in the range 0-1.

This module includes functions and classes for color specification conversions, and for mapping numbers to colors in a 1-D array of colors called a colormap.

Mapping data onto colors using a colormap typically involves two steps: a data array is first mapped onto the range 0-1 using a subclass of *Normalize*, then this number is mapped to a color using a subclass of *Colormap*. Two are provided here: *LinearSegmentedColormap*, which uses piecewise-linear interpolation to define colormaps, and *ListedColormap*, which makes a colormap from a list of colors.

**See also:**

*Creating Colormaps in Matplotlib* for examples of how to make colormaps and

*Choosing Colormaps in Matplotlib* for a list of built-in colormaps.

*Colormap Normalization* for more details about data normalization

More colormaps are available at [palettable](#).

The module also provides functions for checking whether an object can be interpreted as a color (*is\_color\_like()*), for converting such an object to an RGBA tuple (*to\_rgba()*) or to an HTML-like hex string in the #rrggbb format (*to\_hex()*), and a sequence of colors to an (n, 4) RGBA array (*to\_rgba\_array()*). Caching is used for efficiency.

Matplotlib recognizes the following formats to specify a color:

- an RGB or RGBA tuple of float values in [0, 1] (e.g., (0.1, 0.2, 0.5) or (0.1, 0.2, 0.5, 0.3));
- a hex RGB or RGBA string (e.g., '#0f0f0f' or '#0f0f0f80'; case-insensitive);
- a string representation of a float value in [0, 1] inclusive for gray level (e.g., '0.5');
- one of {'b', 'g', 'r', 'c', 'm', 'y', 'k', 'w'};
- a X11/CSS4 color name (case-insensitive);
- a name from the [xkcd color survey](#), prefixed with 'xkcd:' (e.g., 'xkcd:sky blue'; case insensitive);
- one of the Tableau Colors from the 'T10' categorical palette (the default color cycle): {'tab:blue', 'tab:orange', 'tab:green', 'tab:red', 'tab:purple', 'tab:brown', 'tab:pink', 'tab:gray', 'tab:olive', 'tab:cyan'} (case-insensitive);
- a "CN" color spec, i.e. 'C' followed by a number, which is an index into the default property cycle (`matplotlib.rcParams['axes.prop_cycle']`); the indexing is intended to occur at rendering time, and defaults to black if the cycle does not include color.

### 17.17.1 Classes

<i>BoundaryNorm</i> (boundaries, ncolors[, clip])	Generate a colormap index based on discrete intervals.
<i>Colormap</i> (name[, N])	Baseclass for all scalar to RGBA mappings.
<i>DivergingNorm</i> (vcenter[, vmin, vmax])	Normalize data with a set center.
<i>LightSource</i> ([azdeg, altdeg, hsv_min_val, ...])	Create a light source coming from the specified azimuth and elevation.
<i>LinearSegmentedColormap</i> (name, segment-data[, ...])	Colormap objects based on lookup tables using linear segments.
<i>ListedColormap</i> (colors[, name, N])	Colormap object generated from a list of colors.

Continued on next page

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<code>LogNorm([vmin, vmax, clip])</code>	Normalize a given value to the 0-1 range on a log scale.
<code>NoNorm([vmin, vmax, clip])</code>	Dummy replacement for <i>Normalize</i> , for the case where we want to use indices directly in a <i>ScalarMappable</i> .
<code>Normalize([vmin, vmax, clip])</code>	A class which, when called, can normalize data into the [0.0, 1.0] interval.
<code>PowerNorm(gamma[, vmin, vmax, clip])</code>	Linearly map a given value to the 0-1 range and then apply a power-law normalization over that range.
<code>SymLogNorm(linthresh[, linscale, vmin, ...])</code>	The symmetrical logarithmic scale is logarithmic in both the positive and negative directions from the origin.

**matplotlib.colors.BoundaryNorm**

```
class matplotlib.colors.BoundaryNorm(boundaries, ncolors, clip=False)
```

Bases: `matplotlib.colors.Normalize`

Generate a colormap index based on discrete intervals.

Unlike *Normalize* or *LogNorm*, *BoundaryNorm* maps values to integers instead of to the interval 0-1.

Mapping to the 0-1 interval could have been done via piece-wise linear interpolation, but using integers seems simpler, and reduces the number of conversions back and forth between integer and floating point.

**Parameters**

**boundaries** [array-like] Monotonically increasing sequence of boundaries

**ncolors** [int] Number of colors in the colormap to be used

**clip** [bool, optional] If clip is True, out of range values are mapped to 0 if they are below `boundaries[0]` or mapped to `ncolors - 1` if they are above `boundaries[-1]`.

If clip is False, out of range values are mapped to -1 if they are below `boundaries[0]` or mapped to `ncolors` if they are above `boundaries[-1]`. These are then converted to valid indices by `Colormap.__call__()`.

**Notes**

*boundaries* defines the edges of bins, and data falling within a bin is mapped to the color with the same index.

If the number of bins doesn't equal *ncolors*, the color is chosen by linear interpolation of the bin number onto color numbers.

`inverse(self, value)`

**Raises**

**ValueError** *BoundaryNorm* is not invertible, so calling this method will always raise an error

**Examples using `matplotlib.colors.BoundaryNorm`**

- `sphx_glr_gallery_lines_bars_and_markers_multicolored_line.py`
- `sphx_glr_gallery_images_contours_and_fields_image_annotated_heatmap.py`
- `sphx_glr_gallery_images_contours_and_fields_image_masked.py`
- `sphx_glr_gallery_images_contours_and_fields_pcolormesh_levels.py`
- `sphx_glr_gallery_specialty_plots_leftventricle_bulleye.py`
- `sphx_glr_gallery_userdemo_colormap_normalizations.py`
- `sphx_glr_gallery_userdemo_colormap_normalizations_bounds.py`
- *Customized Colorbars Tutorial*
- *Colormap Normalization*

**`matplotlib.colors.Colormap`**

```
class matplotlib.colors.Colormap(name, N=256)
```

```
    Bases: object
```

Baseclass for all scalar to RGBA mappings.

Typically Colormap instances are used to convert data values (floats) from the interval `[0, 1]` to the RGBA color that the respective Colormap represents. For scaling of data into the `[0, 1]` interval see `matplotlib.colors.Normalize`. It is worth noting that `matplotlib.cm.ScalarMappable` subclasses make heavy use of this `data->normalize->map-to-color` processing chain.

**Parameters**

**name** [str] The name of the colormap.

**N** [int] The number of rgb quantization levels.

```
colorbar_extend = None
```

When this colormap exists on a scalar mappable and `colorbar_extend` is not `False`, colorbar creation will pick up `colorbar_extend` as the default value for the `extend` keyword in the `matplotlib.colorbar.Colorbar` constructor.

```
is_gray(self)
```

```
reversed(self, name=None)
```

Make a reversed instance of the Colormap.

---

**Note:** Function not implemented for base class.

---

**Parameters**

**name** [str, optional] The name for the reversed colormap. If it's `None` the name will be the name of the parent colormap + `"_r"`.

**See also:**

`LinearSegmentedColormap.reversed`

*ListedColormap.reversed*

`set_bad(self, color='k', alpha=None)`

Set color to be used for masked values.

`set_over(self, color='k', alpha=None)`

Set color to be used for high out-of-range values. Requires `norm.clip = False`

`set_under(self, color='k', alpha=None)`

Set color to be used for low out-of-range values. Requires `norm.clip = False`

#### Examples using `matplotlib.colors.Colormap`

- `sphx_glr_gallery_images_contours_and_fields_contourf_demo.py`

#### `matplotlib.colors.DivergingNorm`

`class matplotlib.colors.DivergingNorm(vcenter, vmin=None, vmax=None)`

Bases: `matplotlib.colors.Normalize`

Normalize data with a set center.

Useful when mapping data with an unequal rates of change around a conceptual center, e.g., data that range from -2 to 4, with 0 as the midpoint.

#### Parameters

**vcenter** [float] The data value that defines 0.5 in the normalization.

**vmin** [float, optional] The data value that defines 0.0 in the normalization.  
Defaults to the min value of the dataset.

**vmax** [float, optional] The data value that defines 1.0 in the normalization.  
Defaults to the the max value of the dataset.

#### Examples

This maps data value -4000 to 0., 0 to 0.5, and +10000 to 1.0; data between is linearly interpolated:

```
>>> import matplotlib.colors as mcolors
>>> offset = mcolors.DivergingNorm(vmin=-4000.,
                                   vcenter=0., vmax=10000)
>>> data = [-4000., -2000., 0., 2500., 5000., 7500., 10000.]
>>> offset(data)
array([0., 0.25, 0.5, 0.625, 0.75, 0.875, 1.0])
```

`autoscale_None(self, A)`

Get `vmin` and `vmax`, and then clip at `vcenter`

#### Examples using `matplotlib.colors.DivergingNorm`

- `sphx_glr_gallery_userdemo_colormap_normalizations_diverging.py`

- *Colormap Normalization*

### matplotlib.colors.LightSource

```
class matplotlib.colors.LightSource(azdeg=315, altdeg=45, hsv_min_val=0,
                                     hsv_max_val=1, hsv_min_sat=1, hsv_max_sat=0)
```

Bases: `object`

Create a light source coming from the specified azimuth and elevation. Angles are in degrees, with the azimuth measured clockwise from north and elevation up from the zero plane of the surface.

The `shade()` is used to produce "shaded" rgb values for a data array. `shade_rgb()` can be used to combine an rgb image with The `shade_rgb()` The `hillshade()` produces an illumination map of a surface.

Specify the azimuth (measured clockwise from south) and altitude (measured up from the plane of the surface) of the light source in degrees.

#### Parameters

**azdeg** [number, optional] The azimuth (0-360, degrees clockwise from North) of the light source. Defaults to 315 degrees (from the northwest).

**altdeg** [number, optional] The altitude (0-90, degrees up from horizontal) of the light source. Defaults to 45 degrees from horizontal.

#### Notes

For backwards compatibility, the parameters `hsv_min_val`, `hsv_max_val`, `hsv_min_sat`, and `hsv_max_sat` may be supplied at initialization as well. However, these parameters will only be used if "blend\_mode='hsv'" is passed into `shade()` or `shade_rgb()`. See the documentation for `blend_hsv()` for more details.

```
blend_hsv(self, rgb, intensity, hsv_max_sat=None, hsv_max_val=None,
           hsv_min_val=None, hsv_min_sat=None)
```

Take the input data array, convert to HSV values in the given colormap, then adjust those color values to give the impression of a shaded relief map with a specified light source. RGBA values are returned, which can then be used to plot the shaded image with `imshow`.

The color of the resulting image will be darkened by moving the (s,v) values (in hsv colorspace) toward (hsv\_min\_sat, hsv\_min\_val) in the shaded regions, or lightened by sliding (s,v) toward (hsv\_max\_sat, hsv\_max\_val) in regions that are illuminated. The default extremes are chose so that completely shaded points are nearly black (s = 1, v = 0) and completely illuminated points are nearly white (s = 0, v = 1).

#### Parameters

**rgb** [ndarray] An MxNx3 RGB array of floats ranging from 0 to 1 (color image).

**intensity** [ndarray] An MxNx1 array of floats ranging from 0 to 1 (grayscale image).

**hsv\_max\_sat** [number, optional] The maximum saturation value that the `intensity` map can shift the output image to. Defaults to 1.

**hsv\_min\_sat** [number, optional] The minimum saturation value that the *intensity* map can shift the output image to. Defaults to 0.

**hsv\_max\_val** [number, optional] The maximum value ("v" in "hsv") that the *intensity* map can shift the output image to. Defaults to 1.

**hsv\_min\_val** [number, optional] The minimum value ("v" in "hsv") that the *intensity* map can shift the output image to. Defaults to 0.

### Returns

**rgb** [ndarray] An MxNx3 RGB array representing the combined images.

`blend_overlay(self, rgb, intensity)`

Combines an rgb image with an intensity map using "overlay" blending.

### Parameters

**rgb** [ndarray] An MxNx3 RGB array of floats ranging from 0 to 1 (color image).

**intensity** [ndarray] An MxNx1 array of floats ranging from 0 to 1 (grayscale image).

### Returns

**rgb** [ndarray] An MxNx3 RGB array representing the combined images.

`blend_soft_light(self, rgb, intensity)`

Combines an rgb image with an intensity map using "soft light" blending. Uses the "pegtop" formula.

### Parameters

**rgb** [ndarray] An MxNx3 RGB array of floats ranging from 0 to 1 (color image).

**intensity** [ndarray] An MxNx1 array of floats ranging from 0 to 1 (grayscale image).

### Returns

**rgb** [ndarray] An MxNx3 RGB array representing the combined images.

`direction`

The unit vector direction towards the light source.

`hillshade(self, elevation, vert_exag=1, dx=1, dy=1, fraction=1.0)`

Calculates the illumination intensity for a surface using the defined azimuth and elevation for the light source.

This computes the normal vectors for the surface, and then passes them on to `shade_normals`

### Parameters

**elevation** [array-like] A 2d array (or equivalent) of the height values used to generate an illumination map

**vert\_exag** [number, optional] The amount to exaggerate the elevation values by when calculating illumination. This can be used either to correct for differences in units between the x-y coordinate system and the elevation coordinate system (e.g. decimal degrees vs meters) or to exaggerate or de-emphasize topographic effects.

**dx** [number, optional] The x-spacing (columns) of the input *elevation* grid.

**dy** [number, optional] The y-spacing (rows) of the input *elevation* grid.

**fraction** [number, optional] Increases or decreases the contrast of the hillshade. Values greater than one will cause intermediate values to move closer to full illumination or shadow (and clipping any values that move beyond 0 or 1). Note that this is not visually or mathematically the same as vertical exaggeration.

### Returns

---

**intensity** [ndarray] A 2d array of illumination values between 0-1, where 0 is completely in shadow and 1 is completely illuminated.

`shade(self, data, cmap, norm=None, blend_mode='overlay', vmin=None, vmax=None, vert_exag=1, dx=1, dy=1, fraction=1, **kwargs)`

Combine colormapped data values with an illumination intensity map (a.k.a. "hillshade") of the values.

### Parameters

**data** [array-like] A 2d array (or equivalent) of the height values used to generate a shaded map.

**cmap** [*Colormap* instance] The colormap used to color the *data* array. Note that this must be a *Colormap* instance. For example, rather than passing in `cmap='gist_earth'`, use `cmap=plt.get_cmap('gist_earth')` instead.

**norm** [*Normalize* instance, optional] The normalization used to scale values before colormapping. If *None*, the input will be linearly scaled between its min and max.

**blend\_mode** [{*'hsv'*, *'overlay'*, *'soft'*} or callable, optional] The type of blending used to combine the colormapped data values with the illumination intensity. Default is "overlay". Note that for most topographic surfaces, "overlay" or "soft" appear more visually realistic. If a user-defined function is supplied, it is expected to combine an  $M \times N \times 3$  RGB array of floats (ranging 0 to 1) with an  $M \times N \times 1$  hillshade array (also 0 to 1). (Call signature `func(rgb, illum, **kwargs)`) Additional kwargs supplied to this function will be passed on to the *blend\_mode* function.

**vmin** [scalar or *None*, optional] The minimum value used in colormapping *data*. If *None* the minimum value in *data* is used. If *norm* is specified, then this argument will be ignored.

**vmax** [scalar or *None*, optional] The maximum value used in colormapping *data*. If *None* the maximum value in *data* is used. If *norm* is specified, then this argument will be ignored.

**vert\_exag** [number, optional] The amount to exaggerate the elevation values by when calculating illumination. This can be used either to correct for differences in units between the x-y coordinate system and the elevation coordinate system (e.g. decimal degrees vs meters) or to exaggerate or de-emphasize topography.

**dx** [number, optional] The x-spacing (columns) of the input *elevation* grid.

**dy** [number, optional] The y-spacing (rows) of the input *elevation* grid.

**fraction** [number, optional] Increases or decreases the contrast of the hillshade. Values greater than one will cause intermediate values to move closer to full illumination or shadow (and clipping any values that move beyond 0 or 1). Note that this is not visually or mathematically the same as vertical exaggeration.

**Additional kwargs are passed on to the `*blend_mode*` function.**

### Returns

**rgba** [ndarray] An  $M \times N \times 4$  array of floats ranging between 0-1.

`shade_normals(self, normals, fraction=1.0)`

Calculates the illumination intensity for the normal vectors of a surface using the defined azimuth and elevation for the light source.

Imagine an artificial sun placed at infinity in some azimuth and elevation position illuminating our surface. The parts of the surface that slope toward the sun should brighten while those sides facing away should become darker.

### Parameters

**fraction** [number, optional] Increases or decreases the contrast of the hillshade. Values greater than one will cause intermediate values to move closer to full illumination or shadow (and clipping any values that move beyond 0 or 1). Note that this is not visually or mathematically the same as vertical exaggeration.

### Returns

**intensity** [ndarray] A 2d array of illumination values between 0-1, where 0 is completely in shadow and 1 is completely illuminated.

`shade_rgb(self, rgb, elevation, fraction=1.0, blend_mode='hsv', vert_exag=1, dx=1, dy=1, **kwargs)`

Use this light source to adjust the colors of the `rgb` input array to give the impression of a shaded relief map with the given `elevation`.

### Parameters

**rgb** [array-like] An  $(M, N, 3)$  RGB array, assumed to be in the range of 0 to 1.

**elevation** [array-like] An  $(M, N)$  array of the height values used to generate a shaded map.

**fraction** [number] Increases or decreases the contrast of the hillshade. Values greater than one will cause intermediate values to move closer to full illumination or shadow (and clipping any values that move beyond 0 or 1). Note that this is not visually or mathematically the same as vertical exaggeration.

**blend\_mode** [{`'hsv'`, `'overlay'`, `'soft'`} or callable, optional] The type of blending used to combine the colormapped data values with the illumination intensity. For backwards compatibility, this defaults to `"hsv"`. Note that for most topographic surfaces, `"overlay"` or `"soft"` appear more visually realistic. If a user-defined function is supplied, it is expected to combine an  $M \times N \times 3$  RGB array of floats (ranging 0 to 1) with an  $M \times N \times 1$  hillshade array (also 0 to 1). (Call signature `func(rgb, illum, **kwargs)`) Additional kwargs supplied to this function will be passed on to the `blend_mode` function.

**vert\_exag** [number, optional] The amount to exaggerate the elevation values by when calculating illumination. This can be used either to correct for differences in units between the x-y coordinate system and the elevation coordinate system (e.g. decimal degrees vs meters) or to exaggerate or de-emphasize topography.

**dx** [number, optional] The x-spacing (columns) of the input *elevation* grid.

**dy** [number, optional] The y-spacing (rows) of the input *elevation* grid.

**Additional kwargs are passed on to the *\*blend\_mode\** function.**

### Returns

**shaded\_rgb** [ndarray] An (m, n, 3) array of floats ranging between 0-1.

### Examples using `matplotlib.colors.LightSource`

- `sphx_glr_gallery_images_contours_and_fields_shading_example.py`
- `sphx_glr_gallery_showcase_mandelbrot.py`
- `sphx_glr_gallery_frontpage_3D.py`
- `sphx_glr_gallery_misc_demo_agg_filter.py`
- `sphx_glr_gallery_mplot3d_custom_shaded_3d_surface.py`
- `sphx_glr_gallery_specialty_plots_advanced_hillshading.py`
- `sphx_glr_gallery_specialty_plots_topographic_hillshading.py`

### `matplotlib.colors.LinearSegmentedColormap`

```
class matplotlib.colors.LinearSegmentedColormap(name, segmentdata, N=256,
                                                gamma=1.0)
```

Bases: `matplotlib.colors.Colormap`

Colormap objects based on lookup tables using linear segments.

The lookup table is generated using linear interpolation for each primary color, with the 0-1 domain divided into any number of segments.

Create color map from linear mapping segments

`segmentdata` argument is a dictionary with a red, green and blue entries. Each entry should be a list of `x, y0, y1` tuples, forming rows in a table. Entries for alpha are optional.

Example: suppose you want red to increase from 0 to 1 over the bottom half, green to do the same over the middle half, and blue over the top half. Then you would use:

```
cdict = {'red': [(0.0, 0.0, 0.0),
                (0.5, 1.0, 1.0),
                (1.0, 1.0, 1.0)],
         'green': [(0.0, 0.0, 0.0),
                  (0.25, 0.0, 0.0),
                  (0.75, 1.0, 1.0),
                  (1.0, 1.0, 1.0)],
```

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```
'blue': [(0.0, 0.0, 0.0),
         (0.5, 0.0, 0.0),
         (1.0, 1.0, 1.0)]}
```

Each row in the table for a given color is a sequence of  $x$ ,  $y_0$ ,  $y_1$  tuples. In each sequence,  $x$  must increase monotonically from 0 to 1. For any input value  $z$  falling between  $x[i]$  and  $x[i+1]$ , the output value of a given color will be linearly interpolated between  $y_1[i]$  and  $y_0[i+1]$ :

```
row i:   x  y0  y1
         /
        /
row i+1: x  y0  y1
```

Hence  $y_0$  in the first row and  $y_1$  in the last row are never used.

### See also:

*LinearSegmentedColormap.from\_list* Static method; factory function for generating a smoothly-varying *LinearSegmentedColormap*.

*makeMappingArray* For information about making a mapping array.

*static from\_list(name, colors, N=256, gamma=1.0)*

Make a linear segmented colormap with *name* from a sequence of *colors* which evenly transitions from *colors*[0] at *val*=0 to *colors*[-1] at *val*=1. *N* is the number of rgb quantization levels. Alternatively, a list of (value, color) tuples can be given to divide the range unevenly.

*reversed(self, name=None)*

Make a reversed instance of the *Colormap*.

### Parameters

**name** [str, optional] The name for the reversed colormap. If it's None the name will be the name of the parent colormap + "\_r".

### Returns

**LinearSegmentedColormap** The reversed colormap.

*set\_gamma(self, gamma)*

Set a new gamma value and regenerate color map.

### Examples using matplotlib.colors.LinearSegmentedColormap

- sphx\_glr\_gallery\_color\_custom\_cmap.py
- *Creating Colormaps in Matplotlib*

### matplotlib.colors.ListedColormap

*class matplotlib.colors.ListedColormap(colors, name='from\_list', N=None)*

Bases: *matplotlib.colors.Colormap*

Colormap object generated from a list of colors.

This may be most useful when indexing directly into a colormap, but it can also be used to generate special colormaps for ordinary mapping.

### Parameters

**colors** [list, array] List of Matplotlib color specifications, or an equivalent Nx3 or Nx4 floating point array ( $N$  rgb or rgba values).

**name** [str, optional] String to identify the colormap.

**N** [int, optional] Number of entries in the map. The default is *None*, in which case there is one colormap entry for each element in the list of colors. If:

```
N < len(colors)
```

the list will be truncated at  $N$ . If:

```
N > len(colors)
```

the list will be extended by repetition.

`reversed(self, name=None)`

Make a reversed instance of the Colormap.

### Parameters

**name** [str, optional] The name for the reversed colormap. If it's *None* the name will be the name of the parent colormap + "\_r".

### Returns

**ListedColormap** A reversed instance of the colormap.

### Examples using `matplotlib.colors.ListedColormap`

- [sphx\\_glr\\_gallery\\_lines\\_bars\\_and\\_markers\\_multicolored\\_line.py](#)
- [sphx\\_glr\\_gallery\\_specialty\\_plots\\_leftventricle\\_bulleye.py](#)
- *Customized Colorbars Tutorial*
- *Creating Colormaps in Matplotlib*

### `matplotlib.colors.LogNorm`

`class matplotlib.colors.LogNorm(vmin=None, vmax=None, clip=False)`

Bases: `matplotlib.colors.Normalize`

Normalize a given value to the 0-1 range on a log scale.

If *vmin* or *vmax* is not given, they are initialized from the minimum and maximum value respectively of the first input processed. That is, `__call__(A)` calls `autoscale_None(A)`. If *clip* is *True* and the given value falls outside the range, the returned value will be 0 or 1, whichever is closer. Returns 0 if:

```
vmin==vmax
```

Works with scalars or arrays, including masked arrays. If *clip* is *True*, masked values are set to 1; otherwise they remain masked. Clipping silently defeats the purpose of setting the over, under, and masked colors in the colormap, so it is likely to lead to surprises; therefore the default is *clip = False*.

```
autoscale(self, A)
    Set vmin, vmax to min, max of A.
autoscale_None(self, A)
    Autoscale only None-valued vmin or vmax.
inverse(self, value)
```

#### Examples using `matplotlib.colors.LogNorm`

- `sphx_glr_gallery_images_contours_and_fields_pcolor_demo.py`
- `sphx_glr_gallery_statistics_hist.py`
- `sphx_glr_gallery_userdemo_colormap_normalizations.py`
- `sphx_glr_gallery_userdemo_colormap_normalizations_lognorm.py`
- *Colormap Normalization*

#### `matplotlib.colors.NoNorm`

```
class matplotlib.colors.NoNorm(vmin=None, vmax=None, clip=False)
    Bases: matplotlib.colors.Normalize
```

Dummy replacement for *Normalize*, for the case where we want to use indices directly in a *ScalarMappable*.

If *vmin* or *vmax* is not given, they are initialized from the minimum and maximum value respectively of the first input processed. That is, `__call__(A)` calls `autoscale_None(A)`. If *clip* is *True* and the given value falls outside the range, the returned value will be 0 or 1, whichever is closer. Returns 0 if:

```
vmin==vmax
```

Works with scalars or arrays, including masked arrays. If *clip* is *True*, masked values are set to 1; otherwise they remain masked. Clipping silently defeats the purpose of setting the over, under, and masked colors in the colormap, so it is likely to lead to surprises; therefore the default is *clip = False*.

```
inverse(self, value)
```

#### `matplotlib.colors.Normalize`

```
class matplotlib.colors.Normalize(vmin=None, vmax=None, clip=False)
    Bases: object
```

A class which, when called, can normalize data into the [0.0, 1.0] interval.

If *vmin* or *vmax* is not given, they are initialized from the minimum and maximum value respectively of the first input processed. That is, `__call__(A)` calls `autoscale_None(A)`. If

*clip* is *True* and the given value falls outside the range, the returned value will be 0 or 1, whichever is closer. Returns 0 if:

```
vmin==vmax
```

Works with scalars or arrays, including masked arrays. If *clip* is *True*, masked values are set to 1; otherwise they remain masked. Clipping silently defeats the purpose of setting the over, under, and masked colors in the colormap, so it is likely to lead to surprises; therefore the default is *clip = False*.

`autoscale(self, A)`

Set *vmin*, *vmax* to min, max of *A*.

`autoscale_None(self, A)`

Autoscale only None-valued *vmin* or *vmax*.

`inverse(self, value)`

`static process_value(value)`

Homogenize the input *value* for easy and efficient normalization.

*value* can be a scalar or sequence.

Returns *result*, *is\_scalar*, where *result* is a masked array matching *value*. Float dtypes are preserved; integer types with two bytes or smaller are converted to `np.float32`, and larger types are converted to `np.float64`. Preserving `float32` when possible, and using in-place operations, can greatly improve speed for large arrays.

Experimental; we may want to add an option to force the use of `float32`.

`scaled(self)`

Return whether *vmin* and *vmax* are set.

#### Examples using `matplotlib.colors.Normalize`

- `sphx_glr_gallery_images_contours_and_fields_contour_image.py`
- `sphx_glr_gallery_images_contours_and_fields_image_masked.py`
- `sphx_glr_gallery_images_contours_and_fields_image_transparency_blend.py`
- `sphx_glr_gallery_images_contours_and_fields_multi_image.py`
- `sphx_glr_gallery_statistics_hist.py`
- `sphx_glr_gallery_specialty_plots_advanced_hillshading.py`
- `sphx_glr_gallery_specialty_plots_leftventricle_bulleye.py`
- `sphx_glr_gallery_userdemo_colormap_normalizations.py`
- `sphx_glr_gallery_userdemo_colormap_normalizations_custom.py`
- *Constrained Layout Guide*
- *Customized Colorbars Tutorial*
- *Colormap Normalization*

**matplotlib.colors.PowerNorm**

```
class matplotlib.colors.PowerNorm(gamma, vmin=None, vmax=None, clip=False)
    Bases: matplotlib.colors.Normalize
```

Linearly map a given value to the 0-1 range and then apply a power-law normalization over that range.

```
inverse(self, value)
```

**Examples using matplotlib.colors.PowerNorm**

- sphx\_glr\_gallery\_showcase\_mandelbrot.py
- sphx\_glr\_gallery\_scales\_power\_norm.py
- sphx\_glr\_gallery\_userdemo\_colormap\_normalizations.py
- sphx\_glr\_gallery\_userdemo\_colormap\_normalizations\_power.py
- *Colormap Normalization*

**matplotlib.colors.SymLogNorm**

```
class matplotlib.colors.SymLogNorm(linthresh, linscale=1.0, vmin=None, vmax=None,
                                   clip=False)
```

Bases: *matplotlib.colors.Normalize*

The symmetrical logarithmic scale is logarithmic in both the positive and negative directions from the origin.

Since the values close to zero tend toward infinity, there is a need to have a range around zero that is linear. The parameter *linthresh* allows the user to specify the size of this range (*-linthresh*, *linthresh*).

*linthresh*: The range within which the plot is linear (to avoid having the plot go to infinity around zero).

*linscale*: This allows the linear range (*-linthresh* to *linthresh*) to be stretched relative to the logarithmic range. Its value is the number of decades to use for each half of the linear range. For example, when *linscale* == 1.0 (the default), the space used for the positive and negative halves of the linear range will be equal to one decade in the logarithmic range. Defaults to 1.

```
autoscale(self, A)
```

Set *vmin*, *vmax* to min, max of *A*.

```
autoscale_None(self, A)
```

Autoscale only None-valued *vmin* or *vmax*.

```
inverse(self, value)
```

**Examples using matplotlib.colors.SymLogNorm**

- sphx\_glr\_gallery\_userdemo\_colormap\_normalizations.py
- sphx\_glr\_gallery\_userdemo\_colormap\_normalizations\_symlognorm.py

- *Colormap Normalization*

## 17.17.2 Functions

<code>from_levels_and_colors(levels, colors[, extend])</code>	A helper routine to generate a cmap and a norm instance which behave similar to <code>contourf</code> 's levels and colors arguments.
<code>hsv_to_rgb(hsv)</code>	Convert hsv values to rgb.
<code>rgb_to_hsv(arr)</code>	Convert float rgb values (in the range [0, 1]), in a numpy array to hsv values.
<code>to_hex(c[, keep_alpha])</code>	Convert <code>c</code> to a hex color.
<code>to_rgb(c)</code>	Convert <code>c</code> to an RGB color, silently dropping the alpha channel.
<code>to_rgba(c[, alpha])</code>	Convert <code>c</code> to an RGBA color.
<code>to_rgba_array(c[, alpha])</code>	Convert <code>c</code> to a (n, 4) array of RGBA colors.
<code>is_color_like(c)</code>	Return whether <code>c</code> can be interpreted as an RGB(A) color.
<code>makeMappingArray(N, data[, gamma])</code>	Create an $N$ -element 1-d lookup table.
<code>get_named_colors_mapping()</code>	Return the global mapping of names to named colors.

### matplotlib.colors.from\_levels\_and\_colors

`matplotlib.colors.from_levels_and_colors(levels, colors, extend='neither')`

A helper routine to generate a cmap and a norm instance which behave similar to `contourf`'s levels and colors arguments.

#### Parameters

**levels** [sequence of numbers] The quantization levels used to construct the *BoundaryNorm*. Value  $v$  is quantized to level  $i$  if  $lev[i] \leq v < lev[i+1]$ .

**colors** [sequence of colors] The fill color to use for each level. If `extend` is "neither" there must be `n_level - 1` colors. For an `extend` of "min" or "max" add one extra color, and for an `extend` of "both" add two colors.

**extend** [{'neither', 'min', 'max', 'both'}, optional] The behaviour when a value falls out of range of the given levels. See `contourf()` for details.

#### Returns

**(cmap, norm)** [tuple containing a *Colormap* and a *Normalize* instance]

### matplotlib.colors.hsv\_to\_rgb

`matplotlib.colors.hsv_to_rgb(hsv)`

Convert hsv values to rgb.

#### Parameters

**hsv** [(..., 3) array-like] All values assumed to be in range [0, 1]

#### Returns

**rgb** [(..., 3) ndarray] Colors converted to RGB values in range [0, 1]

### `matplotlib.colors.rgb_to_hsv`

`matplotlib.colors.rgb_to_hsv(arr)`

Convert float `rgb` values (in the range [0, 1]), in a numpy array to `hsv` values.

#### **Parameters**

**arr** [(..., 3) array-like] All values must be in the range [0, 1]

#### **Returns**

**hsv** [(..., 3) ndarray] Colors converted to `hsv` values in range [0, 1]

**Examples using `matplotlib.colors.rgb_to_hsv`**

- `sphinx_glr_gallery_color_named_colors.py`

### `matplotlib.colors.to_hex`

`matplotlib.colors.to_hex(c, keep_alpha=False)`

Convert `c` to a hex color.

Uses the `#rrggbb` format if `keep_alpha` is `False` (the default), `#rrggbbaa` otherwise.

### `matplotlib.colors.to_rgb`

`matplotlib.colors.to_rgb(c)`

Convert `c` to an RGB color, silently dropping the alpha channel.

**Examples using `matplotlib.colors.to_rgb`**

- `sphinx_glr_gallery_color_named_colors.py`

### `matplotlib.colors.to_rgba`

`matplotlib.colors.to_rgba(c, alpha=None)`

Convert `c` to an RGBA color.

#### **Parameters**

**c** [Matplotlib color or `np.ma.masked`]

**alpha** [scalar, optional] If `alpha` is not `None`, it forces the alpha value, except if `c` is "none" (case-insensitive), which always maps to (0, 0, 0, 0).

#### **Returns**

**tuple** Tuple of (r, g, b, a) scalars.

**Examples using `matplotlib.colors.to_rgba`**

- `sphx_glr_gallery_color_named_colors.py`
- `sphx_glr_gallery_shapes_and_collections_collections.py`
- `sphx_glr_gallery_shapes_and_collections_line_collection.py`
- `sphx_glr_gallery_event_handling_lasso_demo.py`
- `sphx_glr_gallery_misc_demo_ribbon_box.py`
- `sphx_glr_gallery_widgets_menu.py`

**`matplotlib.colors.to_rgba_array`**

`matplotlib.colors.to_rgba_array(c, alpha=None)`

Convert *c* to a (n, 4) array of RGBA colors.

If *alpha* is not `None`, it forces the alpha value. If *c* is "none" (case-insensitive) or an empty list, an empty array is returned. If *c* is a masked array, an ndarray is returned with a (0, 0, 0, 0) row for each masked value or row in *c*.

**`matplotlib.colors.is_color_like`**

`matplotlib.colors.is_color_like(c)`

Return whether *c* can be interpreted as an RGB(A) color.

**`matplotlib.colors.makeMappingArray`**

`matplotlib.colors.makeMappingArray(N, data, gamma=1.0)`

Create an *N* -element 1-d lookup table.

This assumes a mapping  $f : [0, 1] \rightarrow [0, 1]$ . The returned data is an array of *N* values  $y = f(x)$  where *x* is sampled from  $[0, 1]$ .

By default (*gamma* = 1) *x* is equidistantly sampled from  $[0, 1]$ . The *gamma* correction factor  $\gamma$  distorts this equidistant sampling by  $x \rightarrow x^\gamma$ .

**Parameters**

**N** [int] The number of elements of the created lookup table. This must be  $N \geq 1$ .

**data** [Mx3 array-like or callable] Defines the mapping *f*.

If a Mx3 array-like, the rows define values (x, y0, y1). The x values must start with x=0, end with x=1, and all x values be in increasing order.

A value between  $x_i$  and  $x_{i+1}$  is mapped to the range  $y_{i-1}^1 \dots y_i^0$  by linear interpolation.

For the simple case of a y-continuous mapping, y0 and y1 are identical.

The two values of y are to allow for discontinuous mapping functions. E.g. a sawtooth with a period of 0.2 and an amplitude of 1 would be:

```
[(0, 1, 0), (0.2, 1, 0), (0.4, 1, 0), ..., [(1, 1, 0)]]
```

In the special case of  $N == 1$ , by convention the returned value is  $y_0$  for  $x == 1$ .

If *data* is a callable, it must accept and return numpy arrays:

```
data(x : ndarray) -> ndarray
```

and map values between 0 - 1 to 0 - 1.

**gamma** [float] Gamma correction factor for input distribution *x* of the mapping.

See also [https://en.wikipedia.org/wiki/Gamma\\_correction](https://en.wikipedia.org/wiki/Gamma_correction).

### Returns

**lut** [array] The lookup table where `lut[x * (N-1)]` gives the closest value for values of *x* between 0 and 1.

### Notes

This function is internally used for `LinearSegmentedColormaps`.

### matplotlib.colors.get\_named\_colors\_mapping

```
matplotlib.colors.get_named_colors_mapping()
```

Return the global mapping of names to named colors.

## 17.18 matplotlib.container

```
class matplotlib.container.BarContainer(patches, errorbar=None, **kwargs)
```

Bases: `matplotlib.container.Container`

Container for the artists of bar plots (e.g. created by `Axes.bar`).

The container can be treated as a tuple of the *patches* themselves. Additionally, you can access these and further parameters by the attributes.

### Attributes

**patches** [list of *Rectangle*] The artists of the bars.

**errorbar** [None or *ErrorbarContainer*] A container for the error bar artists if error bars are present. *None* otherwise.

```
class matplotlib.container.Container(kl, label=None)
```

Bases: `tuple`

Base class for containers.

Containers are classes that collect semantically related Artists such as the bars of a bar plot.

`add_callback(self, func)`

Adds a callback function that will be called whenever one of the `Artist`'s properties changes.

Returns an `id` that is useful for removing the callback with `remove_callback()` later.

`get_children(self)`

`get_label(self)`

Get the label used for this artist in the legend.

`pchanged(self)`

Fire an event when property changed, calling all of the registered callbacks.

`remove(self)`

`remove_callback(self, oid)`

Remove a callback based on its `id`.

### See also:

`add_callback()` For adding callbacks

`set_label(self, s)`

Set the label to `s` for auto legend.

### Parameters

**s** [object] Any object other than `None` gets converted to its `str`.

`set_remove_method(self, f)`

[*Deprecated*]

### Notes

Deprecated since version 3.0:

```
class matplotlib.container.ErrorbarContainer(lines, has_xerr=False, has_yerr=False,
**kwargs)
```

Bases: `matplotlib.container.Container`

Container for the artists of error bars (e.g. created by `Axes.errorbar`).

The container can be treated as the `lines` tuple itself. Additionally, you can access these and further parameters by the attributes.

### Attributes

**lines** [tuple] Tuple of (`data_line`, `caplines`, `barlinecols`).

- `data_line` : `Line2D` instance of x, y plot markers and/or line.
- `caplines` : tuple of `Line2D` instances of the error bar caps.
- `barlinecols` : list of `LineCollection` with the horizontal and vertical error ranges.

**has\_xerr, has\_yerr** [bool] True if the errorbar has x/y errors.

```
class matplotlib.container.StemContainer(markerline_stemlines_baseline, **kwargs)
```

Bases: `matplotlib.container.Container`

Container for the artists created in a `Axes.stem()` plot.

The container can be treated like a namedtuple (markerline, stemlines, baseline).

**Attributes**

- markerline** [*Line2D*] The artist of the markers at the stem heads.
- stemlines** [list of *Line2D*] The artists of the vertical lines for all stems.
- baseline** [*Line2D*] The artist of the horizontal baseline.

**Parameters**

- markerline\_stemlines\_baseline** [tuple] Tuple of (markerline, stemlines, baseline). markerline contains the LineCollection of the markers, stemlines is a LineCollection of the main lines, baseline is the Line2D of the baseline.

## 17.19 matplotlib.contour

These are classes to support contour plotting and labelling for the Axes class.

```
class matplotlib.contour.ClabelText(x=0, y=0, text="", color=None, verticalalign='baseline', horizontalalignment='left', multialignment=None, fontproperties=None, rotation=None, linespacing=None, rotation_mode=None, usetex=None, wrap=False, **kwargs)
```

Bases: *matplotlib.text.Text*

Unlike the ordinary text, the `get_rotation` returns an updated angle in the pixel coordinate assuming that the input rotation is an angle in data coordinate (or whatever transform set).

Create a *Text* instance at *x*, *y* with string *text*.

Valid kwargs are

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and
<i>alpha</i>		float
<i>animated</i>		bool
<i>backgroundcolor</i>		color
<i>bbox</i>		dict with properties for <i>patches.FancyBboxPatch</i>
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>color</i> or <i>c</i>		color
<i>contains</i>		callable
<i>figure</i>		<i>Figure</i>
<i>fontfamily</i> or <i>family</i>		{ <i>FONTNAME</i> , 'serif', 'sans-serif', 'cursive', 'fantasy', 'monospace'}
<i>fontproperties</i> or <i>font_properties</i>		<i>font_manager.FontProperties</i>
<i>fontsize</i> or <i>size</i>		{size in points, 'xx-small', 'x-small', 'small', 'medium', 'large', 'x-large'}
<i>fontstretch</i> or <i>stretch</i>		{a numeric value in range 0-1000, 'ultra-condensed', 'extra-condensed'}
<i>fontstyle</i> or <i>style</i>		{'normal', 'italic', 'oblique'}

Continued on next page

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	Property	Description
<code>fontvariant</code> or <code>variant</code>		{'normal', 'small-caps'}
<code>fontweight</code> or <code>weight</code>		{a numeric value in range 0-1000, 'ultralight', 'light', 'normal', 'regular', 'bold', 'extra-bold'}
<code>gid</code>		str
<code>horizontalalignment</code> or <code>ha</code>		{'center', 'right', 'left'}
<code>in_layout</code>		bool
<code>label</code>		object
<code>linespacing</code>		float (multiple of font size)
<code>multialignment</code> or <code>ma</code>		{'left', 'right', 'center'}
<code>path_effects</code>		<i>AbstractPathEffect</i>
<code>picker</code>		None or bool or float or callable
<code>position</code>		(float, float)
<code>rasterized</code>		bool or None
<code>rotation</code>		{angle in degrees, 'vertical', 'horizontal'}
<code>rotation_mode</code>		{None, 'default', 'anchor'}
<code>sketch_params</code>		(scale: float, length: float, randomness: float)
<code>snap</code>		bool or None
<code>text</code>		object
<code>transform</code>		<i>Transform</i>
<code>url</code>		str
<code>usetex</code>		bool or None
<code>verticalalignment</code> or <code>va</code>		{'center', 'top', 'bottom', 'baseline', 'center_baseline'}
<code>visible</code>		bool
<code>wrap</code>		bool
<code>x</code>		float
<code>y</code>		float
<code>zorder</code>		float

```
get_rotation(self)
```

Return the text angle as float in degrees.

```
class matplotlib.contour.ContourLabeler
```

Bases: `object`

Mixin to provide labelling capability to *ContourSet*.

```
add_label(self, x, y, rotation, lev, cvalue)
```

Add contour label using *Text* class.

```
add_label_clabeltext(self, x, y, rotation, lev, cvalue)
```

Add contour label using *ClabelText* class.

```
add_label_near(self, x, y, inline=True, inline_spacing=5, transform=None)
```

Add a label near the point (x, y). If transform is None (default), (x, y) is in data coordinates; if transform is False, (x, y) is in display coordinates; otherwise, the specified transform will be used to translate (x, y) into display coordinates.

### Parameters

**x, y** [float] The approximate location of the label.

**inline** [bool, optional, default: True] If *True* remove the segment of the contour beneath the label.

**inline\_spacing** [int, optional, default: 5] Space in pixels to leave on each side of label when placing inline. This spacing will be exact for labels at locations where the contour is straight, less so for labels on curved contours.

`calc_label_rot_and_inline(self, slc, ind, lw, lc=None, spacing=5)`

This function calculates the appropriate label rotation given the linecontour coordinates in screen units, the index of the label location and the label width.

It will also break contour and calculate inlining if *lc* is not empty (*lc* defaults to the empty list if *None*). *spacing* is the space around the label in pixels to leave empty.

Do both of these tasks at once to avoid calculating path lengths multiple times, which is relatively costly.

The method used here involves calculating the path length along the contour in pixel coordinates and then looking approximately label width / 2 away from central point to determine rotation and then to break contour if desired.

`cl`

`cl_cvalues`

`cl_xy`

`clabel(self, *args, fontsize=None, inline=True, inline_spacing=5, fmt='%1.3f', colors=None, use_clabeltext=False, manual=False, rightside_up=True)`

Label a contour plot.

Call signature:

```
clabel(cs, [levels,] **kwargs)
```

Adds labels to line contours in *cs*, where *cs* is a *ContourSet* object returned by `contour()`.

### Parameters

**cs** [*ContourSet*] The *ContourSet* to label.

**levels** [array-like, optional] A list of level values, that should be labeled. The list must be a subset of `cs.levels`. If not given, all levels are labeled.

**fontsize** [string or float, optional] Size in points or relative size e.g., 'smaller', 'x-large'. See `Text.set_size` for accepted string values.

**colors** [color-spec, optional] The label colors:

- If *None*, the color of each label matches the color of the corresponding contour.
- If one string color, e.g., `colors = 'r'` or `colors = 'red'`, all labels will be plotted in this color.
- If a tuple of matplotlib color args (string, float, rgb, etc), different labels will be plotted in different colors in the order specified.

**inline** [bool, optional] If `True` the underlying contour is removed where the label is placed. Default is `True`.

**inline\_spacing** [float, optional] Space in pixels to leave on each side of label when placing inline. Defaults to 5.

This spacing will be exact for labels at locations where the contour is straight, less so for labels on curved contours.

**fmt** [string or dict, optional] A format string for the label. Default is `'%1.3f'`

Alternatively, this can be a dictionary matching contour levels with arbitrary strings to use for each contour level (i.e., `fmt[level]=string`), or it can be any callable, such as a *Formatter* instance, that returns a string when called with a numeric contour level.

**manual** [bool or iterable, optional] If `True`, contour labels will be placed manually using mouse clicks. Click the first button near a contour to add a label, click the second button (or potentially both mouse buttons at once) to finish adding labels. The third button can be used to remove the last label added, but only if labels are not inline. Alternatively, the keyboard can be used to select label locations (enter to end label placement, delete or backspace act like the third mouse button, and any other key will select a label location).

*manual* can also be an iterable object of x,y tuples. Contour labels will be created as if mouse is clicked at each x,y positions.

**rightside\_up** [bool, optional] If `True`, label rotations will always be plus or minus 90 degrees from level. Default is `True`.

**use\_clabeltext** [bool, optional] If `True`, *ClabelText* class (instead of *Text*) is used to create labels. *ClabelText* recalculates rotation angles of texts during the drawing time, therefore this can be used if aspect of the axes changes. Default is `False`.

### Returns

**labels** A list of *Text* instances for the labels.

`get_label_coords(self, distances, XX, YY, ysize, lw)`

Return x, y, and the index of a label location.

Labels are plotted at a location with the smallest deviation of the contour from a straight line unless there is another label nearby, in which case the next best place on the contour is picked up. If all such candidates are rejected, the beginning of the contour is chosen.

`get_label_width(self, lev, fmt, fsize)`

Return the width of the label in points.

`get_text(self, lev, fmt)`

Get the text of the label.

`labels(self, inline, inline_spacing)`

`locate_label(self, linecontour, labelwidth)`

Find good place to draw a label (relatively flat part of the contour).

`pop_label(self, index=-1)`

Defaults to removing last label, but any index can be supplied

`print_label(self, linecontour, labelwidth)`

Return *False* if contours are too short for a label.

`set_label_props(self, label, text, color)`

Set the label properties - color, fontsize, text.

```
too_close(self, x, y, lw)
```

Return *True* if a label is already near this location.

```
class matplotlib.contour.ContourSet(ax, *args, levels=None, filled=False,
                                     linewidths=None, linestyles=None, alpha=None,
                                     origin=None, extent=None, cmap=None,
                                     colors=None, norm=None, vmin=None,
                                     vmax=None, extend='neither', antialiased=None,
                                     **kwargs)
```

Bases: *matplotlib.cm.ScalarMappable*, *matplotlib.contour.ContourLabeler*

Store a set of contour lines or filled regions.

User-callable method: *clabel*

### Parameters

**ax** [*Axes*]

**levels** [[*level0*, *level1*, ..., *leveln*]] A list of floating point numbers indicating the contour levels.

**allsegs** [[*level0segs*, *level1segs*, ...]] List of all the polygon segments for all the *levels*. For contour lines  $\text{len}(\text{allsegs}) == \text{len}(\text{levels})$ , and for filled contour regions  $\text{len}(\text{allsegs}) = \text{len}(\text{levels}) - 1$ . The lists should look like:

```
level0segs = [polygon0, polygon1, ...]
polygon0 = array_like [[x0,y0], [x1,y1], ...]
```

**allkinds** [*None* or [*level0kinds*, *level1kinds*, ...]] Optional list of all the polygon vertex kinds (code types), as described and used in *Path*. This is used to allow multiply- connected paths such as holes within filled polygons. If not *None*,  $\text{len}(\text{allkinds}) == \text{len}(\text{allsegs})$ . The lists should look like:

```
level0kinds = [polygon0kinds, ...]
polygon0kinds = [vertexcode0, vertexcode1, ...]
```

If *allkinds* is not *None*, usually all polygons for a particular contour level are grouped together so that  $\text{level0segs} = [\text{polygon0}]$  and  $\text{level0kinds} = [\text{polygon0kinds}]$ .

**\*\*kwargs** Keyword arguments are as described in the docstring of *contour*.

### Attributes

**ax** The axes object in which the contours are drawn.

**collections** A *silent\_list* of *LineCollections* or *PolyCollections*.

**levels** Contour levels.

**layers** Same as *levels* for line contours; half-way between levels for filled contours. See *\_process\_colors()*.

Draw contour lines or filled regions, depending on whether keyword arg *filled* is *False* (default) or *True*.

Call signature:

```
ContourSet(ax, levels, allsegs, [allkinds], **kwargs)
```

### Parameters

**ax** [*Axes*] The *Axes* object to draw on.

**levels** [[level0, level1, ..., leveln]] A list of floating point numbers indicating the contour levels.

**allsegs** [[level0segs, level1segs, ...]] List of all the polygon segments for all the *levels*. For contour lines  $\text{len}(\text{allsegs}) == \text{len}(\text{levels})$ , and for filled contour regions  $\text{len}(\text{allsegs}) = \text{len}(\text{levels}) - 1$ . The lists should look like:

```
level0segs = [polygon0, polygon1, ...]
polygon0 = array_like [[x0,y0], [x1,y1], ...]
```

**allkinds** [[level0kinds, level1kinds, ...], optional] Optional list of all the polygon vertex kinds (code types), as described and used in Path. This is used to allow multiply- connected paths such as holes within filled polygons. If not *None*,  $\text{len}(\text{allkinds}) == \text{len}(\text{allsegs})$ . The lists should look like:

```
level0kinds = [polygon0kinds, ...]
polygon0kinds = [vertexcode0, vertexcode1, ...]
```

If *allkinds* is not *None*, usually all polygons for a particular contour level are grouped together so that  $\text{level0segs} = [\text{polygon0}]$  and  $\text{level0kinds} = [\text{polygon0kinds}]$ .

**\*\*kwargs** Keyword arguments are as described in the docstring of *contour*.

**changed(*self*)**

Call this whenever the mappable is changed to notify all the callbackSM listeners to the 'changed' signal

**find\_nearest\_contour(*self*, *x*, *y*, *indices=None*, *pixel=True*)**

Finds contour that is closest to a point. Defaults to measuring distance in pixels (screen space - useful for manual contour labeling), but this can be controlled via a keyword argument.

Returns a tuple containing the contour, segment, index of segment, x & y of segment point and distance to minimum point.

Optional keyword arguments:

***indices***: Indexes of contour levels to consider when looking for nearest point. Defaults to using all levels.

***pixel***: If *True*, measure distance in pixel space, if not, measure distance in axes space. Defaults to *True*.

**get\_alpha(*self*)**

returns alpha to be applied to all ContourSet artists

**get\_transform(*self*)**

Return the *Transform* instance used by this ContourSet.

**legend\_elements(*self*, *variable\_name='x'*, *str\_format=<class 'str'>*)**

Return a list of artists and labels suitable for passing through to `plt.legend()` which represent this ContourSet.

The labels have the form "`0 < x <= 1`" stating the data ranges which the artists represent.

### Parameters

**variable\_name** [str] The string used inside the inequality used on the labels.

**str\_format** [function: float -> str] Function used to format the numbers in the labels.

### Returns

**artists** [List[Artist]] A list of the artists.

**labels** [List[str]] A list of the labels.

`set_alpha(self, alpha)`

Set the alpha blending value for all ContourSet artists. *alpha* must be between 0 (transparent) and 1 (opaque).

```
class matplotlib.contour.QuadContourSet(ax, *args, levels=None, filled=False,
                                         linewidths=None, linestyle=None, al-
                                         pha=None, origin=None, extent=None,
                                         cmap=None, colors=None, norm=None,
                                         vmin=None, vmax=None, extend='neither',
                                         antialiased=None, **kwargs)
```

Bases: `matplotlib.contour.ContourSet`

Create and store a set of contour lines or filled regions.

User-callable method: `clabel`

### Attributes

**ax** The axes object in which the contours are drawn.

**collections** A silent\_list of LineCollections or PolyCollections.

**levels** Contour levels.

**layers** Same as levels for line contours; half-way between levels for filled contours. See `_process_colors()` method.

Draw contour lines or filled regions, depending on whether keyword arg *filled* is False (default) or True.

Call signature:

```
ContourSet(ax, levels, allsegs, [allkinds], **kwargs)
```

### Parameters

**ax** [Axes] The *Axes* object to draw on.

**levels** [[level0, level1, ..., leveln]] A list of floating point numbers indicating the contour levels.

**allsegs** [[level0segs, level1segs, ...]] List of all the polygon segments for all the *levels*. For contour lines `len(allsegs) == len(levels)`, and for filled contour regions `len(allsegs) = len(levels)-1`. The lists should look like:

```
level0segs = [polygon0, polygon1, ...]
polygon0 = array_like [[x0,y0], [x1,y1], ...]
```

**allkinds** [[level0kinds, level1kinds, ...], optional] Optional list of all the polygon vertex kinds (code types), as described and used in Path. This is

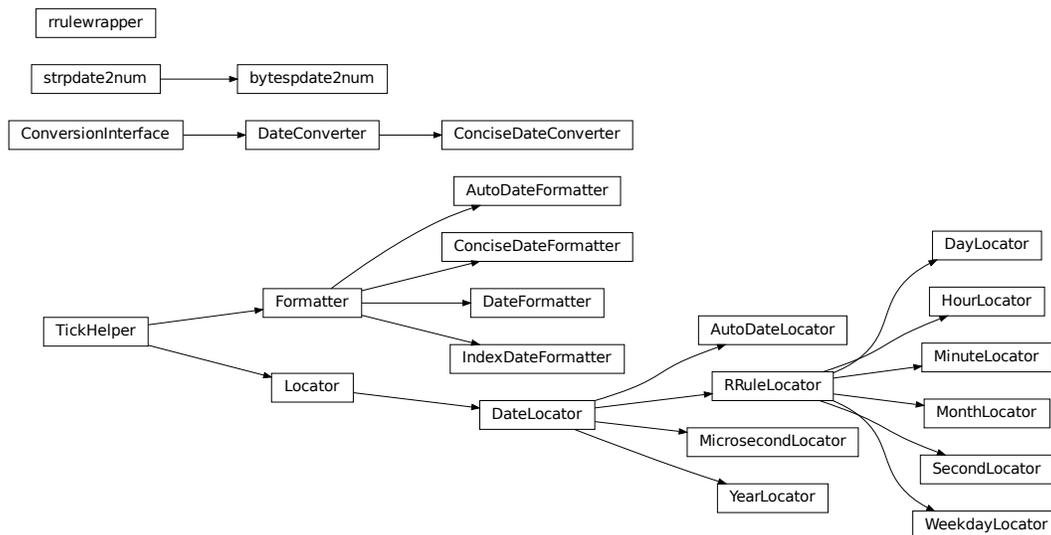
used to allow multiply- connected paths such as holes within filled polygons. If not `None`, `len(allkinds) == len(allsegs)`. The lists should look like:

```
level0kinds = [polygon0kinds, ...]
polygon0kinds = [vertexcode0, vertexcode1, ...]
```

If `allkinds` is not `None`, usually all polygons for a particular contour level are grouped together so that `level0segs = [polygon0]` and `level0kinds = [polygon0kinds]`.

**\*\*kwargs** Keyword arguments are as described in the docstring of `contour`.

## 17.20 matplotlib.dates



Matplotlib provides sophisticated date plotting capabilities, standing on the shoulders of python `datetime` and the add-on module `dateutil`.

### 17.20.1 Matplotlib date format

Matplotlib represents dates using floating point numbers specifying the number of days since 0001-01-01 UTC, plus 1. For example, 0001-01-01, 06:00 is 1.25, not 0.25. Values  $< 1$ , i.e. dates before 0001-01-01 UTC are not supported.

There are a number of helper functions to convert between `datetime` objects and Matplotlib dates:

<code>datestr2num</code>	Convert a date string to a datenum using <code>dateutil.parser.parse()</code> .
<code>date2num</code>	Convert <code>datetime</code> objects to Matplotlib dates.
<code>num2date</code>	Convert Matplotlib dates to <code>datetime</code> objects.
<code>num2timedelta</code>	Convert number of days to a <code>timedelta</code> object.
<code>epoch2num</code>	Convert an epoch or sequence of epochs to the new date format, that is days since 0001.
<code>num2epoch</code>	Convert days since 0001 to epoch.
<code>mx2num</code>	Convert <code>mx datetime</code> instance (or sequence of <code>mx</code> instances) to the new date format.
<code>drange</code>	Return a sequence of equally spaced Matplotlib dates.

**Note:** Like Python's `datetime`, `mpl` uses the Gregorian calendar for all conversions between dates and floating point numbers. This practice is not universal, and calendar differences can cause confusing differences between what Python and `mpl` give as the number of days since 0001-01-01 and what other software and databases yield. For example, the US Naval Observatory uses a calendar that switches from Julian to Gregorian in October, 1582. Hence, using their calculator, the number of days between 0001-01-01 and 2006-04-01 is 732403, whereas using the Gregorian calendar via the `datetime` module we find:

```
In [1]: date(2006, 4, 1).toordinal() - date(1, 1, 1).toordinal()
Out[1]: 732401
```

All the Matplotlib date converters, tickers and formatters are timezone aware. If no explicit timezone is provided, the `rcParam` `timezone` is assumed. If you want to use a custom time zone, pass a `datetime.tzinfo` instance with the `tz` keyword argument to `num2date()`, `plot_date()`, and any custom date tickers or locators you create.

A wide range of specific and general purpose date tick locators and formatters are provided in this module. See `matplotlib.ticker` for general information on tick locators and formatters. These are described below.

The `dateutil` module provides additional code to handle date ticking, making it easy to place ticks on any kinds of dates. See examples below.

## 17.20.2 Date tickers

Most of the date tickers can locate single or multiple values. For example:

```
# import constants for the days of the week
from matplotlib.dates import MO, TU, WE, TH, FR, SA, SU

# tick on Mondays every week
loc = WeekdayLocator(byweekday=MO, tz=tz)

# tick on Mondays and Saturdays
loc = WeekdayLocator(byweekday=(MO, SA))
```

In addition, most of the constructors take an interval argument:

```
# tick on Mondays every second week
loc = WeekdayLocator(byweekday=MO, interval=2)
```

The rrule locator allows completely general date ticking:

```
# tick every 5th easter
rule = rrulewrapper(YEARLY, byeaster=1, interval=5)
loc = RRuleLocator(rule)
```

Here are all the date tickers:

- *MicrosecondLocator*: locate microseconds
- *SecondLocator*: locate seconds
- *MinuteLocator*: locate minutes
- *HourLocator*: locate hours
- *DayLocator*: locate specified days of the month
- *WeekdayLocator*: Locate days of the week, e.g., MO, TU
- *MonthLocator*: locate months, e.g., 7 for July
- *YearLocator*: locate years that are multiples of base
- *RRuleLocator*: locate using a `matplotlib.dates.rrulewrapper`. `rrulewrapper` is a simple wrapper around `dateutil`'s `dateutil.rrule` which allow almost arbitrary date tick specifications. See `rrule` example.
- *AutoDateLocator*: On autoscale, this class picks the best *DateLocator* (e.g., *RRuleLocator*) to set the view limits and the tick locations. If called with `interval_multiples=True` it will make ticks line up with sensible multiples of the tick intervals. E.g. if the interval is 4 hours, it will pick hours 0, 4, 8, etc as ticks. This behaviour is not guaranteed by default.

### 17.20.3 Date formatters

Here are all the date formatters:

- *AutoDateFormatter*: attempts to figure out the best format to use. This is most useful when used with the *AutoDateLocator*.
- *ConciseDateFormatter*: also attempts to figure out the best format to use, and to make the format as compact as possible while still having complete date information. This is most useful when used with the *AutoDateLocator*.
- *DateFormatter*: use `strftime()` format strings
- *IndexDateFormatter*: date plots with implicit *x* indexing.

`matplotlib.dates.datestr2num(d, default=None)`

Convert a date string to a datenum using `dateutil.parser.parse()`.

#### Parameters

**d** [string or sequence of strings] The dates to convert.

**default** [datetime instance, optional] The default date to use when fields are missing in *d*.

`matplotlib.dates.date2num(d)`

Convert datetime objects to Matplotlib dates.

### Parameters

**d** [`datetime.datetime` or `numpy.datetime64` or sequences of these]

### Returns

**float or sequence of floats** Number of days (fraction part represents hours, minutes, seconds, ms) since 0001-01-01 00:00:00 UTC, plus one.

### Notes

The addition of one here is a historical artifact. Also, note that the Gregorian calendar is assumed; this is not universal practice. For details see the module docstring.

`matplotlib.dates.num2date(x, tz=None)`

Convert Matplotlib dates to `datetime` objects.

### Parameters

**x** [float or sequence of floats] Number of days (fraction part represents hours, minutes, seconds) since 0001-01-01 00:00:00 UTC, plus one.

**tz** [string, optional] Timezone of `x` (defaults to `rcparams.timezone`).

### Returns

`datetime` or **sequence of `datetime`** Dates are returned in timezone `tz`.

If `x` is a sequence, a sequence of `datetime` objects will be returned.

### Notes

The addition of one here is a historical artifact. Also, note that the Gregorian calendar is assumed; this is not universal practice. For details, see the module docstring.

`matplotlib.dates.num2timedelta(x)`

Convert number of days to a `timedelta` object.

If `x` is a sequence, a sequence of `timedelta` objects will be returned.

### Parameters

**x** [float, sequence of floats] Number of days. The fraction part represents hours, minutes, seconds.

### Returns

`datetime.timedelta` or **list[`datetime.timedelta`]**

`matplotlib.dates.drange(dstart, dend, delta)`

Return a sequence of equally spaced Matplotlib dates.

The dates start at `dstart` and reach up to, but not including `dend`. They are spaced by `delta`.

### Parameters

**dstart, dend** [`datetime`] The date limits.

**delta** [`datetime.timedelta`] Spacing of the dates.

## Returns

**drange** [`numpy.array`] A list floats representing Matplotlib dates.

`matplotlib.dates.epoch2num(e)`

Convert an epoch or sequence of epochs to the new date format, that is days since 0001.

`matplotlib.dates.num2epoch(d)`

Convert days since 0001 to epoch. *d* can be a number or sequence.

`matplotlib.dates.mx2num(mxdates)`

Convert *mx* datetime instance (or sequence of *mx* instances) to the new date format.

`class matplotlib.dates.DateFormatter(fmt, tz=None)`

Bases: `matplotlib.ticker.Formatter`

Format a tick (in seconds since the epoch) with a *strftime* format string.

## Parameters

**fmt** [`str`] *strftime* format string

**tz** [`tzinfo`]

`illegal_s = re.compile('((^[^%])|%)*%s')`

`set_tzinfo(self, tz)`

`strftime(self, dt, fmt=None)`

[*Deprecated*] Refer to documentation for `datetime.datetime.strftime()`

*fmt* is a `datetime.datetime.strftime()` format string.

Warning: For years before 1900, depending upon the current locale it is possible that the year displayed with `%x` might be incorrect. For years before 100, `%y` and `%Y` will yield zero-padded strings.

## Notes

Deprecated since version 3.0.

`strftime_pre_1900(self, dt, fmt=None)`

[*Deprecated*] Call `time.strftime` for years before 1900 by rolling forward a multiple of 28 years.

*fmt* is a `strftime()` format string.

Dalke: I hope I did this math right. Every 28 years the calendar repeats, except through century leap years excepting the 400 year leap years. But only if you're using the Gregorian calendar.

## Notes

Deprecated since version 3.0.

`class matplotlib.dates.ConciseDateFormatter(locator, tz=None, formats=None, offset_formats=None, zero_formats=None, show_offset=True)`

Bases: `matplotlib.ticker.Formatter`

This class attempts to figure out the best format to use for the date, and to make it as compact as possible, but still be complete. This is most useful when used with the *AutoDateLocator*:

```
>>> locator = AutoDateLocator()
>>> formatter = ConciseDateFormatter(locator)
```

### Parameters

**locator** [*ticker.Locator*] Locator that this axis is using.

**tz** [string, optional] Passed to *dates.date2num*.

**formats** [list of 6 strings, optional] Format strings for 6 levels of tick labelling: mostly years, months, days, hours, minutes, and seconds. Strings use the same format codes as *strftime*. Default is ['%Y', '%b', '%d', '%H:%M', '%H:%M', '%S.%f']

**zero\_formats** [list of 6 strings, optional] Format strings for tick labels that are "zeros" for a given tick level. For instance, if most ticks are months, ticks around 1 Jan 2005 will be labeled "Dec", "2005", "Feb". The default is ['', '%Y', '%b', '%b-%d', '%H:%M', '%H:%M']

**offset\_formats** [list of 6 strings, optional] Format strings for the 6 levels that is applied to the "offset" string found on the right side of an x-axis, or top of a y-axis. Combined with the tick labels this should completely specify the date. The default is:

```
['', '%Y', '%Y-%b', '%Y-%b-%d', '%Y-%b-%d', '%Y-%b-%d %H:%M']
```

**show\_offset** [bool] Whether to show the offset or not. Default is True.

### Examples

See [/gallery/ticks\\_and\\_spines/date\\_concise\\_formatter](#)

Autoformat the date labels. The default format is used to form an initial string, and then redundant elements are removed.

*format\_data\_short(self, value)*

Return a short string version of the tick value.

Defaults to the position-independent long value.

*format\_ticks(self, values)*

Return the tick labels for all the ticks at once.

*get\_offset(self)*

```
class matplotlib.dates.IndexDateFormatter(t, fmt, tz=None)
```

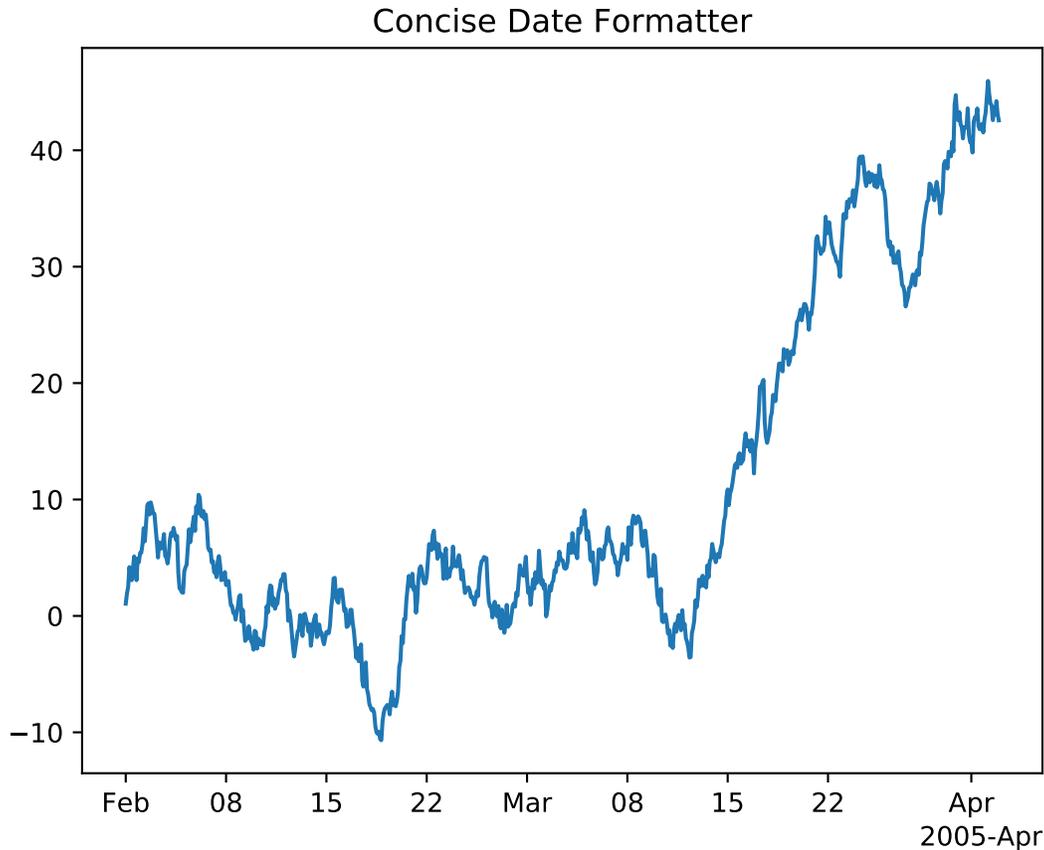
Bases: *matplotlib.ticker.Formatter*

Use with *IndexLocator* to cycle format strings by index.

*t* is a sequence of dates (floating point days). *fmt* is a *strftime()* format string.

```
class matplotlib.dates.AutoDateFormatter(locator, tz=None, defaultfmt='%Y-%m-%d')
```

Bases: *matplotlib.ticker.Formatter*



This class attempts to figure out the best format to use. This is most useful when used with the *AutoDateLocator*.

The *AutoDateFormatter* has a scale dictionary that maps the scale of the tick (the distance in days between one major tick) and a format string. The default looks like this:

```
self.scaled = {
    DAYS_PER_YEAR: rcParams['date.autoformat.year'],
    DAYS_PER_MONTH: rcParams['date.autoformat.month'],
    1.0: rcParams['date.autoformat.day'],
    1. / HOURS_PER_DAY: rcParams['date.autoformat.hour'],
    1. / (MINUTES_PER_DAY): rcParams['date.autoformat.minute'],
    1. / (SEC_PER_DAY): rcParams['date.autoformat.second'],
    1. / (MUSECONDS_PER_DAY): rcParams['date.autoformat.microsecond'],
}
```

The algorithm picks the key in the dictionary that is  $\geq$  the current scale and uses that format string. You can customize this dictionary by doing:

```
>>> locator = AutoDateLocator()
>>> formatter = AutoDateFormatter(locator)
>>> formatter.scaled[1/(24.*60.)] = '%M:%S' # only show min and sec
```

A custom *FuncFormatter* can also be used. The following example shows how to use a custom format function to strip trailing zeros from decimal seconds and adds the date to the first ticklabel:

```

>>> def my_format_function(x, pos=None):
...     x = matplotlib.dates.num2date(x)
...     if pos == 0:
...         fmt = '%D %H:%M:%S.%f'
...     else:
...         fmt = '%H:%M:%S.%f'
...     label = x.strftime(fmt)
...     label = label.rstrip("0")
...     label = label.rstrip(".")
...     return label
>>> from matplotlib.ticker import FuncFormatter
>>> formatter.scaled[1/(24.*60.)] = FuncFormatter(my_format_function)

```

Autoformat the date labels. The default format is the one to use if none of the values in `self.scaled` are greater than the unit returned by `locator._get_unit()`.

```
class matplotlib.dates.DateLocator(tz=None)
```

Bases: *matplotlib.ticker.Locator*

Determines the tick locations when plotting dates.

This class is subclassed by other Locators and is not meant to be used on its own.

*tz* is a `tzinfo` instance.

`datalim_to_dt(self)`

Convert axis data interval to datetime objects.

`hms0d = {'byhour': 0, 'byminute': 0, 'bysecond': 0}`

`nonsingular(self, vmin, vmax)`

Given the proposed upper and lower extent, adjust the range if it is too close to being singular (i.e. a range of  $\sim 0$ ).

`set_tzinfo(self, tz)`

Set time zone info.

`viewlim_to_dt(self)`

Converts the view interval to datetime objects.

```
class matplotlib.dates.RRRuleLocator(o, tz=None)
```

Bases: *matplotlib.dates.DateLocator*

`autoscale(self)`

Set the view limits to include the data range.

`static get_unit_generic(freq)`

`tick_values(self, vmin, vmax)`

Return the values of the located ticks given **vmin** and **vmax**.

---

**Note:** To get tick locations with the `vmin` and `vmax` values defined automatically for the associated axis simply call the Locator instance:

```

>>> print(type(loc))
<type 'Locator'>
>>> print(loc())
[1, 2, 3, 4]

```

```
class matplotlib.dates.AutoDateLocator(tz=None, minticks=5, maxticks=None, interval_multiples=True)
```

Bases: `matplotlib.dates.DateLocator`

On autoscale, this class picks the best `DateLocator` to set the view limits and the tick locations.

`minticks` is the minimum number of ticks desired, which is used to select the type of ticking (yearly, monthly, etc.).

`maxticks` is the maximum number of ticks desired, which controls any interval between ticks (ticking every other, every 3, etc.). For really fine-grained control, this can be a dictionary mapping individual `rrule` frequency constants (YEARLY, MONTHLY, etc.) to their own maximum number of ticks. This can be used to keep the number of ticks appropriate to the format chosen in `AutoDateFormatter`. Any frequency not specified in this dictionary is given a default value.

`tz` is a `tzinfo` instance.

`interval_multiples` is a boolean that indicates whether ticks should be chosen to be multiple of the interval. This will lock ticks to 'nicer' locations. For example, this will force the ticks to be at hours 0,6,12,18 when hourly ticking is done at 6 hour intervals.

The `AutoDateLocator` has an interval dictionary that maps the frequency of the tick (a constant from `dateutil.rrule`) and a multiple allowed for that ticking. The default looks like this:

```
self.intervald = {
    YEARLY : [1, 2, 4, 5, 10, 20, 40, 50, 100, 200, 400, 500,
              1000, 2000, 4000, 5000, 10000],
    MONTHLY : [1, 2, 3, 4, 6],
    DAILY : [1, 2, 3, 7, 14],
    HOURLY : [1, 2, 3, 4, 6, 12],
    MINUTELY: [1, 5, 10, 15, 30],
    SECONDLY: [1, 5, 10, 15, 30],
    MICROSECONDLY: [1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000,
                    5000, 10000, 20000, 50000, 100000, 200000, 500000,
                    1000000],
}
```

The interval is used to specify multiples that are appropriate for the frequency of ticking. For instance, every 7 days is sensible for daily ticks, but for minutes/seconds, 15 or 30 make sense. You can customize this dictionary by doing:

```
locator = AutoDateLocator()
locator.intervald[HOURLY] = [3] # only show every 3 hours
```

`autoscale(self)`

Try to choose the view limits intelligently.

`get_locator(self, dmin, dmax)`

Pick the best locator based on a distance.

`nonsingular(self, vmin, vmax)`

Given the proposed upper and lower extent, adjust the range if it is too close to being singular (i.e. a range of  $\sim 0$ ).

`refresh(self)`

Refresh internal information based on current limits.

`set_axis(self, axis)`

`tick_values(self, vmin, vmax)`

Return the values of the located ticks given **vmin** and **vmax**.

---

**Note:** To get tick locations with the `vmin` and `vmax` values defined automatically for the associated axis simply call the Locator instance:

```
>>> print(type(loc))
<type 'Locator'>
>>> print(loc())
[1, 2, 3, 4]
```

---

`class matplotlib.dates.YearLocator(base=1, month=1, day=1, tz=None)`

Bases: `matplotlib.dates.DateLocator`

Make ticks on a given day of each year that is a multiple of base.

Examples:

```
# Tick every year on Jan 1st
locator = YearLocator()

# Tick every 5 years on July 4th
locator = YearLocator(5, month=7, day=4)
```

Mark years that are multiple of base on a given month and day (default jan 1).

`autoscale(self)`

Set the view limits to include the data range.

`tick_values(self, vmin, vmax)`

Return the values of the located ticks given **vmin** and **vmax**.

---

**Note:** To get tick locations with the `vmin` and `vmax` values defined automatically for the associated axis simply call the Locator instance:

```
>>> print(type(loc))
<type 'Locator'>
>>> print(loc())
[1, 2, 3, 4]
```

---

`class matplotlib.dates.MonthLocator(bymonth=None, bymonthday=1, interval=1, tz=None)`

Bases: `matplotlib.dates.RRuleLocator`

Make ticks on occurrences of each month, e.g., 1, 3, 12.

Mark every month in `bymonth`; `bymonth` can be an int or sequence. Default is `range(1, 13)`, i.e. every month.

`interval` is the interval between each iteration. For example, if `interval=2`, mark every second occurrence.

`class matplotlib.dates.WeekdayLocator(byweekday=1, interval=1, tz=None)`

Bases: `matplotlib.dates.RRuleLocator`

Make ticks on occurrences of each weekday.

Mark every weekday in *byweekday*; *byweekday* can be a number or sequence.

Elements of *byweekday* must be one of MO, TU, WE, TH, FR, SA, SU, the constants from `dateutil.rrule`, which have been imported into the `matplotlib.dates` namespace.

*interval* specifies the number of weeks to skip. For example, `interval=2` plots every second week.

```
class matplotlib.dates.DayLocator(bymonthday=None, interval=1, tz=None)
    Bases: matplotlib.dates.RRuleLocator
```

Make ticks on occurrences of each day of the month. For example, 1, 15, 30.

Mark every day in *bymonthday*; *bymonthday* can be an int or sequence.

Default is to tick every day of the month: `bymonthday=range(1,32)`

```
class matplotlib.dates.HourLocator(byhour=None, interval=1, tz=None)
    Bases: matplotlib.dates.RRuleLocator
```

Make ticks on occurrences of each hour.

Mark every hour in *byhour*; *byhour* can be an int or sequence. Default is to tick every hour: `byhour=range(24)`

*interval* is the interval between each iteration. For example, if `interval=2`, mark every second occurrence.

```
class matplotlib.dates.MinuteLocator(byminute=None, interval=1, tz=None)
    Bases: matplotlib.dates.RRuleLocator
```

Make ticks on occurrences of each minute.

Mark every minute in *byminute*; *byminute* can be an int or sequence. Default is to tick every minute: `byminute=range(60)`

*interval* is the interval between each iteration. For example, if `interval=2`, mark every second occurrence.

```
class matplotlib.dates.SecondLocator(bysecond=None, interval=1, tz=None)
    Bases: matplotlib.dates.RRuleLocator
```

Make ticks on occurrences of each second.

Mark every second in *bysecond*; *bysecond* can be an int or sequence. Default is to tick every second: `bysecond = range(60)`

*interval* is the interval between each iteration. For example, if `interval=2`, mark every second occurrence.

```
class matplotlib.dates.MicrosecondLocator(interval=1, tz=None)
    Bases: matplotlib.dates.DateLocator
```

Make ticks on regular intervals of one or more microsecond(s).

---

**Note:** Due to the floating point representation of time in days since 0001-01-01 UTC (plus 1), plotting data with microsecond time resolution does not work well with current dates.

If you want microsecond resolution time plots, it is strongly recommended to use floating point seconds, not datetime-like time representation.

If you really must use `datetime.datetime()` or similar and still need microsecond precision, your only chance is to use very early years; using year 0001 is recommended.

*interval* is the interval between each iteration. For example, if `interval=2`, mark every second microsecond.

```
set_axis(self, axis)
```

```
set_data_interval(self, vmin, vmax)
```

```
set_view_interval(self, vmin, vmax)
```

```
tick_values(self, vmin, vmax)
```

Return the values of the located ticks given **vmin** and **vmax**.

**Note:** To get tick locations with the `vmin` and `vmax` values defined automatically for the associated axis simply call the Locator instance:

```
>>> print(type(loc))
<type 'Locator'>
>>> print(loc())
[1, 2, 3, 4]
```

```
class matplotlib.dates.rrule(freq, dtstart=None, interval=1, wkst=None,
                             count=None, until=None, bysetpos=None, by-
                             month=None, bymonthday=None, byyearday=None,
                             byeaster=None, byweekno=None, byweekday=None,
                             byhour=None, byminute=None, bysecond=None,
                             cache=False)
```

Bases: `dateutil.rrule.rrulebase`

That's the base of the `rrule` operation. It accepts all the keywords defined in the RFC as its constructor parameters (except `byday`, which was renamed to `byweekday`) and more. The constructor prototype is:

```
rrule(freq)
```

Where `freq` must be one of `YEARLY`, `MONTHLY`, `WEEKLY`, `DAILY`, `HOURLY`, `MINUTELY`, or `SECONDLY`.

**Note:** Per RFC section 3.3.10, recurrence instances falling on invalid dates and times are ignored rather than coerced:

Recurrence rules may generate recurrence instances with an invalid date (e.g., February 30) or nonexistent local time (e.g., 1:30 AM on a day where the local time is moved forward by an hour at 1:00 AM). Such recurrence instances **MUST** be ignored and **MUST NOT** be counted as part of the recurrence set.

This can lead to possibly surprising behavior when, for example, the start date occurs at the end of the month:

```
>>> from dateutil.rrule import rrule, MONTHLY
>>> from datetime import datetime
>>> start_date = datetime(2014, 12, 31)
>>> list(rrule(freq=MONTHLY, count=4, dtstart=start_date))
```

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```
... # doctest: +NORMALIZE_WHITESPACE
[datetime.datetime(2014, 12, 31, 0, 0),
datetime.datetime(2015, 1, 31, 0, 0),
datetime.datetime(2015, 3, 31, 0, 0),
datetime.datetime(2015, 5, 31, 0, 0)]
```

Additionally, it supports the following keyword arguments:

### Parameters

- `dtstart` - The recurrence start. Besides being the base for the recurrence, missing parameters in the final recurrence instances will also be extracted from this date. If not given, `datetime.now()` will be used instead.
- `interval` - The interval between each `freq` iteration. For example, when using `YEARLY`, an interval of 2 means once every two years, but with `HOURLY`, it means once every two hours. The default interval is 1.
- `wkst` - The week start day. Must be one of the `MO`, `TU`, `WE` constants, or an integer, specifying the first day of the week. This will affect recurrences based on weekly periods. The default week start is got from `calendar.firstweekday()`, and may be modified by `calendar.setfirstweekday()`.
- `count` - If given, this determines how many occurrences will be generated.

---

**Note:** As of version 2.5.0, the use of the keyword `until` in conjunction with `count` is deprecated, to make sure `dateutil` is fully compliant with [RFC-5545 Sec. 3.3.10](#). Therefore, `until` and `count` **must not** occur in the same call to `rrule`.

---

- `until` - If given, this must be a `datetime` instance specifying the upper-bound limit of the recurrence. The last recurrence in the rule is the greatest `datetime` that is less than or equal to the value specified in the `until` parameter.

---

**Note:** As of version 2.5.0, the use of the keyword `until` in conjunction with `count` is deprecated, to make sure `dateutil` is fully compliant with [RFC-5545 Sec. 3.3.10](#). Therefore, `until` and `count` **must not** occur in the same call to `rrule`.

---

- `bysetpos` - If given, it must be either an integer, or a sequence of integers, positive or negative. Each given integer will specify an occurrence number, corresponding to the `n`th occurrence of the rule inside the frequency period. For example, a `bysetpos` of -1 if combined with a `MONTHLY` frequency, and a `byweekday` of (`MO`, `TU`, `WE`, `TH`, `FR`), will result in the last work day of every month.
- `bymonth` - If given, it must be either an integer, or a sequence of integers, meaning the months to apply the recurrence to.

- `bymonthday` - If given, it must be either an integer, or a sequence of integers, meaning the month days to apply the recurrence to.
- `byyearday` - If given, it must be either an integer, or a sequence of integers, meaning the year days to apply the recurrence to.
- `byeaster` - If given, it must be either an integer, or a sequence of integers, positive or negative. Each integer will define an offset from the Easter Sunday. Passing the offset 0 to `byeaster` will yield the Easter Sunday itself. This is an extension to the RFC specification.
- `byweekno` - If given, it must be either an integer, or a sequence of integers, meaning the week numbers to apply the recurrence to. Week numbers have the meaning described in ISO8601, that is, the first week of the year is that containing at least four days of the new year.
- `byweekday` - If given, it must be either an integer (0 == MO), a sequence of integers, one of the weekday constants (MO, TU, etc), or a sequence of these constants. When given, these variables will define the weekdays where the recurrence will be applied. It's also possible to use an argument `n` for the weekday instances, which will mean the `n`th occurrence of this weekday in the period. For example, with MONTHLY, or with YEARLY and BYMONTH, using FR(+1) in `byweekday` will specify the first friday of the month where the recurrence happens. Notice that in the RFC documentation, this is specified as BYDAY, but was renamed to avoid the ambiguity of that keyword.
- `byhour` - If given, it must be either an integer, or a sequence of integers, meaning the hours to apply the recurrence to.
- `byminute` - If given, it must be either an integer, or a sequence of integers, meaning the minutes to apply the recurrence to.
- `bysecond` - If given, it must be either an integer, or a sequence of integers, meaning the seconds to apply the recurrence to.
- `cache` - If given, it must be a boolean value specifying to enable or disable caching of results. If you will use the same `rrule` instance multiple times, enabling caching will improve the performance considerably.

`replace(self, **kwargs)`

Return new `rrule` with same attributes except for those attributes given new values by whichever keyword arguments are specified.

```
class matplotlib.dates.relativedelta(dt1=None, dt2=None, years=0, months=0,
                                     days=0, leapdays=0, weeks=0, hours=0,
                                     minutes=0, seconds=0, microseconds=0,
                                     year=None, month=None, day=None, week-
                                     day=None, yearday=None, nlyearday=None,
                                     hour=None, minute=None, second=None, mi-
                                     crosecond=None)
```

Bases: `object`

The `relativedelta` type is designed to be applied to an existing `datetime` and can replace specific components of that `datetime`, or represents an interval of time.

It is based on the specification of the excellent work done by M.-A. Lemburg in his [mx.DateTime](#) extension. However, notice that this type does *NOT* implement the same algorithm as his work. Do *NOT* expect it to behave like `mx.DateTime`'s counterpart.

There are two different ways to build a `relativedelta` instance. The first one is passing it two date/datetime classes:

```
relativedelta(datetime1, datetime2)
```

The second one is passing it any number of the following keyword arguments:

```
relativedelta(arg1=x,arg2=y,arg3=z...)
```

`year`, `month`, `day`, `hour`, `minute`, `second`, `microsecond`:

Absolute information (argument `is` singular); adding `or` subtracting a `relativedelta` `with` absolute information does `not` perform an arithmetic operation, but rather REPLACES the corresponding value `in` the original datetime `with` the value(s) `in` `relativedelta`.

`years`, `months`, `weeks`, `days`, `hours`, `minutes`, `seconds`, `microseconds`:

Relative information, may be negative (argument `is` plural); adding `or` subtracting a `relativedelta` `with` relative information performs the corresponding arithmetic operation on the original datetime value `with` the information `in` the `relativedelta`.

`weekday`:

One of the weekday instances (`MO`, `TU`, etc) available `in` the `relativedelta` module. These instances may receive a parameter `N`, specifying the `N`th weekday, which could be positive `or` negative (like `MO(+1)` `or` `MO(-2)`). Not specifying it `is` the same `as` specifying `+1`. You can also use an integer, where `0=MO`. This argument `is` always relative e.g. `if` the calculated date `is` already Monday, using `MO(1)` `or` `MO(-1)` won't change the day. To effectively make it absolute, use it `in` combination `with` the `day` argument (e.g. `day=1`, `MO(1)` for first Monday of the month).

`leapdays`:

Will add given days to the date found, `if` year `is` a leap year, `and` the date found `is` post 28 of february.

`yearday`, `nlyearday`:

Set the `yearday` `or` the non-leap year day (jump leap days). These are converted to `day/month/leapdays` information.

There are relative and absolute forms of the keyword arguments. The plural is relative, and the singular is absolute. For each argument in the order below, the absolute form is applied first (by setting each attribute to that value) and then the relative form (by adding the value to the attribute).

The order of attributes considered when this `relativedelta` is added to a datetime is:

1. Year
2. Month
3. Day
4. Hours
5. Minutes
6. Seconds

## 7. Microseconds

Finally, weekday is applied, using the rule described above.

For example

```
>>> from datetime import datetime
>>> from dateutil.relativedelta import relativedelta, MO
>>> dt = datetime(2018, 4, 9, 13, 37, 0)
>>> delta = relativedelta(hours=25, day=1, weekday=MO(1))
>>> dt + delta
datetime.datetime(2018, 4, 2, 14, 37)
```

First, the day is set to 1 (the first of the month), then 25 hours are added, to get to the 2nd day and 14th hour, finally the weekday is applied, but since the 2nd is already a Monday there is no effect.

`normalized(self)`

Return a version of this object represented entirely using integer values for the relative attributes.

```
>>> relativedelta(days=1.5, hours=2).normalized()
relativedelta(days=+1, hours=+14)
```

**Returns** Returns a `dateutil.relativedelta.relativedelta` object.

**weeks**

`matplotlib.dates.seconds(s)`

*[Deprecated]* Return seconds as days.

**Notes**

Deprecated since version 3.1.

`matplotlib.dates.minutes(m)`

*[Deprecated]* Return minutes as days.

**Notes**

Deprecated since version 3.1.

`matplotlib.dates.hours(h)`

*[Deprecated]* Return hours as days.

**Notes**

Deprecated since version 3.1.

`matplotlib.dates.weeks(w)`

*[Deprecated]* Return weeks as days.

## Notes

Deprecated since version 3.1.

## 17.21 matplotlib.dviread

A module for reading dvi files output by TeX. Several limitations make this not (currently) useful as a general-purpose dvi preprocessor, but it is currently used by the pdf backend for processing usetex text.

Interface:

```

with Dvi(filename, 72) as dvi:
    # iterate over pages:
    for page in dvi:
        w, h, d = page.width, page.height, page.descent
        for x, y, font, glyph, width in page.text:
            fontname = font.texname
            pointsize = font.size
            ...
        for x, y, height, width in page.bboxes:
            ...

```

class matplotlib.dviread.Dvi(*filename*, *dpi*)

Bases: object

A reader for a dvi ("device-independent") file, as produced by TeX. The current implementation can only iterate through pages in order, and does not even attempt to verify the postamble.

This class can be used as a context manager to close the underlying file upon exit. Pages can be read via iteration. Here is an overly simple way to extract text without trying to detect whitespace:

```

>>> with matplotlib.dviread.Dvi('input.dvi', 72) as dvi:
...     for page in dvi:
...         print(''.join(chr(t.glyph) for t in page.text))

```

Read the data from the file named *filename* and convert TeX's internal units to units of *dpi* per inch. *dpi* only sets the units and does not limit the resolution. Use None to return TeX's internal units.

close(*self*)

Close the underlying file if it is open.

class matplotlib.dviread.DviFont(*scale*, *tfm*, *texname*, *vf*)

Bases: object

Encapsulation of a font that a DVI file can refer to.

This class holds a font's texname and size, supports comparison, and knows the widths of glyphs in the same units as the AFM file. There are also internal attributes (for use by dviread.py) that are *not* used for comparison.

The size is in Adobe points (converted from TeX points).

### Parameters

**scale** [float] Factor by which the font is scaled from its natural size.

**tfm** [Tfm] TeX font metrics for this font

**texname** [bytes] Name of the font as used internally by TeX and friends, as an ASCII bytestring. This is usually very different from any external font names, and `dviread.PsfontsMap` can be used to find the external name of the font.

**vf** [Vf] A TeX "virtual font" file, or None if this font is not virtual.

### Attributes

**texname** [bytes]

**size** [float] Size of the font in Adobe points, converted from the slightly smaller TeX points.

**widths** [list] Widths of glyphs in glyph-space units, typically 1/1000ths of the point size.

size

texname

widths

```
class matplotlib.dviread.Encoding(filename)
```

Bases: `object`

Parses a \*.enc file referenced from a psfonts.map style file. The format this class understands is a very limited subset of PostScript.

Usage (subject to change):

```
for name in Encoding(filename):
    whatever(name)
```

### Parameters

**filename** [string or bytestring]

### Attributes

**encoding** [list] List of character names

encoding

```
matplotlib.dviread.PsFont
```

alias of `matplotlib.dviread.Font`

```
class matplotlib.dviread.PsfontsMap
```

Bases: `object`

A psfonts.map formatted file, mapping TeX fonts to PS fonts.

Usage:

```
>>> map = PsfontsMap(find_tex_file('pdftex.map'))
>>> entry = map[b'ptmbo8r']
>>> entry.texname
b'ptmbo8r'
>>> entry.psname
```

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```

b'Times-Bold'
>>> entry.encoding
'/usr/local/texlive/2008/texmf-dist/fonts/enc/dvips/base/8r.enc'
>>> entry.effects
{'slant': 0.16700000000000001}
>>> entry.filename

```

### Parameters

**filename** [string or bytestring]

### Notes

For historical reasons, TeX knows many Type-1 fonts by different names than the outside world. (For one thing, the names have to fit in eight characters.) Also, TeX's native fonts are not Type-1 but Metafont, which is nontrivial to convert to PostScript except as a bitmap. While high-quality conversions to Type-1 format exist and are shipped with modern TeX distributions, we need to know which Type-1 fonts are the counterparts of which native fonts. For these reasons a mapping is needed from internal font names to font file names.

A texmf tree typically includes mapping files called e.g. `psfonts.map`, `pdftex.map`, or `dvipdfm.map`. The file `psfonts.map` is used by `dvips`, `pdftex.map` by `pdfTeX`, and `dvipdfm.map` by `dvipdfm`. `psfonts.map` might avoid embedding the 35 PostScript fonts (i.e., have no filename for them, as in the Times-Bold example above), while the pdf-related files perhaps only avoid the "Base 14" pdf fonts. But the user may have configured these files differently.

```

class matplotlib.dviread.Tfm(filename)
    Bases: object

```

A TeX Font Metric file.

This implementation covers only the bare minimum needed by the Dvi class.

### Parameters

**filename** [string or bytestring]

### Attributes

**checksum** [int] Used for verifying against the dvi file.

**design\_size** [int] Design size of the font (unknown units)

**width, height, depth** [dict] Dimensions of each character, need to be scaled by the factor specified in the dvi file. These are dicts because indexing may not start from 0.

checksum

depth

design\_size

height

width

```
class matplotlib.dviread.Vf(filename)
```

```
    Bases: matplotlib.dviread.Dvi
```

A virtual font (\*.vf file) containing subroutines for dvi files.

Usage:

```
vf = Vf(filename)
glyph = vf[code]
glyph.text, glyph.bboxes, glyph.width
```

### Parameters

**filename** [string or bytestring]

### Notes

The virtual font format is a derivative of dvi: <http://mirrors.ctan.org/info/knuth/virtual-fonts> This class reuses some of the machinery of *Dvi* but replaces the `_read` loop and dispatch mechanism.

```
matplotlib.dviread.find_tex_file(filename, format=None)
```

Find a file in the texmf tree.

Calls `kpsewhich` which is an interface to the `kpathsea` library [?]. Most existing TeX distributions on Unix-like systems use `kpathsea`. It is also available as part of MikTeX, a popular distribution on Windows.

*If the file is not found, an empty string is returned.*

### Parameters

**filename** [string or bytestring]

**format** [string or bytestring] Used as the value of the `--format` option to `kpsewhich`. Could be e.g. 'tfm' or 'vf' to limit the search to that type of files.

### References

[?]

## 17.22 matplotlib.figure

The figure module provides the top-level *Artist*, the *Figure*, which contains all the plot elements. The following classes are defined

*SubplotParams* control the default spacing of the subplots

*Figure* Top level container for all plot elements.

### 17.22.1 Classes

<i>AxesStack</i>	Specialization of the <i>Stack</i> to handle all tracking of <i>Axes</i> in a <i>Figure</i> .
<i>Figure</i>	The top level container for all the plot elements.
<i>SubplotParams</i>	A class to hold the parameters for a subplot.

### matplotlib.figure.AxesStack

```
class matplotlib.figure.AxesStack
    Bases: matplotlib.cbook.Stack
```

Specialization of the *Stack* to handle all tracking of *Axes* in a *Figure*. This stack stores key, (ind, axes) pairs, where:

- **key** should be a hash of the args and kwargs used in generating the Axes.
- **ind** is a serial number for tracking the order in which axes were added.

The AxesStack is a callable, where `ax_stack()` returns the current axes. Alternatively the `current_key_axes()` will return the current key and associated axes.

```
add(self, key, a)
```

Add Axes *a*, with key *key*, to the stack, and return the stack.

If *key* is unhashable, replace it by a unique, arbitrary object.

If *a* is already on the stack, don't add it again, but return *None*.

```
as_list(self)
```

Return a list of the Axes instances that have been added to the figure.

```
bubble(self, a)
```

Move the given axes, which must already exist in the stack, to the top.

```
current_key_axes(self)
```

Return a tuple of (key, axes) for the active axes.

If no axes exists on the stack, then returns (None, None).

```
get(self, key)
```

Return the Axes instance that was added with *key*. If it is not present, return *None*.

```
remove(self, a)
```

Remove the axes from the stack.

### matplotlib.figure.Figure

```
class matplotlib.figure.Figure(figsize=None, dpi=None, facecolor=None, edge-
                               color=None, linewidth=0.0, frameon=None,
                               subplotpars=None, tight_layout=None, con-
                               strained_layout=None)
    Bases: matplotlib.artist.Artist
```

The top level container for all the plot elements.

The Figure instance supports callbacks through a *callbacks* attribute which is a *CallbackRegistry* instance. The events you can connect to are 'dpi\_changed', and the callback will be called with `func(fig)` where *fig* is the *Figure* instance.

#### Attributes

**patch** The *Rectangle* instance representing the figure background patch.

**suppressComposite** For multiple figure images, the figure will make composite images depending on the renderer option `image_nocomposite` function. If `suppressComposite` is a boolean, this will override the renderer.

### Parameters

**figsize** [2-tuple of floats, default: `rcParams["figure.figsize"]`] Figure dimension (width, height) in inches.

**dpi** [float, default: `rcParams["figure.dpi"]`] Dots per inch.

**facecolor** [default: `rcParams["figure.facecolor"]`] The figure patch facecolor.

**edgecolor** [default: `rcParams["figure.edgecolor"]`] The figure patch edgecolor.

**linewidth** [float] The linewidth of the frame (i.e. the edge linewidth of the figure patch).

**frameon** [bool, default: `rcParams["figure.frameon"]`] If False, suppress drawing the figure background patch.

**subplotpars** [*SubplotParams*] Subplot parameters. If not given, the default subplot parameters `rcParams["figure.subplot.*"]` are used.

**tight\_layout** [bool or dict, default: `rcParams["figure.autolayout"]`] If False use *subplotpars*. If True adjust subplot parameters using *tight\_layout* with default padding. When providing a dict containing the keys `pad`, `w_pad`, `h_pad`, and `rect`, the default *tight\_layout* paddings will be overridden.

**constrained\_layout** [bool] If True use constrained layout to adjust positioning of plot elements. Like *tight\_layout*, but designed to be more flexible. See *Constrained Layout Guide* for examples. (Note: does not work with `subplot()` or `subplot2grid()`.) Defaults to `rcParams["figure.constrained_layout.use"]`.

`add_artist(self, artist, clip=False)`  
Add any *Artist* to the figure.

Usually artists are added to axes objects using `matplotlib.axes.Axes.add_artist()`, but use this method in the rare cases that adding directly to the figure is necessary.

### Parameters

**artist** [*Artist*] The artist to add to the figure. If the added artist has no transform previously set, its transform will be set to `figure.transFigure`.

**clip** [bool, optional, default False] An optional parameter `clip` determines whether the added artist should be clipped by the figure patch. Default is *False*, i.e. no clipping.

### Returns

**artist** [The added *Artist*]

`add_axes(self, *args, **kwargs)`  
Add an axes to the figure.

Call signatures:

```
add_axes(rect, projection=None, polar=False, **kwargs)
add_axes(ax)
```

### Parameters

**rect** [sequence of float] The dimensions [left, bottom, width, height] of the new axes. All quantities are in fractions of figure width and height.

**projection** [{None, 'aitoff', 'hammer', 'lambert', 'mollweide', 'polar', 'rectilinear', str}, optional] The projection type of the *Axes*. *str* is the name of a custom projection, see *projections*. The default None results in a 'rectilinear' projection.

**polar** [boolean, optional] If True, equivalent to projection='polar'.

**sharex, sharey** [*Axes*, optional] Share the x or y *axis* with sharex and/or sharey. The axis will have the same limits, ticks, and scale as the axis of the shared axes.

**label** [str] A label for the returned axes.

### Returns

**axes** [*Axes* (or a subclass of *Axes*)] The returned axes class depends on the projection used. It is *Axes* if rectilinear projection are used and *projections.polar.PolarAxes* if polar projection are used.

### Other Parameters

**\*\*kwargs** This method also takes the keyword arguments for the returned axes class. The keyword arguments for the rectilinear axes class *Axes* can be found in the following table but there might also be other keyword arguments if another projection is used, see the actual axes class.

	Property	Description
<i>adjustable</i>	{'box', 'datalim'}	
<i>agg_filter</i>	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3)	
<i>alpha</i>	float	
<i>anchor</i>	2-tuple of floats or {'C', 'SW', 'S', 'SE', ...}	
<i>animated</i>	bool	
<i>aspect</i>	{'auto', 'equal'} or num	
<i>autoscale_on</i>	bool	
<i>autoscalex_on</i>	bool	
<i>autoscaley_on</i>	bool	
<i>axes_locator</i>	Callable[[ <i>Axes</i> , <i>Renderer</i> ], <i>Bbox</i> ]	
<i>axisbelow</i>	bool or 'line'	
<i>clip_box</i>	<i>Bbox</i>	
<i>clip_on</i>	bool	
<i>clip_path</i>	[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]	
<i>contains</i>	callable	
<i>facecolor</i>	color	
<i>fc</i>	color	
<i>figure</i>	<i>Figure</i>	

Continued on next page

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	Property	Description
<i>frame_on</i>	bool	
<i>gid</i>	str	
<i>in_layout</i>	bool	
<i>label</i>	object	
<i>navigate</i>	bool	
<i>navigate_mode</i>	unknown	
<i>path_effects</i>	<i>AbstractPathEffect</i>	
<i>picker</i>	None or bool or float or callable	
<i>position</i>	[left, bottom, width, height] or <i>Bbox</i>	
<i>rasterization_zorder</i>	float or None	
<i>rasterized</i>	bool or None	
<i>sketch_params</i>	(scale: float, length: float, randomness: float)	
<i>snap</i>	bool or None	
<i>title</i>	str	
<i>transform</i>	<i>Transform</i>	
<i>url</i>	str	
<i>visible</i>	bool	
<i>xbound</i>	unknown	
<i>xlabel</i>	str	
<i>xlim</i>	(left: float, right: float)	
<i>xmargin</i>	float greater than -0.5	
<i>xscale</i>	{"linear", "log", "symlog", "logit", ...}	
<i>xticklabels</i>	List[str]	
<i>xticks</i>	list	
<i>ybound</i>	unknown	
<i>ylabel</i>	str	
<i>ylim</i>	(bottom: float, top: float)	
<i>ymargin</i>	float greater than -0.5	
<i>yscale</i>	{"linear", "log", "symlog", "logit", ...}	
<i>yticklabels</i>	List[str]	
<i>yticks</i>	list	
<i>zorder</i>	float	

**See also:***Figure.add\_subplot**pyplot.subplot**pyplot.axes**Figure.subplots**pyplot.subplots***Notes**

If the figure already has an axes with key (*args*, *kwargs*) then it will simply make that axes current and return it. This behavior is deprecated. Meanwhile, if you do not want this behavior (i.e., you want to force the creation of a new axes), you must use a unique set of args and kwargs. The axes *label* attribute has been exposed for

this purpose: if you want two axes that are otherwise identical to be added to the figure, make sure you give them unique labels.

In rare circumstances, `add_axes` may be called with a single argument, a axes instance already created in the present figure but not in the figure's list of axes.

### Examples

Some simple examples:

```
rect = l, b, w, h
fig = plt.figure()
fig.add_axes(rect,label=label1)
fig.add_axes(rect,label=label2)
fig.add_axes(rect, frameon=False, facecolor='g')
fig.add_axes(rect, polar=True)
ax=fig.add_axes(rect, projection='polar')
fig.delaxes(ax)
fig.add_axes(ax)
```

`add_axobserver(self, func)`

Whenever the axes state change, `func(self)` will be called.

`add_gridspec(self, nrows, ncols, **kwargs)`

Return a `GridSpec` that has this figure as a parent. This allows complex layout of axes in the figure.

#### Parameters

**nrows** [int] Number of rows in grid.

**ncols** [int] Number or columns in grid.

#### Returns

**gridspec** [`GridSpec`]

#### Other Parameters

**\*\*kwargs** Keyword arguments are passed to `GridSpec`.

#### See also:

`matplotlib.pyplot.subplots`

### Examples

Adding a subplot that spans two rows:

```
fig = plt.figure()
gs = fig.add_gridspec(2, 2)
ax1 = fig.add_subplot(gs[0, 0])
ax2 = fig.add_subplot(gs[1, 0])
# spans two rows:
ax3 = fig.add_subplot(gs[:, 1])
```

`add_subplot(self, *args, **kwargs)`

Add an *Axes* to the figure as part of a subplot arrangement.

Call signatures:

```
add_subplot(nrows, ncols, index, **kwargs)
add_subplot(pos, **kwargs)
add_subplot(ax)
add_subplot()
```

### Parameters

**\*args** Either a 3-digit integer or three separate integers describing the position of the subplot. If the three integers are *nrows*, *ncols*, and *index* in order, the subplot will take the *index* position on a grid with *nrows* rows and *ncols* columns. *index* starts at 1 in the upper left corner and increases to the right.

*pos* is a three digit integer, where the first digit is the number of rows, the second the number of columns, and the third the index of the subplot. i.e. `fig.add_subplot(235)` is the same as `fig.add_subplot(2, 3, 5)`. Note that all integers must be less than 10 for this form to work.

If no positional arguments are passed, defaults to (1, 1, 1).

In rare circumstances, `add_subplot` may be called with a single argument, a subplot axes instance already created in the present figure but not in the figure's list of axes.

**projection** [{None, 'aitoff', 'hammer', 'lambert', 'mollweide', 'polar', 'rectilinear', str}, optional] The projection type of the subplot (*Axes*). *str* is the name of a custom projection, see *projections*. The default None results in a 'rectilinear' projection.

**polar** [boolean, optional] If True, equivalent to `projection='polar'`.

**sharex, sharey** [*Axes*, optional] Share the x or y *axis* with `sharex` and/or `sharey`. The axis will have the same limits, ticks, and scale as the axis of the shared axes.

**label** [str] A label for the returned axes.

### Returns

**axes** [*axes.SubplotBase*, or another subclass of *Axes*] The axes of the subplot. The returned axes base class depends on the projection used. It is *Axes* if rectilinear projection are used and *projections.polar.PolarAxes* if polar projection are used. The returned axes is then a subplot subclass of the base class.

### Other Parameters

**\*\*kwargs** This method also takes the keyword arguments for the returned axes base class. The keyword arguments for the rectilinear base class *Axes* can be found in the following table but there might also be other keyword arguments if another projection is used.

	Property	Description
<i>adjustable</i>		{'box', 'datalim'}
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3)
<i>alpha</i>		float
<i>anchor</i>		2-tuple of floats or {'C', 'SW', 'S', 'SE', ...}
<i>animated</i>		bool
<i>aspect</i>		{'auto', 'equal'} or num
<i>autoscale_on</i>		bool
<i>autoscalex_on</i>		bool
<i>autoscaley_on</i>		bool
<i>axes_locator</i>		Callable[[Axes, Renderer], Bbox]
<i>axisbelow</i>		bool or 'line'
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>contains</i>		callable
<i>facecolor</i>		color
<i>fc</i>		color
<i>figure</i>		<i>Figure</i>
<i>frame_on</i>		bool
<i>gid</i>		str
<i>in_layout</i>		bool
<i>label</i>		object
<i>navigate</i>		bool
<i>navigate_mode</i>		unknown
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		None or bool or float or callable
<i>position</i>		[left, bottom, width, height] or <i>Bbox</i>
<i>rasterization_zorder</i>		float or None
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>title</i>		str
<i>transform</i>		<i>Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>xbound</i>		unknown
<i>xlabel</i>		str
<i>xlim</i>		(left: float, right: float)
<i>xmargin</i>		float greater than -0.5
<i>xscale</i>		{"linear", "log", "symlog", "logit", ...}
<i>xticklabels</i>		List[str]
<i>xticks</i>		list
<i>ybound</i>		unknown
<i>ylabel</i>		str
<i>ylim</i>		(bottom: float, top: float)
<i>ymargin</i>		float greater than -0.5
<i>yscale</i>		{"linear", "log", "symlog", "logit", ...}
<i>yticklabels</i>		List[str]
<i>yticks</i>		list
<i>zorder</i>		float

**See also:**`Figure.add_axes``pyplot.subplot``pyplot.axes``Figure.subplots``pyplot.subplots`**Notes**

If the figure already has a subplot with key (*args, kwargs*) then it will simply make that subplot current and return it. This behavior is deprecated. Meanwhile, if you do not want this behavior (i.e., you want to force the creation of a new subplot), you must use a unique set of args and kwargs. The axes *label* attribute has been exposed for this purpose: if you want two subplots that are otherwise identical to be added to the figure, make sure you give them unique labels.

**Examples**

```
fig = plt.figure()
fig.add_subplot(221)

# equivalent but more general
ax1 = fig.add_subplot(2, 2, 1)

# add a subplot with no frame
ax2 = fig.add_subplot(222, frameon=False)

# add a polar subplot
fig.add_subplot(223, projection='polar')

# add a red subplot that share the x-axis with ax1
fig.add_subplot(224, sharex=ax1, facecolor='red')

#delete ax2 from the figure
fig.delaxes(ax2)

#add ax2 to the figure again
fig.add_subplot(ax2)
```

`align_labels(self, axs=None)`

Align the xlabels and ylabels of subplots with the same subplots row or column (respectively) if label alignment is being done automatically (i.e. the label position is not manually set).

Alignment persists for draw events after this is called.

**Parameters**

**axs** [list of *Axes*] Optional list (or ndarray) of *Axes* to align the labels. Default is to align all axes on the figure.

**See also:**

`matplotlib.figure.Figure.align_xlabel`

`matplotlib.figure.Figure.align_ylabel`

`align_xlabel(self, axs=None)`

Align the ylabels of subplots in the same subplot column if label alignment is being done automatically (i.e. the label position is not manually set).

Alignment persists for draw events after this is called.

If a label is on the bottom, it is aligned with labels on axes that also have their label on the bottom and that have the same bottom-most subplot row. If the label is on the top, it is aligned with labels on axes with the same top-most row.

**Parameters**

**axs** [list of *Axes*] Optional list of (or ndarray) *Axes* to align the xlabels. Default is to align all axes on the figure.

**See also:**

`matplotlib.figure.Figure.align_ylabel`

`matplotlib.figure.Figure.align_labels`

**Notes**

This assumes that *axs* are from the same *GridSpec*, so that their *SubplotSpec* positions correspond to figure positions.

**Examples**

Example with rotated xtick labels:

```
fig, axs = plt.subplots(1, 2)
for tick in axs[0].get_xticklabels():
    tick.set_rotation(55)
axs[0].set_xlabel('XLabel 0')
axs[1].set_xlabel('XLabel 1')
fig.align_xlabel()
```

`align_ylabel(self, axs=None)`

Align the ylabels of subplots in the same subplot column if label alignment is being done automatically (i.e. the label position is not manually set).

Alignment persists for draw events after this is called.

If a label is on the left, it is aligned with labels on axes that also have their label on the left and that have the same left-most subplot column. If the label is on the right, it is aligned with labels on axes with the same right-most column.

**Parameters**

**axs** [list of *Axes*] Optional list (or ndarray) of *Axes* to align the ylabels. Default is to align all axes on the figure.

**See also:**

`matplotlib.figure.Figure.align_xlabels`

`matplotlib.figure.Figure.align_labels`

**Notes**

This assumes that axes are from the same *GridSpec*, so that their *SubplotSpec* positions correspond to figure positions.

**Examples**

Example with large yticks labels:

```
fig, axs = plt.subplots(2, 1)
axs[0].plot(np.arange(0, 1000, 50))
axs[0].set_ylabel('YLabel 0')
axs[1].set_ylabel('YLabel 1')
fig.align_ylabels()
```

`autofmt_xdate(self, bottom=0.2, rotation=30, ha='right', which=None)`

Date ticklabels often overlap, so it is useful to rotate them and right align them. Also, a common use case is a number of subplots with shared xaxes where the x-axis is date data. The ticklabels are often long, and it helps to rotate them on the bottom subplot and turn them off on other subplots, as well as turn off xlabels.

**Parameters**

**bottom** [scalar] The bottom of the subplots for `subplots_adjust()`.

**rotation** [angle in degrees] The rotation of the xtick labels.

**ha** [string] The horizontal alignment of the xticklabels.

**which** [{None, 'major', 'minor', 'both'}] Selects which ticklabels to rotate. Default is None which works the same as major.

**axes**

List of axes in the Figure. You can access the axes in the Figure through this list. Do not modify the list itself. Instead, use `add_axes`, `subplot` or `delaxes` to add or remove an axes.

`clear(self, keep_observers=False)`

Clear the figure - synonym for `clf()`.

`clf(self, keep_observers=False)`

Clear the figure.

Set `keep_observers` to True if, for example, a gui widget is tracking the axes in the figure.

`colorbar(self, mappable, cax=None, ax=None, use_gridspec=True, **kw)`

Create a colorbar for a `ScalarMappable` instance, `mappable`.

Documentation for the pyplot thin wrapper:

Add a colorbar to a plot.

Function signatures for the *pyplot* interface; all but the first are also method signatures for the *colorbar()* method:

```
colorbar(**kwargs)
colorbar(mappable, **kwargs)
colorbar(mappable, cax=cax, **kwargs)
colorbar(mappable, ax=ax, **kwargs)
```

### Parameters

**mappable** The *matplotlib.cm.ScalarMappable* (i.e., *Image*, *ContourSet*, etc.) described by this colorbar. This argument is mandatory for the *Figure.colorbar* method but optional for the *pyplot.colorbar* function, which sets the default to the current image.

Note that one can create a *ScalarMappable* "on-the-fly" to generate colorbars not attached to a previously drawn artist, e.g.

```
fig.colorbar(cm.ScalarMappable(norm=norm, cmap=cmap), ax=ax)
```

**cax** [*Axes* object, optional] Axes into which the colorbar will be drawn.

**ax** [*Axes*, list of *Axes*, optional] Parent axes from which space for a new colorbar axes will be stolen. If a list of axes is given they will all be resized to make room for the colorbar axes.

**use\_gridspec** [bool, optional] If *cax* is *None*, a new *cax* is created as an instance of *Axes*. If *ax* is an instance of *Subplot* and *use\_gridspec* is *True*, *cax* is created as an instance of *Subplot* using the *gridspec* module.

### Returns

**colorbar** [*Colorbar*] See also its base class, *ColorbarBase*. Use *set\_label* to label the colorbar.

### Notes

Additional keyword arguments are of two kinds:

axes properties:

Property	Description
<i>orientation</i>	vertical or horizontal
<i>fraction</i>	0.15; fraction of original axes to use for colorbar
<i>pad</i>	0.05 if vertical, 0.15 if horizontal; fraction of original axes between colorbar and new image axes
<i>shrink</i>	1.0; fraction by which to multiply the size of the colorbar
<i>aspect</i>	20; ratio of long to short dimensions
<i>anchor</i>	(0.0, 0.5) if vertical; (0.5, 1.0) if horizontal; the anchor point of the colorbar axes
<i>panchor</i>	(1.0, 0.5) if vertical; (0.5, 0.0) if horizontal; the anchor point of the colorbar parent axes. If False, the parent axes' anchor will be unchanged

colorbar properties:

Property	Description
<i>extend</i>	[ 'neither'   'both'   'min'   'max' ] If not 'neither', make pointed end(s) for out-of-range values. These are set for a given colormap using the colormap <code>set_under</code> and <code>set_over</code> methods.
<i>extendfrac</i>	[ <i>None</i>   'auto'   length   lengths ] If set to <i>None</i> , both the minimum and maximum triangular colorbar extensions with have a length of 5% of the interior colorbar length (this is the default setting). If set to 'auto', makes the triangular colorbar extensions the same lengths as the interior boxes (when <i>spacing</i> is set to 'uniform') or the same lengths as the respective adjacent interior boxes (when <i>spacing</i> is set to 'proportional'). If a scalar, indicates the length of both the minimum and maximum triangular colorbar extensions as a fraction of the interior colorbar length. A two-element sequence of fractions may also be given, indicating the lengths of the minimum and maximum colorbar extensions respectively as a fraction of the interior colorbar length.
<i>extendrect</i>	bool If <i>False</i> the minimum and maximum colorbar extensions will be triangular (the default). If <i>True</i> the extensions will be rectangular.
<i>spacing</i>	[ 'uniform'   'proportional' ] Uniform spacing gives each discrete color the same space; proportional makes the space proportional to the data interval.
<i>ticks</i>	[ <i>None</i>   list of ticks   Locator object ] If <i>None</i> , ticks are determined automatically from the input.
<i>format</i>	[ <i>None</i>   format string   Formatter object ] If <i>None</i> , the <i>ScalarFormatter</i> is used. If a format string is given, e.g., '%.3f', that is used. An alternative <i>Formatter</i> object may be given instead.
<i>drawedges</i>	bool Whether to draw lines at color boundaries.

The following will probably be useful only in the context of indexed colors (that is, when the mappable has `norm=NoNorm()`), or other unusual circumstances.

Property	Description
<i>boundaries</i>	<i>None</i> or a sequence
<i>values</i>	<i>None</i> or a sequence which must be of length 1 less than the sequence of <i>boundaries</i> . For each region delimited by adjacent entries in <i>boundaries</i> , the color mapped to the corresponding value in <i>values</i> will be used.

If *mappable* is a `ContourSet`, its *extend* kwarg is included automatically.

The *shrink* kwarg provides a simple way to scale the colorbar with respect to the axes. Note that if *cax* is specified, it determines the size of the colorbar and *shrink* and *aspect* kwargs are ignored.

For more precise control, you can manually specify the positions of the axes objects

in which the mappable and the colorbar are drawn. In this case, do not use any of the axes properties kwargs.

It is known that some vector graphics viewers (svg and pdf) renders white gaps between segments of the colorbar. This is due to bugs in the viewers, not Matplotlib. As a workaround, the colorbar can be rendered with overlapping segments:

```
cbar = colorbar()
cbar.solids.set_edgecolor("face")
draw()
```

However this has negative consequences in other circumstances, e.g. with semi-transparent images ( $\alpha < 1$ ) and colorbar extensions; therefore, this workaround is not used by default (see issue #1188).

`contains(self, mouseevent)`

Test whether the mouse event occurred on the figure.

### Returns

**bool, {}**

`delaxes(self, ax)`

Remove the *Axes* *ax* from the figure and update the current axes.

`dpi`

The resolution in dots per inch.

`draw(self, renderer)`

Render the figure using `matplotlib.backend_bases.RendererBase` instance *renderer*.

`draw_artist(self, a)`

Draw `matplotlib.artist.Artist` instance *a* only. This is available only after the figure is drawn.

`execute_constrained_layout(self, renderer=None)`

Use `layoutbox` to determine pos positions within axes.

See also `set_constrained_layout_pads`.

`figimage(self, X, xo=0, yo=0, alpha=None, norm=None, cmap=None, vmin=None, vmax=None, origin=None, resize=False, **kwargs)`

Add a non-resampled image to the figure.

The image is attached to the lower or upper left corner depending on *origin*.

### Parameters

**X** The image data. This is an array of one of the following shapes:

- MxN: luminance (grayscale) values
- MxNx3: RGB values
- MxNx4: RGBA values

**xo, yo** [int] The x/y image offset in pixels.

**alpha** [None or float] The alpha blending value.

**norm** [`matplotlib.colors.Normalize`] A `Normalize` instance to map the luminance to the interval [0, 1].

**cmap** [str or `matplotlib.colors.Colormap`] The colormap to use. Default: `rcParams["image.cmap"]`.

**vmin, vmax** [scalar] If *norm* is not given, these values set the data limits for the colormap.

**origin** [{'upper', 'lower'}] Indicates where the [0, 0] index of the array is in the upper left or lower left corner of the axes. Defaults to `rcParams["image.origin"]`.

**resize** [bool] If *True*, resize the figure to match the given image size.

### Returns

`matplotlib.image.FigureImage`

### Other Parameters

**\*\*kwargs** Additional kwargs are *Artist* kwargs passed on to *FigureImage*.

### Notes

`figimage` complements the axes image (`imshow()`) which will be resampled to fit the current axes. If you want a resampled image to fill the entire figure, you can define an *Axes* with extent [0,0,1,1].

Examples:

```
f = plt.figure()
nx = int(f.get_figwidth() * f.dpi)
ny = int(f.get_figheight() * f.dpi)
data = np.random.random((ny, nx))
f.figimage(data)
plt.show()
```

### frameon

Return the figure's background patch visibility, i.e. whether the figure background will be drawn. Equivalent to `Figure.patch.get_visible()`.

### gca(self, \*\*kwargs)

Get the current axes, creating one if necessary.

The following kwargs are supported for ensuring the returned axes adheres to the given projection etc., and for axes creation if the active axes does not exist:

	Property	Description
<code>adjustable</code>	{'box', 'datalim'}	
<code>agg_filter</code>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<code>alpha</code>	float	
<code>anchor</code>	2-tuple of floats or {'C', 'SW', 'S', 'SE', ...}	
<code>animated</code>	bool	
<code>aspect</code>	{'auto', 'equal'} or num	
<code>autoscale_on</code>	bool	
<code>autoscalex_on</code>	bool	
<code>autoscaley_on</code>	bool	
<code>axes_locator</code>	Callable[[Axes, Renderer], Bbox]	
<code>axisbelow</code>	bool or 'line'	
<code>clip_box</code>	<i>Bbox</i>	
<code>clip_on</code>	bool	

Continued on next page

Table 138 – continued from previous page

	Property	Description
<i>clip_path</i>	<code>[(Path, Transform)   Patch   None]</code>	
<i>contains</i>	callable	
<i>facecolor</i>	color	
<i>fc</i>	color	
<i>figure</i>	<i>Figure</i>	
<i>frame_on</i>	bool	
<i>gid</i>	str	
<i>in_layout</i>	bool	
<i>label</i>	object	
<i>navigate</i>	bool	
<i>navigate_mode</i>	unknown	
<i>path_effects</i>	<i>AbstractPathEffect</i>	
<i>picker</i>	None or bool or float or callable	
<i>position</i>	[left, bottom, width, height] or <i>Bbox</i>	
<i>rasterization_zorder</i>	float or None	
<i>rasterized</i>	bool or None	
<i>sketch_params</i>	(scale: float, length: float, randomness: float)	
<i>snap</i>	bool or None	
<i>title</i>	str	
<i>transform</i>	<i>Transform</i>	
<i>url</i>	str	
<i>visible</i>	bool	
<i>xbound</i>	unknown	
<i>xlabel</i>	str	
<i>xlim</i>	(left: float, right: float)	
<i>xmargin</i>	float greater than -0.5	
<i>xscale</i>	{"linear", "log", "symlog", "logit", ...}	
<i>xticklabels</i>	List[str]	
<i>xticks</i>	list	
<i>ybound</i>	unknown	
<i>ylabel</i>	str	
<i>ylim</i>	(bottom: float, top: float)	
<i>ymargin</i>	float greater than -0.5	
<i>yscale</i>	{"linear", "log", "symlog", "logit", ...}	
<i>yticklabels</i>	List[str]	
<i>yticks</i>	list	
<i>zorder</i>	float	

`get_axes(self)`

Return a list of axes in the Figure. You can access and modify the axes in the Figure through this list.

Do not modify the list itself. Instead, use `add_axes`, `subplot` or `delaxes` to add or remove an axes.

Note: This is equivalent to the property `axes`.

`get_children(self)`

Get a list of artists contained in the figure.

`get_constrained_layout(self)`

Return a boolean: True means constrained layout is being used.

See *Constrained Layout Guide*.

`get_constrained_layout_pads(self, relative=False)`

Get padding for `constrained_layout`.

Returns a list of `w_pad`, `h_pad` in inches and `wspace` and `hspace` as fractions of the subplot.

See *Constrained Layout Guide*.

### Parameters

**relative** [boolean] If `True`, then convert from inches to figure relative.

`get_default_bbox_extra_artists(self)`

`get_dpi(self)`

Return the resolution in dots per inch as a float.

`get_edgecolor(self)`

Get the edge color of the Figure rectangle.

`get_facecolor(self)`

Get the face color of the Figure rectangle.

`get_figheight(self)`

Return the figure height as a float.

`get_figwidth(self)`

Return the figure width as a float.

`get_frameon(self)`

Return the figure's background patch visibility, i.e. whether the figure background will be drawn. Equivalent to `Figure.patch.get_visible()`.

`get_size_inches(self)`

Returns the current size of the figure in inches.

### Returns

**size** [ndarray] The size (width, height) of the figure in inches.

### See also:

`matplotlib.figure.set_size_inches`

`get_tight_layout(self)`

Return whether `tight_layout` is called when drawing.

`get_tightbbox(self, renderer, bbox_extra_artists=None)`

Return a (tight) bounding box of the figure in inches.

Artists that have `artist.set_in_layout(False)` are not included in the `bbox`.

### Parameters

**renderer** [*RendererBase* instance] renderer that will be used to draw the figures (i.e. `fig.canvas.get_renderer()`)

**bbox\_extra\_artists** [list of *Artist* or *None*] List of artists to include in the tight bounding box. If *None* (default), then all artist children of each axes are included in the tight bounding box.

### Returns

**bbox** [*BboxBase*] containing the bounding box (in figure inches).

`get_window_extent(self, *args, **kwargs)`

Return the figure bounding box in display space. Arguments are ignored.

`ginput(self, n=1, timeout=30, show_clicks=True, mouse_add=1, mouse_pop=3, mouse_stop=2)`

Blocking call to interact with a figure.

Wait until the user clicks *n* times on the figure, and return the coordinates of each click in a list.

There are three possible interactions:

- Add a point.
- Remove the most recently added point.
- Stop the interaction and return the points added so far.

The actions are assigned to mouse buttons via the arguments *mouse\_add*, *mouse\_pop* and *mouse\_stop*. Mouse buttons are defined by the numbers:

- 1: left mouse button
- 2: middle mouse button
- 3: right mouse button
- None: no mouse button

### Parameters

**n** [int, optional, default: 1] Number of mouse clicks to accumulate. If negative, accumulate clicks until the input is terminated manually.

**timeout** [scalar, optional, default: 30] Number of seconds to wait before timing out. If zero or negative will never timeout.

**show\_clicks** [bool, optional, default: True] If True, show a red cross at the location of each click.

**mouse\_add** [{1, 2, 3, None}, optional, default: 1 (left click)] Mouse button used to add points.

**mouse\_pop** [{1, 2, 3, None}, optional, default: 3 (right click)] Mouse button used to remove the most recently added point.

**mouse\_stop** [{1, 2, 3, None}, optional, default: 2 (middle click)] Mouse button used to stop input.

### Returns

**points** [list of tuples] A list of the clicked (x, y) coordinates.

### Notes

The keyboard can also be used to select points in case your mouse does not have one or more of the buttons. The delete and backspace keys act like right clicking (i.e., remove last point), the enter key terminates input and any other key (not already used by the window manager) selects a point.

`init_layoutbox(self)`  
Initialize the layoutbox for use in `constrained_layout`.

`legend(self, *args, **kwargs)`  
Place a legend on the figure.

To make a legend from existing artists on every axes:

```
legend()
```

To make a legend for a list of lines and labels:

```
legend(
    (line1, line2, line3),
    ('label1', 'label2', 'label3'),
    loc='upper right')
```

These can also be specified by keyword:

```
legend(
    handles=(line1, line2, line3),
    labels=('label1', 'label2', 'label3'),
    loc='upper right')
```

## Parameters

**handles** [sequence of *Artist*, optional] A list of Artists (lines, patches) to be added to the legend. Use this together with *labels*, if you need full control on what is shown in the legend and the automatic mechanism described above is not sufficient.

The length of handles and labels should be the same in this case. If they are not, they are truncated to the smaller length.

**labels** [sequence of strings, optional] A list of labels to show next to the artists. Use this together with *handles*, if you need full control on what is shown in the legend and the automatic mechanism described above is not sufficient.

## Returns

*matplotlib.legend.Legend* instance

## Other Parameters

**loc** [str or pair of floats, default: `rcParams["legend.loc"]` ('best' for axes, 'upper right' for figures)] The location of the legend.

The strings 'upper left', 'upper right', 'lower left', 'lower right' place the legend at the corresponding corner of the axes/figure.

The strings 'upper center', 'lower center', 'center left', 'center right' place the legend at the center of the corresponding edge of the axes/figure.

The string 'center' places the legend at the center of the axes/figure.

The string 'best' places the legend at the location, among the nine locations defined so far, with the minimum overlap with other drawn artists. This option can be quite slow for plots with large amounts of data; your plotting speed may benefit from providing a specific location.

The location can also be a 2-tuple giving the coordinates of the lower-left corner of the legend in axes coordinates (in which case `bbox_to_anchor` will be ignored).

For back-compatibility, 'center right' (but no other location) can also be spelled 'right', and each "string" locations can also be given as a numeric value:

Location String	Location Code
'best'	0
'upper right'	1
'upper left'	2
'lower left'	3
'lower right'	4
'right'	5
'center left'	6
'center right'	7
'lower center'	8
'upper center'	9
'center'	10

**bbox\_to\_anchor** [*BboxBase*, 2-tuple, or 4-tuple of floats] Box that is used to position the legend in conjunction with *loc*. Defaults to `axes.bbox` (if called as a method to *Axes.legend*) or `figure.bbox` (if *Figure.legend*). This argument allows arbitrary placement of the legend.

Bbox coordinates are interpreted in the coordinate system given by `bbox_transform`, with the default transform Axes or Figure coordinates, depending on which legend is called.

If a 4-tuple or *BboxBase* is given, then it specifies the bbox (*x*, *y*, width, height) that the legend is placed in. To put the legend in the best location in the bottom right quadrant of the axes (or figure):

```
loc='best', bbox_to_anchor=(0.5, 0., 0.5, 0.5)
```

A 2-tuple (*x*, *y*) places the corner of the legend specified by *loc* at *x*, *y*. For example, to put the legend's upper right-hand corner in the center of the axes (or figure) the following keywords can be used:

```
loc='upper right', bbox_to_anchor=(0.5, 0.5)
```

**ncol** [integer] The number of columns that the legend has. Default is 1.

**prop** [None or `matplotlib.font_manager.FontProperties` or dict] The font properties of the legend. If None (default), the current `matplotlib.rcParams` will be used.

**fontsize** [int or float or {'xx-small', 'x-small', 'small', 'medium', 'large', 'x-large', 'xx-large'}] Controls the font size of the legend. If the value is numeric the size will be the absolute font size in points. String values are relative to the current default font size. This argument is only used if `prop` is not specified.

**numpoints** [None or int] The number of marker points in the legend when creating a legend entry for a *Line2D* (line). Default is None, which will take the value from `rcParams["legend.numpoints"]`.

- scatterpoints** [None or int] The number of marker points in the legend when creating a legend entry for a *PathCollection* (scatter plot). Default is `None`, which will take the value from `rcParams["legend.scatterpoints"]`.
- scatteryoffsets** [iterable of floats] The vertical offset (relative to the font size) for the markers created for a scatter plot legend entry. 0.0 is at the base the legend text, and 1.0 is at the top. To draw all markers at the same height, set to `[0.5]`. Default is `[0.375, 0.5, 0.3125]`.
- markerscale** [None or int or float] The relative size of legend markers compared with the originally drawn ones. Default is `None`, which will take the value from `rcParams["legend.markerscale"]`.
- markerfirst** [bool] If `True`, legend marker is placed to the left of the legend label. If `False`, legend marker is placed to the right of the legend label. Default is `True`.
- frameon** [None or bool] Control whether the legend should be drawn on a patch (frame). Default is `None`, which will take the value from `rcParams["legend.frameon"]`.
- fancybox** [None or bool] Control whether round edges should be enabled around the *FancyBboxPatch* which makes up the legend's background. Default is `None`, which will take the value from `rcParams["legend.fancybox"]`.
- shadow** [None or bool] Control whether to draw a shadow behind the legend. Default is `None`, which will take the value from `rcParams["legend.shadow"]`.
- framealpha** [None or float] Control the alpha transparency of the legend's background. Default is `None`, which will take the value from `rcParams["legend.framealpha"]`. If shadow is activated and *framealpha* is `None`, the default value is ignored.
- facecolor** [None or "inherit" or a color spec] Control the legend's background color. Default is `None`, which will take the value from `rcParams["legend.facecolor"]`. If "inherit", it will take `rcParams["axes.facecolor"]`.
- edgecolor** [None or "inherit" or a color spec] Control the legend's background patch edge color. Default is `None`, which will take the value from `rcParams["legend.edgecolor"]`. If "inherit", it will take `rcParams["axes.edgecolor"]`.
- mode** [{"expand", None}] If mode is set to "expand" the legend will be horizontally expanded to fill the axes area (or `bbox_to_anchor` if defines the legend's size).
- bbox\_transform** [None or *matplotlib.transforms.Transform*] The transform for the bounding box (`bbox_to_anchor`). For a value of `None` (default) the Axes' `transAxes` transform will be used.
- title** [str or None] The legend's title. Default is no title (`None`).
- title\_fontsize: str or None** The fontsize of the legend's title. Default is the default fontsize.
- borderpad** [float or None] The fractional whitespace inside the legend border. Measured in font-size units. Default is `None`, which will take the

value from `rcParams["legend.borderpad"]`.

**labelspacing** [float or None] The vertical space between the legend entries. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.labelspacing"]`.

**handlelength** [float or None] The length of the legend handles. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.handlelength"]`.

**handletextpad** [float or None] The pad between the legend handle and text. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.handletextpad"]`.

**borderaxespad** [float or None] The pad between the axes and legend border. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.borderaxespad"]`.

**columnspacing** [float or None] The spacing between columns. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.columnspacing"]`.

**handler\_map** [dict or None] The custom dictionary mapping instances or types to a legend handler. This `handler_map` updates the default handler map found at `matplotlib.legend.Legend.get_legend_handler_map()`.

## Notes

Not all kinds of artist are supported by the legend command. See *Legend guide* for details.

`savefig(self, fname, *, transparent=None, **kwargs)`

Save the current figure.

Call signature:

```
savefig(fname, dpi=None, facecolor='w', edgecolor='w',
        orientation='portrait', papertype=None, format=None,
        transparent=False, bbox_inches=None, pad_inches=0.1,
        frameon=None, metadata=None)
```

The output formats available depend on the backend being used.

## Parameters

**fname** [str or PathLike or file-like object] A path, or a Python file-like object, or possibly some backend-dependent object such as `matplotlib.backends.backend_pdf.PdfPages`.

If `format` is not set, then the output format is inferred from the extension of `fname`, if any, and from `rcParams["savefig.format"]` otherwise. If `format` is set, it determines the output format.

Hence, if `fname` is not a path or has no extension, remember to specify `format` to ensure that the correct backend is used.

## Other Parameters

- dpi** [[ *None* | scalar > 0 | 'figure' ]] The resolution in dots per inch. If *None*, defaults to `rcParams["savefig.dpi"]`. If 'figure', uses the figure's dpi value.
- quality** [[ *None* | 1 <= scalar <= 100 ]] The image quality, on a scale from 1 (worst) to 95 (best). Applicable only if *format* is `jpg` or `jpeg`, ignored otherwise. If *None*, defaults to `rcParams["savefig.jpeg_quality"]` (95 by default). Values above 95 should be avoided; 100 completely disables the JPEG quantization stage.
- optimize** [bool] If *True*, indicates that the JPEG encoder should make an extra pass over the image in order to select optimal encoder settings. Applicable only if *format* is `jpg` or `jpeg`, ignored otherwise. Is *False* by default.
- progressive** [bool] If *True*, indicates that this image should be stored as a progressive JPEG file. Applicable only if *format* is `jpg` or `jpeg`, ignored otherwise. Is *False* by default.
- facecolor** [color spec or *None*, optional] The facecolor of the figure; if *None*, defaults to `rcParams["savefig.facecolor"]`.
- edgecolor** [color spec or *None*, optional] The edgecolor of the figure; if *None*, defaults to `rcParams["savefig.edgecolor"]`
- orientation** [{'landscape', 'portrait'}] Currently only supported by the postscript backend.
- papertype** [str] One of 'letter', 'legal', 'executive', 'ledger', 'a0' through 'a10', 'b0' through 'b10'. Only supported for postscript output.
- format** [str] The file format, e.g. 'png', 'pdf', 'svg', ... The behavior when this is unset is documented under *fname*.
- transparent** [bool] If *True*, the axes patches will all be transparent; the figure patch will also be transparent unless *facecolor* and/or *edgecolor* are specified via *kwargs*. This is useful, for example, for displaying a plot on top of a colored background on a web page. The transparency of these patches will be restored to their original values upon exit of this function.
- bbox\_inches** [str or *Bbox*, optional] Bbox in inches. Only the given portion of the figure is saved. If 'tight', try to figure out the tight bbox of the figure. If *None*, use `savefig.bbox`
- pad\_inches** [scalar, optional] Amount of padding around the figure when `bbox_inches` is 'tight'. If *None*, use `savefig.pad_inches`
- bbox\_extra\_artists** [list of *Artist*, optional] A list of extra artists that will be considered when the tight bbox is calculated.
- metadata** [dict, optional] Key/value pairs to store in the image metadata. The supported keys and defaults depend on the image format and backend:
- 'png' with Agg backend: See the parameter `metadata` of `print_png`.
  - 'pdf' with pdf backend: See the parameter `metadata` of `PdfPages`.
  - 'eps' and 'ps' with PS backend: Only 'Creator' is supported.

**pil\_kwargs** [dict, optional] Additional keyword arguments that are passed to `PIL.Image.save` when saving the figure. Only applicable for formats that are saved using Pillow, i.e. JPEG, TIFF, and (if the keyword is set to a non-None value) PNG.

`sca(self, a)`

Set the current axes to be `a` and return `a`.

`set_canvas(self, canvas)`

Set the canvas that contains the figure

#### Parameters

**canvas** [FigureCanvas]

`set_constrained_layout(self, constrained)`

Set whether `constrained_layout` is used upon drawing. If `None`, the `rcParams['figure.constrained_layout.use']` value will be used.

When providing a dict containing the keys `w_pad`, `h_pad` the default `constrained_layout` paddings will be overridden. These pads are in inches and default to 3.0/72.0. `w_pad` is the width padding and `h_pad` is the height padding.

See *Constrained Layout Guide*.

#### Parameters

**constrained** [bool or dict or None]

`set_constrained_layout_pads(self, **kwargs)`

Set padding for `constrained_layout`. Note the kwargs can be passed as a dictionary `fig.set_constrained_layout(**paddict)`.

See *Constrained Layout Guide*.

#### Parameters

**w\_pad** [scalar] Width padding in inches. This is the pad around axes and is meant to make sure there is enough room for fonts to look good. Defaults to 3 pts = 0.04167 inches

**h\_pad** [scalar] Height padding in inches. Defaults to 3 pts.

**wspace** [scalar] Width padding between subplots, expressed as a fraction of the subplot width. The total padding ends up being `w_pad + wspace`.

**hspace** [scalar] Height padding between subplots, expressed as a fraction of the subplot width. The total padding ends up being `h_pad + hspace`.

`set_dpi(self, val)`

Set the resolution of the figure in dots-per-inch.

#### Parameters

**val** [float]

`set_edgecolor(self, color)`

Set the edge color of the Figure rectangle.

#### Parameters

**color** [color]

`set_facecolor(self, color)`  
Set the face color of the Figure rectangle.

**Parameters**

**color** [color]

`set_figheight(self, val, forward=True)`  
Set the height of the figure in inches.

**Parameters**

**val** [float]

**forward** [bool]

`set_figwidth(self, val, forward=True)`  
Set the width of the figure in inches.

**Parameters**

**val** [float]

**forward** [bool]

`set_frameon(self, b)`  
Set the figure's background patch visibility, i.e. whether the figure background will be drawn. Equivalent to `Figure.patch.set_visible()`.

**Parameters**

**b** [bool]

`set_size_inches(self, w, h=None, forward=True)`  
Set the figure size in inches.

Call signatures:

```
fig.set_size_inches(w, h) # OR
fig.set_size_inches((w, h))
```

optional kwarg `forward=True` will cause the canvas size to be automatically updated; e.g., you can resize the figure window from the shell

ACCEPTS: a (w, h) tuple with w, h in inches

**See also:**

`matplotlib.Figure.get_size_inches`

`set_tight_layout(self, tight)`  
Set whether and how `tight_layout` is called when drawing.

**Parameters**

**tight** [bool or dict with keys "pad", "w\_pad", "h\_pad", "rect" or None]  
If a bool, sets whether to call `tight_layout` upon drawing. If None, use the `figure.autolayout` rparam instead. If a dict, pass it as kwargs to `tight_layout`, overriding the default paddings.

`show(self, warn=True)`  
If using a GUI backend with pyplot, display the figure window.

If the figure was not created using `figure()`, it will lack a `FigureManagerBase`, and will raise an `AttributeError`.

**Warning:** This does not manage an GUI event loop. Consequently, the figure may only be shown briefly or not shown at all if you or your environment are not managing an event loop.

Proper use cases for `Figure.show` include running this from a GUI application or an IPython shell.

If you're running a pure python shell or executing a non-GUI python script, you should use `matplotlib.pyplot.show` instead, which takes care of managing the event loop for you.

### Parameters

**warn** [bool] If `True` and we are not running headless (i.e. on Linux with an unset `DISPLAY`), issue warning when called on a non-GUI backend.

`subplots(self, nrows=1, ncols=1, sharex=False, sharey=False, squeeze=True, subplot_kw=None, gridspec_kw=None)`

Add a set of subplots to this figure.

This utility wrapper makes it convenient to create common layouts of subplots in a single call.

### Parameters

**nrows, ncols** [int, optional, default: 1] Number of rows/columns of the subplot grid.

**sharex, sharey** [bool or {'none', 'all', 'row', 'col'}, default: False] Controls sharing of properties among x (`sharex`) or y (`sharey`) axes:

- `True` or `'all'`: x- or y-axis will be shared among all subplots.
- `False` or `'none'`: each subplot x- or y-axis will be independent.
- `'row'`: each subplot row will share an x- or y-axis.
- `'col'`: each subplot column will share an x- or y-axis.

When subplots have a shared x-axis along a column, only the x tick labels of the bottom subplot are created. Similarly, when subplots have a shared y-axis along a row, only the y tick labels of the first column subplot are created. To later turn other subplots' ticklabels on, use `tick_params`.

**squeeze** [bool, optional, default: True]

- If `True`, extra dimensions are squeezed out from the returned array of Axes:
  - if only one subplot is constructed (`nrows=ncols=1`), the resulting single Axes object is returned as a scalar.
  - for `Nx1` or `1xM` subplots, the returned object is a 1D numpy object array of Axes objects.
  - for `NxM`, subplots with `N>1` and `M>1` are returned as a 2D array.
- If `False`, no squeezing at all is done: the returned Axes object is always a 2D array containing Axes instances, even if it ends up being `1x1`.

**subplot\_kw** [dict, optional] Dict with keywords passed to the `add_subplot()` call used to create each subplot.

**gridspec\_kw** [dict, optional] Dict with keywords passed to the `GridSpec` constructor used to create the grid the subplots are placed on.

### Returns

**ax** [*Axes* object or array of *Axes* objects.] *ax* can be either a single *Axes* object or an array of *Axes* objects if more than one subplot was created. The dimensions of the resulting array can be controlled with the `squeeze` keyword, see above.

### Examples

```
# First create some toy data:
x = np.linspace(0, 2*np.pi, 400)
y = np.sin(x**2)

# Create a figure
plt.figure()

# Creates a subplot
ax = fig.subplots()
ax.plot(x, y)
ax.set_title('Simple plot')

# Creates two subplots and unpacks the output array immediately
ax1, ax2 = fig.subplots(1, 2, sharey=True)
ax1.plot(x, y)
ax1.set_title('Sharing Y axis')
ax2.scatter(x, y)

# Creates four polar axes, and accesses them through the
# returned array
axes = fig.subplots(2, 2, subplot_kw=dict(polar=True))
axes[0, 0].plot(x, y)
axes[1, 1].scatter(x, y)

# Share a X axis with each column of subplots
fig.subplots(2, 2, sharex='col')

# Share a Y axis with each row of subplots
fig.subplots(2, 2, sharey='row')

# Share both X and Y axes with all subplots
fig.subplots(2, 2, sharex='all', sharey='all')

# Note that this is the same as
fig.subplots(2, 2, sharex=True, sharey=True)
```

`subplots_adjust(self, left=None, bottom=None, right=None, top=None, wspace=None, hspace=None)`

Update the `SubplotParams` with `kwargs` (defaulting to `rc` when `None`) and update the

subplot locations.

`suptitle(self, t, **kwargs)`

Add a centered title to the figure.

#### Parameters

**t** [str] The title text.

**x** [float, default 0.5] The x location of the text in figure coordinates.

**y** [float, default 0.98] The y location of the text in figure coordinates.

**horizontalalignment, ha** [{'center', 'left', 'right'}, default: 'center']  
The horizontal alignment of the text relative to (x, y).

**verticalalignment, va** [{'top', 'center', 'bottom', 'baseline'}, default: 'top']  
The vertical alignment of the text relative to (x, y).

**fontsize, size** [default: `rcParams["figure.titlesize"]`] The font size of the text. See `Text.set_size` for possible values.

**fontweight, weight** [default: `rcParams["figure.titleweight"]`] The font weight of the text. See `Text.set_weight` for possible values.

#### Returns

**text** The `Text` instance of the title.

#### Other Parameters

**fontproperties** [None or dict, optional] A dict of font properties. If `fontproperties` is given the default values for font size and weight are taken from the `FontProperties` defaults. `rcParams["figure.titlesize"]` and `rcParams["figure.titleweight"]` are ignored in this case.

**\*\*kwargs** Additional kwargs are `matplotlib.text.Text` properties.

#### Examples

```
>>> fig.suptitle('This is the figure title', fontsize=12)
```

`text(self, x, y, s, fontdict=None, withdash=<deprecated parameter>, **kwargs)`  
Add text to figure.

#### Parameters

**x, y** [float] The position to place the text. By default, this is in figure coordinates, floats in [0, 1]. The coordinate system can be changed using the `transform` keyword.

**s** [str] The text string.

**fontdict** [dictionary, optional, default: None] A dictionary to override the default text properties. If `fontdict` is None, the defaults are determined by your rc parameters. A property in `kwargs` override the same property in `fontdict`.

**withdash** [boolean, optional, default: False] Creates a `TextWithDash` instance instead of a `Text` instance.

#### Returns

**text** [*Text*]**Other Parameters****\*\*kwargs** [*Text* properties] Other miscellaneous text parameters.

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and
<i>alpha</i>	float	
<i>animated</i>	bool	
<i>backgroundcolor</i>	color	
<i>bbox</i>		dict with properties for <i>patches.FancyBboxPatch</i>
<i>clip_box</i>	<i>Bbox</i>	
<i>clip_on</i>	bool	
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>color</i> or <i>c</i>	color	
<i>contains</i>	callable	
<i>figure</i>	<i>Figure</i>	
<i>fontfamily</i> or <i>family</i>		{ <i>FONTNAME</i> , 'serif', 'sans-serif', 'cursive', 'fantasy', 'monospace'}
<i>fontproperties</i> or <i>font_properties</i>		<i>font_manager.FontProperties</i>
<i>fontsize</i> or <i>size</i>		{size in points, 'xx-small', 'x-small', 'small', 'medium', 'large', 'x-large'}
<i>fontstretch</i> or <i>stretch</i>		{a numeric value in range 0-1000, 'ultra-condensed', 'extra-condensed'}
<i>fontstyle</i> or <i>style</i>		{'normal', 'italic', 'oblique'}
<i>fontvariant</i> or <i>variant</i>		{'normal', 'small-caps'}
<i>fontweight</i> or <i>weight</i>		{a numeric value in range 0-1000, 'ultralight', 'light', 'normal', 'regular'}
<i>gid</i>	str	
<i>horizontalalignment</i> or <i>ha</i>		{'center', 'right', 'left'}
<i>in_layout</i>	bool	
<i>label</i>	object	
<i>linespacing</i>		float (multiple of font size)
<i>multialignment</i> or <i>ma</i>		{'left', 'right', 'center'}
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		None or bool or float or callable
<i>position</i>		(float, float)
<i>rasterized</i>		bool or None
<i>rotation</i>		{angle in degrees, 'vertical', 'horizontal'}
<i>rotation_mode</i>		{None, 'default', 'anchor'}
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>text</i>		object
<i>transform</i>		<i>Transform</i>
<i>url</i>	str	
<i>usetex</i>		bool or None
<i>verticalalignment</i> or <i>va</i>		{'center', 'top', 'bottom', 'baseline', 'center_baseline'}
<i>visible</i>	bool	
<i>wrap</i>	bool	
<i>x</i>	float	
<i>y</i>	float	
<i>zorder</i>	float	

**See also:***Axes.text*

*pyplot.text*

`tight_layout(self, renderer=None, pad=1.08, h_pad=None, w_pad=None, rect=None)`

Automatically adjust subplot parameters to give specified padding.

To exclude an artist on the axes from the bounding box calculation that determines the subplot parameters (i.e. legend, or annotation), then set `a.set_in_layout(False)` for that artist.

### Parameters

**renderer** [subclass of *RendererBase*, optional] Defaults to the renderer for the figure.

**pad** [float, optional] Padding between the figure edge and the edges of subplots, as a fraction of the font size.

**h\_pad, w\_pad** [float, optional] Padding (height/width) between edges of adjacent subplots, as a fraction of the font size. Defaults to *pad*.

**rect** [tuple (left, bottom, right, top), optional] A rectangle (left, bottom, right, top) in the normalized figure coordinate that the whole subplots area (including labels) will fit into. Default is (0, 0, 1, 1).

### See also:

*Figure.set\_tight\_layout*

*pyplot.tight\_layout*

`waitforbuttonpress(self, timeout=-1)`

Blocking call to interact with the figure.

This will return True is a key was pressed, False if a mouse button was pressed and None if *timeout* was reached without either being pressed.

If *timeout* is negative, does not timeout.

### Examples using `matplotlib.figure.Figure`

- `sphx_glr_gallery_images_contours_and_fields_figimage_demo.py`
- `sphx_glr_gallery_subplots_axes_and_figures_custom_figure_class.py`
- `sphx_glr_gallery_shapes_and_collections_collections.py`
- `sphx_glr_gallery_user_interfaces_canvasagg.py`
- `sphx_glr_gallery_user_interfaces_embedding_in_gtk3_panzoom_sgskip.py`
- `sphx_glr_gallery_user_interfaces_embedding_in_gtk3_sgskip.py`
- `sphx_glr_gallery_user_interfaces_embedding_in_qt_sgskip.py`
- `sphx_glr_gallery_user_interfaces_embedding_in_tk_sgskip.py`
- `sphx_glr_gallery_user_interfaces_embedding_in_wx2_sgskip.py`
- `sphx_glr_gallery_user_interfaces_embedding_in_wx3_sgskip.py`
- `sphx_glr_gallery_user_interfaces_embedding_in_wx4_sgskip.py`

- sphx\_glr\_gallery\_user\_interfaces\_embedding\_in\_wx5\_sgskip.py
- sphx\_glr\_gallery\_user\_interfaces\_embedding\_webagg\_sgskip.py
- sphx\_glr\_gallery\_user\_interfaces\_fourier\_demo\_wx\_sgskip.py
- sphx\_glr\_gallery\_user\_interfaces\_gtk\_spreadsheet\_sgskip.py
- sphx\_glr\_gallery\_user\_interfaces\_mathtext\_wx\_sgskip.py
- sphx\_glr\_gallery\_user\_interfaces\_mpl\_with\_glade3\_sgskip.py
- sphx\_glr\_gallery\_user\_interfaces\_wxcursor\_demo\_sgskip.py
- *Pyplot tutorial*
- *Artist tutorial*
- *The mplot3d Toolkit*

### matplotlib.figure.SubplotParams

```
class matplotlib.figure.SubplotParams(left=None, bottom=None, right=None,
                                     top=None, wspace=None, hspace=None)
```

Bases: `object`

A class to hold the parameters for a subplot.

All dimensions are fractions of the figure width or height. Defaults are given by `rcParams["figure.subplot.[name]"]`.

#### Parameters

**left** [float] The left side of the subplots of the figure.

**right** [float] The right side of the subplots of the figure.

**bottom** [float] The bottom of the subplots of the figure.

**top** [float] The top of the subplots of the figure.

**wspace** [float] The amount of width reserved for space between subplots, expressed as a fraction of the average axis width.

**hspace** [float] The amount of height reserved for space between subplots, expressed as a fraction of the average axis height.

```
update(self, left=None, bottom=None, right=None, top=None, wspace=None,
       hspace=None)
```

Update the dimensions of the passed parameters. *None* means unchanged.

#### Examples using matplotlib.figure.SubplotParams

- sphx\_glr\_gallery\_pyplots\_auto\_subplots\_adjust.py

## 17.22.2 Functions

*figaspect*Calculate the width and height for a figure with a specified aspect ratio.

---

**matplotlib.figure.figaspect**`matplotlib.figure.figaspect(arg)`

Calculate the width and height for a figure with a specified aspect ratio.

While the height is taken from `rcParams["figure.figsize"]`, the width is adjusted to match the desired aspect ratio. Additionally, it is ensured that the width is in the range [4., 16.] and the height is in the range [2., 16.]. If necessary, the default height is adjusted to ensure this.

**Parameters**

**arg** [scalar or 2d array] If a scalar, this defines the aspect ratio (i.e. the ratio height / width). In case of an array the aspect ratio is number of rows / number of columns, so that the array could be fitted in the figure undistorted.

**Returns**

**width, height** The figure size in inches.

**Notes**

If you want to create an axes within the figure, that still preserves the aspect ratio, be sure to create it with equal width and height. See examples below.

Thanks to Fernando Perez for this function.

**Examples**

Make a figure twice as tall as it is wide:

```
w, h = figaspect(2.)
fig = Figure(figsize=(w, h))
ax = fig.add_axes([0.1, 0.1, 0.8, 0.8])
ax.imshow(A, **kwargs)
```

Make a figure with the proper aspect for an array:

```
A = rand(5,3)
w, h = figaspect(A)
fig = Figure(figsize=(w, h))
ax = fig.add_axes([0.1, 0.1, 0.8, 0.8])
ax.imshow(A, **kwargs)
```

## 17.23 matplotlib.font\_manager

A module for finding, managing, and using fonts across platforms.

This module provides a single *FontManager* instance that can be shared across backends and platforms. The `findfont()` function returns the best TrueType (TTF) font file in the local or system font path that matches the specified *FontProperties* instance. The *FontManager* also handles Adobe Font Metrics (AFM) font files for use by the PostScript backend.

The design is based on the [W3C Cascading Style Sheet, Level 1 \(CSS1\) font specification](#). Future versions may implement the Level 2 or 2.1 specifications.

```
class matplotlib.font_manager.FontEntry(fname="", name="", style='normal',
                                       variant='normal', weight='normal',
                                       stretch='normal', size='medium')
```

Bases: `object`

A class for storing Font properties. It is used when populating the font lookup dictionary.

```
class matplotlib.font_manager.FontManager(size=None, weight='normal')
```

Bases: `object`

On import, the *FontManager* singleton instance creates a list of TrueType fonts based on the font properties: name, style, variant, weight, stretch, and size. The `findfont()` method does a nearest neighbor search to find the font that most closely matches the specification. If no good enough match is found, a default font is returned.

`afmfiles`

`defaultFont`

```
findfont(self, prop, fonttext='ttf', directory=None, fallback_to_default=True,
         rebuild_if_missing=True)
```

Find a font that most closely matches the given font properties.

### Parameters

**prop** [str or *FontProperties*] The font properties to search for. This can be either a *FontProperties* object or a string defining a [fontconfig patterns](#).

**fonttext** [{'ttf', 'afm'}, optional, default: 'ttf'] The extension of the font file:

- 'ttf': TrueType and OpenType fonts (.ttf, .ttc, .otf)
- 'afm': Adobe Font Metrics (.afm)

**directory** [str, optional] If given, only search this directory and its sub-directories.

**fallback\_to\_default** [bool] If True, will fallback to the default font family (usually "DejaVu Sans" or "Helvetica") if the first lookup hard-fails.

**rebuild\_if\_missing** [bool] Whether to rebuild the font cache and search again if no match is found.

### Returns

**fontfile** [str] The filename of the best matching font.

### Notes

This performs a nearest neighbor search. Each font is given a similarity score to the target font properties. The first font with the highest score is returned. If no

matches below a certain threshold are found, the default font (usually DejaVu Sans) is returned.

The result is cached, so subsequent lookups don't have to perform the  $O(n)$  nearest neighbor search.

See the [W3C Cascading Style Sheet, Level 1](#) documentation for a description of the font finding algorithm.

```
static get_default_size()
    Return the default font size.

get_default_weight(self)
    Return the default font weight.

score_family(self, families, family2)
    Returns a match score between the list of font families in families and the font family name family2.

    An exact match at the head of the list returns 0.0.
    A match further down the list will return between 0 and 1.
    No match will return 1.0.

score_size(self, size1, size2)
    Returns a match score between size1 and size2.

    If size2 (the size specified in the font file) is 'scalable', this function always returns 0.0, since any font size can be generated.

    Otherwise, the result is the absolute distance between size1 and size2, normalized so that the usual range of font sizes (6pt - 72pt) will lie between 0.0 and 1.0.

score_stretch(self, stretch1, stretch2)
    Returns a match score between stretch1 and stretch2.

    The result is the absolute value of the difference between the CSS numeric values of stretch1 and stretch2, normalized between 0.0 and 1.0.

score_style(self, style1, style2)
    Returns a match score between style1 and style2.

    An exact match returns 0.0.
    A match between 'italic' and 'oblique' returns 0.1.
    No match returns 1.0.

score_variant(self, variant1, variant2)
    Returns a match score between variant1 and variant2.

    An exact match returns 0.0, otherwise 1.0.

score_weight(self, weight1, weight2)
    Returns a match score between weight1 and weight2.

    The result is 0.0 if both weight1 and weight2 are given as strings and have the same value.

    Otherwise, the result is the absolute value of the difference between the CSS numeric values of weight1 and weight2, normalized between 0.05 and 1.0.

set_default_weight(self, weight)
    Set the default font weight. The initial value is 'normal'.
```

ttfiles

```
class matplotlib.font_manager.FontProperties(family=None, style=None, variant=None, weight=None, stretch=None, size=None, fname=None)
```

Bases: `object`

A class for storing and manipulating font properties.

The font properties are those described in the [W3C Cascading Style Sheet, Level 1](#) font specification. The six properties are:

- **family:** A list of font names in decreasing order of priority. The items may include a generic font family name, either 'serif', 'sans-serif', 'cursive', 'fantasy', or 'monospace'. In that case, the actual font to be used will be looked up from the associated rcParam.
- **style:** Either 'normal', 'italic' or 'oblique'.
- **variant:** Either 'normal' or 'small-caps'.
- **stretch:** A numeric value in the range 0-1000 or one of 'ultra-condensed', 'extra-condensed', 'condensed', 'semi-condensed', 'normal', 'semi-expanded', 'expanded', 'extra-expanded' or 'ultra-expanded'
- **weight:** A numeric value in the range 0-1000 or one of 'ultralight', 'light', 'normal', 'regular', 'book', 'medium', 'roman', 'semibold', 'demibold', 'demi', 'bold', 'heavy', 'extra bold', 'black'
- **size:** Either an relative value of 'xx-small', 'x-small', 'small', 'medium', 'large', 'x-large', 'xx-large' or an absolute font size, e.g., 12

The default font property for TrueType fonts (as specified in the default rcParams) is:

```
sans-serif, normal, normal, normal, normal, scalable.
```

Alternatively, a font may be specified using an absolute path to a .ttf file, by using the *fname* kwarg.

The preferred usage of font sizes is to use the relative values, e.g., 'large', instead of absolute font sizes, e.g., 12. This approach allows all text sizes to be made larger or smaller based on the font manager's default font size.

This class will also accept a [fontconfig pattern](#), if it is the only argument provided. This support does not require fontconfig to be installed. We are merely borrowing its pattern syntax for use here.

Note that Matplotlib's internal font manager and fontconfig use a different algorithm to lookup fonts, so the results of the same pattern may be different in Matplotlib than in other applications that use fontconfig.

`copy(self)`

Return a copy of self.

`get_family(self)`

Return a list of font names that comprise the font family.

`get_file(self)`

Return the filename of the associated font.

`get_fontconfig_pattern(self)`

Get a [fontconfig pattern](#) suitable for looking up the font as specified with fontconfig's `fc-match` utility.

This support does not require fontconfig to be installed or support for it to be enabled. We are merely borrowing its pattern syntax for use here.

`get_name(self)`

Return the name of the font that best matches the font properties.

`get_size(self)`

Return the font size.

`get_size_in_points(self)`

`get_slant(self)`

Return the font style. Values are: 'normal', 'italic' or 'oblique'.

`get_stretch(self)`

Return the font stretch or width. Options are: 'ultra-condensed', 'extra-condensed', 'condensed', 'semi-condensed', 'normal', 'semi-expanded', 'expanded', 'extra-expanded', 'ultra-expanded'.

`get_style(self)`

Return the font style. Values are: 'normal', 'italic' or 'oblique'.

`get_variant(self)`

Return the font variant. Values are: 'normal' or 'small-caps'.

`get_weight(self)`

Set the font weight. Options are: A numeric value in the range 0-1000 or one of 'light', 'normal', 'regular', 'book', 'medium', 'roman', 'semibold', 'demibold', 'demi', 'bold', 'heavy', 'extra bold', 'black'

`set_family(self, family)`

Change the font family. May be either an alias (generic name is CSS parlance), such as: 'serif', 'sans-serif', 'cursive', 'fantasy', or 'monospace', a real font name or a list of real font names. Real font names are not supported when `text.usetex` is `True`.

`set_file(self, file)`

Set the filename of the fontfile to use. In this case, all other properties will be ignored.

`set_fontconfig_pattern(self, pattern)`

Set the properties by parsing a [fontconfig pattern](#).

This support does not require fontconfig to be installed or support for it to be enabled. We are merely borrowing its pattern syntax for use here.

`set_name(self, family)`

Change the font family. May be either an alias (generic name is CSS parlance), such as: 'serif', 'sans-serif', 'cursive', 'fantasy', or 'monospace', a real font name or a list of real font names. Real font names are not supported when `text.usetex` is `True`.

`set_size(self, size)`

Set the font size. Either an relative value of 'xx-small', 'x-small', 'small', 'medium', 'large', 'x-large', 'xx-large' or an absolute font size, e.g., 12.

`set_slant(self, style)`

Set the font style. Values are: 'normal', 'italic' or 'oblique'.

`set_stretch(self, stretch)`

Set the font stretch or width. Options are: 'ultra-condensed', 'extra-condensed', 'condensed', 'semi-condensed', 'normal', 'semi-expanded', 'expanded', 'extra-expanded' or 'ultra-expanded', or a numeric value in the range 0-1000.

`set_style(self, style)`

Set the font style. Values are: 'normal', 'italic' or 'oblique'.

`set_variant(self, variant)`

Set the font variant. Values are: 'normal' or 'small-caps'.

`set_weight(self, weight)`

Set the font weight. May be either a numeric value in the range 0-1000 or one of 'ultralight', 'light', 'normal', 'regular', 'book', 'medium', 'roman', 'semibold', 'demi-bold', 'demi', 'bold', 'heavy', 'extra bold', 'black'

```
class matplotlib.font_manager.JSONEncoder(*, skipkeys=False, ensure_ascii=True,
                                          check_circular=True, allow_nan=True,
                                          sort_keys=False, indent=None, separa-
                                          tors=None, default=None)
```

Bases: `json.encoder.JSONEncoder`

Constructor for JSONEncoder, with sensible defaults.

If `skipkeys` is false, then it is a `TypeError` to attempt encoding of keys that are not str, int, float or None. If `skipkeys` is True, such items are simply skipped.

If `ensure_ascii` is true, the output is guaranteed to be str objects with all incoming non-ASCII characters escaped. If `ensure_ascii` is false, the output can contain non-ASCII characters.

If `check_circular` is true, then lists, dicts, and custom encoded objects will be checked for circular references during encoding to prevent an infinite recursion (which would cause an `OverflowError`). Otherwise, no such check takes place.

If `allow_nan` is true, then NaN, Infinity, and -Infinity will be encoded as such. This behavior is not JSON specification compliant, but is consistent with most JavaScript based encoders and decoders. Otherwise, it will be a `ValueError` to encode such floats.

If `sort_keys` is true, then the output of dictionaries will be sorted by key; this is useful for regression tests to ensure that JSON serializations can be compared on a day-to-day basis.

If `indent` is a non-negative integer, then JSON array elements and object members will be pretty-printed with that indent level. An indent level of 0 will only insert newlines. None is the most compact representation.

If specified, separators should be an (item\_separator, key\_separator) tuple. The default is (', ', ': ') if `indent` is None and (',', ': ') otherwise. To get the most compact JSON representation, you should specify (',', ':') to eliminate whitespace.

If specified, default is a function that gets called for objects that can't otherwise be serialized. It should return a JSON encodable version of the object or raise a `TypeError`.

`default(self, o)`

Implement this method in a subclass such that it returns a serializable object for `o`, or calls the base implementation (to raise a `TypeError`).

For example, to support arbitrary iterators, you could implement default like this:

```
def default(self, o):
    try:
        iterable = iter(o)
    except TypeError:
        pass
```

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```

else:
    return list(iterable)
# Let the base class default method raise the TypeError
return JSONEncoder.default(self, o)

```

`matplotlib.font_manager.OSXInstalledFonts(directories=None, fontext='ttf')`  
 [Deprecated] Get list of font files on OS X.

### Notes

Deprecated since version 3.1.

`class matplotlib.font_manager.TempCache(**kwargs)`  
 Bases: `object`

[Deprecated] A class to store temporary caches that are (a) not saved to disk and (b) invalidated whenever certain font-related rcParams—namely the family lookup lists—are changed or the font cache is reloaded. This avoids the expensive linear search through all fonts every time a font is looked up.

### Notes

Deprecated since version 3.0.

`get(self, prop)`

`invalidating_rcparams = ('font.serif', 'font.sans-serif', 'font.cursive', 'font.fantasy', 'font.monospace')`

`make_rcparams_key(self)`

`set(self, prop, value)`

`matplotlib.font_manager.afmFontProperty(fontpath, font)`  
 Extract information from an AFM font file.

### Parameters

**font** [AFM] The AFM font file from which information will be extracted.

### Returns

*FontEntry* The extracted font properties.

`matplotlib.font_manager.createFontList(fontfiles, fontext='ttf')`

A function to create a font lookup list. The default is to create a list of TrueType fonts. An AFM font list can optionally be created.

`matplotlib.font_manager.findSystemFonts(fontpaths=None, fontext='ttf')`

Search for fonts in the specified font paths. If no paths are given, will use a standard set of system paths, as well as the list of fonts tracked by fontconfig if fontconfig is installed and available. A list of TrueType fonts are returned by default with AFM fonts as an option.

`matplotlib.font_manager.get_font(filename, hinting_factor=None)`

`matplotlib.font_manager.get_fontconfig_fonts(fontext='ttf')`

List the font filenames known to fc-list having the given extension.

`matplotlib.font_manager.get_fonttext_synonyms(fonttext)`  
 Return a list of file extensions extensions that are synonyms for the given file extension *fileext*.

`matplotlib.font_manager.is_opentype_cff_font(filename)`  
 Return whether the given font is a Postscript Compact Font Format Font embedded in an OpenType wrapper. Used by the PostScript and PDF backends that can not subset these fonts.

`matplotlib.font_manager.json_dump(data, filename)`  
 Dumps a data structure as JSON in the named file.  
 Handles FontManager and its fields. File paths that are children of the Matplotlib data path (typically, fonts shipped with Matplotlib) are stored relative to that data path (to remain valid across virtualenvs).

`matplotlib.font_manager.json_load(filename)`  
 Loads a data structure as JSON from the named file.  
 Handles FontManager and its fields. Relative file paths are interpreted as being relative to the Matplotlib data path, and transformed into absolute paths.

`matplotlib.font_manager.list_fonts(directory, extensions)`  
 Return a list of all fonts matching any of the extensions, found recursively under the directory.

`matplotlib.font_manager.ttfFontProperty(font)`  
 Extract information from a TrueType font file.

#### Parameters

**font** [FT2Font] The TrueType font file from which information will be extracted.

#### Returns

*FontEntry* The extracted font properties.

`matplotlib.font_manager.win32FontDirectory()`  
 Return the user-specified font directory for Win32. This is looked up from the registry key:

```
\\HKEY_CURRENT_USER\Software\Microsoft\Windows\CurrentVersion\Explorer\Shell_
↔Folders\Fonts
```

If the key is not found, %WINDIR%\Fonts will be returned.

`matplotlib.font_manager.win32InstalledFonts(directory=None, fonttext='ttf')`  
 Search for fonts in the specified font directory, or use the system directories if none given. Additionally, it is searched for user fonts installed. A list of TrueType font filenames are returned by default, or AFM fonts if *fonttext* == 'afm'.

## 17.24 matplotlib.fontconfig\_pattern

A module for parsing and generating `fontconfig` patterns.

```
class matplotlib.fontconfig_pattern.FontconfigPatternParser
  Bases: object
```

A simple pyparsing-based parser for `fontconfig` patterns.

`parse(self, pattern)`

Parse the given fontconfig *pattern* and return a dictionary of key/value pairs useful for initializing a `font_manager.FontProperties` object.

`matplotlib.fontconfig_pattern.family_escape(repl, string, count=0)`

Return the string obtained by replacing the leftmost non-overlapping occurrences of *pattern* in *string* by the replacement *repl*.

`matplotlib.fontconfig_pattern.family_unescape(repl, string, count=0)`

Return the string obtained by replacing the leftmost non-overlapping occurrences of *pattern* in *string* by the replacement *repl*.

`matplotlib.fontconfig_pattern.generate_fontconfig_pattern(d)`

Given a dictionary of key/value pairs, generates a fontconfig pattern string.

`matplotlib.fontconfig_pattern.parse_fontconfig_pattern(pattern)`

Parse the given fontconfig *pattern* and return a dictionary of key/value pairs useful for initializing a `font_manager.FontProperties` object.

`matplotlib.fontconfig_pattern.value_escape(repl, string, count=0)`

Return the string obtained by replacing the leftmost non-overlapping occurrences of *pattern* in *string* by the replacement *repl*.

`matplotlib.fontconfig_pattern.value_unescape(repl, string, count=0)`

Return the string obtained by replacing the leftmost non-overlapping occurrences of *pattern* in *string* by the replacement *repl*.

## 17.25 matplotlib.gridspec

*gridspec* contains classes that help to layout multiple Axes in a grid-like pattern within a figure.

The *GridSpec* specifies the overall grid structure. Individual cells within the grid are referenced by *SubplotSpecs*.

See the tutorial *Customizing Figure Layouts Using GridSpec and Other Functions* for a comprehensive usage guide.

### 17.25.1 Classes

<code>GridSpec(nrows, ncols[, figure, left, ...])</code>	Specifies the geometry of the grid that a subplot can be placed in.
<code>SubplotSpec(gridspec, num1[, num2])</code>	Specifies the location of a subplot in a <i>GridSpec</i> .
<code>GridSpecBase(nrows, ncols[, height_ratios, ...])</code>	A base class of <i>GridSpec</i> that specifies the geometry of the grid that a subplot will be placed.
<code>GridSpecFromSubplotSpec(nrows, ncols, ...[, ...])</code>	<i>GridSpec</i> whose subplot layout parameters are inherited from the location specified by a given <i>SubplotSpec</i> .

**matplotlib.gridspec.GridSpec**

```
class matplotlib.gridspec.GridSpec(nrows, ncols, figure=None, left=None, bottom=None, right=None, top=None, wspace=None, hspace=None, width_ratios=None, height_ratios=None)
```

Bases: *matplotlib.gridspec.GridSpecBase*

Specifies the geometry of the grid that a subplot can be placed in.

The location of grid is determined by similar way as the SubplotParams.

The number of rows and number of columns of the grid need to be set. Optionally, the subplot layout parameters (e.g., left, right, etc.) can be tuned.

**Parameters**

**nrows** [int] Number of rows in grid.

**ncols** [int] Number or columns in grid.

**figure** [*Figure*, optional]

**left, right, top, bottom** [float, optional] Extent of the subplots as a fraction of figure width or height. Left cannot be larger than right, and bottom cannot be larger than top.

**wspace** [float, optional] The amount of width reserved for space between subplots, expressed as a fraction of the average axis width.

**hspace** [float, optional] The amount of height reserved for space between subplots, expressed as a fraction of the average axis height.

**width\_ratios** [length *ncols* iterable, optional] Width ratios of the columns.

**height\_ratios** [length *nrows* iterable, optional] Height ratios of the rows.

**Notes**

See *SubplotParams* for descriptions of the layout parameters.

```
get_subplot_params(self, figure=None)
```

Return a dictionary of subplot layout parameters. The default parameters are from rcParams unless a figure attribute is set.

```
locally_modified_subplot_params(self)
```

```
tight_layout(self, figure, renderer=None, pad=1.08, h_pad=None, w_pad=None, rect=None)
```

Adjust subplot parameters to give specified padding.

**Parameters**

**pad** [float] Padding between the figure edge and the edges of subplots, as a fraction of the font-size.

**h\_pad, w\_pad** [float, optional] Padding (height/width) between edges of adjacent subplots. Defaults to *pad*.

**rect** [tuple of 4 floats, optional] (left, bottom, right, top) rectangle in normalized figure coordinates that the whole subplots area (including labels) will fit into. Default is (0, 0, 1, 1).

```
update(self, **kwargs)
    Update the current values.

    Values set to None use the rcParams value.
```

#### Examples using `matplotlib.gridspec.GridSpec`

- `sphx_glr_gallery_lines_bars_and_markers_psd_demo.py`
- `sphx_glr_gallery_images_contours_and_fields_plot_streamplot.py`
- `sphx_glr_gallery_subplots_axes_and_figures_align_labels_demo.py`
- `sphx_glr_gallery_subplots_axes_and_figures_demo_constrained_layout.py`
- `sphx_glr_gallery_subplots_axes_and_figures_gridspec_multicolumn.py`
- `sphx_glr_gallery_subplots_axes_and_figures_gridspec_nested.py`
- `sphx_glr_gallery_userdemo_demo_gridspec03.py`
- `sphx_glr_gallery_userdemo_demo_gridspec06.py`
- *Customizing Figure Layouts Using GridSpec and Other Functions*
- *Constrained Layout Guide*
- *Tight Layout guide*
- *origin and extent in imshow*

#### `matplotlib.gridspec.SubplotSpec`

```
class matplotlib.gridspec.SubplotSpec(gridspec, num1, num2=None)
    Bases: object
```

Specifies the location of a subplot in a *GridSpec*.

---

**Note:** Likely, you'll never instantiate a *SubplotSpec* yourself. Instead you will typically obtain one from a *GridSpec* using item-access.

---

#### Parameters

**gridspec** [*GridSpec*] The *GridSpec*, which the subplot is referencing.

**num1, num2** [int] The subplot will occupy the num1-th cell of the given *gridspec*. If num2 is provided, the subplot will span between num1-th cell and num2-th cell.

The index starts from 0.

```
get_geometry(self)
    Return the subplot geometry as tuple (n_rows, n_cols, start, stop).
```

The indices *start* and *stop* define the range of the subplot within the *GridSpec*. *stop* is inclusive (i.e. for a single cell `start == stop`).

```
get_gridspec(self)
```

`get_position(self, figure, return_all=False)`  
 Update the subplot position from `figure.subplotpars`.

`get_rows_columns(self)`  
 Return the subplot row and column numbers as a tuple (`n_rows`, `n_cols`, `row_start`, `row_stop`, `col_start`, `col_stop`).

`get_topmost_subplotspec(self)`  
 Return the topmost *SubplotSpec* instance associated with the subplot.

`subgridspec(self, nrows, ncols, **kwargs)`  
 Create a *GridSpec* within this subplot.

The created *GridSpecFromSubplotSpec* will have this *SubplotSpec* as a parent.

**Parameters**

**nrows** [int] Number of rows in grid.

**ncols** [int] Number or columns in grid.

**Returns**

**gridspec** [*GridSpecFromSubplotSpec*]

**Other Parameters**

**\*\*kwargs** All other parameters are passed to *GridSpecFromSubplotSpec*.

**See also:**

`matplotlib.pyplot.subplots`

**Examples**

Adding three subplots in the space occupied by a single subplot:

```
fig = plt.figure()
gs0 = fig.add_gridspec(3, 1)
ax1 = fig.add_subplot(gs0[0])
ax2 = fig.add_subplot(gs0[1])
gssub = gs0[2].subgridspec(1, 3)
for i in range(3):
    fig.add_subplot(gssub[0, i])
```

**matplotlib.gridspec.GridSpecBase**

```
class matplotlib.gridspec.GridSpecBase(nrows,          ncols,          height_ratios=None,
                                       width_ratios=None)
```

Bases: `object`

A base class of *GridSpec* that specifies the geometry of the grid that a subplot will be placed.

The number of rows and number of columns of the grid need to be set. Optionally, the ratio of heights and widths of rows and columns can be specified.

`get_geometry(self)`

Return a tuple containing the number of rows and columns in the grid.

```
get_grid_positions(self, fig, raw=False)
    Return lists of bottom and top position of rows, left and right positions of columns.

    If raw=True, then these are all in units relative to the container with no margins.
    (used for constrained_layout).

get_height_ratios(self)

get_subplot_params(self, figure=None, fig=None)

get_width_ratios(self)

new_subplotspec(self, loc, rowspan=1, colspan=1)
    Create and return a SubplotSpec instance.

set_height_ratios(self, height_ratios)

set_width_ratios(self, width_ratios)
```

### matplotlib.gridspec.GridSpecFromSubplotSpec

```
class matplotlib.gridspec.GridSpecFromSubplotSpec(nrows, ncols, subplot_spec, ws-
                                                    pace=None, hspace=None,
                                                    height_ratios=None,
                                                    width_ratios=None)
```

Bases: *matplotlib.gridspec.GridSpecBase*

GridSpec whose subplot layout parameters are inherited from the location specified by a given SubplotSpec.

The number of rows and number of columns of the grid need to be set. An instance of SubplotSpec is also needed to be set from which the layout parameters will be inherited. The wspace and hspace of the layout can be optionally specified or the default values (from the figure or rcParams) will be used.

```
get_subplot_params(self, figure=None)
    Return a dictionary of subplot layout parameters.

get_topmost_subplotspec(self)
    Return the topmost SubplotSpec instance associated with the subplot.
```

### Examples using matplotlib.gridspec.GridSpecFromSubplotSpec

- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_demo\_constrained\_layout.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_gridspec\_nested.py
- sphx\_glr\_gallery\_userdemo\_demo\_gridspec06.py
- *Customizing Figure Layouts Using GridSpec and Other Functions*

## 17.26 matplotlib.image

The image module supports basic image loading, rescaling and display operations.

```
class matplotlib.image.AxesImage(ax, cmap=None, norm=None, interpolation=None,
                                origin=None, extent=None, filternorm=1, filter-
                                rad=4.0, resample=False, **kwargs)
```

Bases: `matplotlib.image._ImageBase`

interpolation and cmap default to their rc settings

cmap is a `colors.Colormap` instance norm is a `colors.Normalize` instance to map luminance to 0-1

extent is data axes (left, right, bottom, top) for making image plots registered with data plots. Default is to label the pixel centers with the zero-based row and column indices.

Additional kwargs are `matplotlib.artist` properties

```
format_cursor_data(self, data)
```

Return a string representation of *data*.

---

**Note:** This method is intended to be overridden by artist subclasses. As an end-user of Matplotlib you will most likely not call this method yourself.

---

The default implementation converts ints and floats and arrays of ints and floats into a comma-separated string enclosed in square brackets.

**See also:**

`get_cursor_data`

```
get_cursor_data(self, event)
```

Return the image value at the event position or *None* if the event is outside the image.

**See also:**

`matplotlib.artist.Artist.get_cursor_data`

```
get_extent(self)
```

Get the image extent: left, right, bottom, top

```
get_window_extent(self, renderer=None)
```

Get the axes bounding box in display space.

The bounding box' width and height are nonnegative.

Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

```
make_image(self, renderer, magnification=1.0, unsampled=False)
```

Normalize, rescale, and colormap this image's data for rendering using *renderer*, with the given *magnification*.

If *unsampled* is True, the image will not be scaled, but an appropriate affine transformation will be returned instead.

**Returns**

**image** [(M, N, 4) uint8 array] The RGBA image, resampled unless *unsampled* is True.

**x, y** [float] The upper left corner where the image should be drawn, in pixel space.

**trans** [Affine2D] The affine transformation from image to pixel space.

`set_extent(self, extent)`

extent is data axes (left, right, bottom, top) for making image plots

This updates `ax.dataLim`, and, if autoscaling, sets `viewLim` to tightly fit the image, regardless of `dataLim`. Autoscaling state is not changed, so following this with `ax.autoscale_view` will redo the autoscaling in accord with `dataLim`.

```
class matplotlib.image.BboxImage(bbox, cmap=None, norm=None, interpolation=None,
                                origin=None, filtnorm=1, filterrad=4.0, resample=False,
                                interp_at_native=<deprecated parameter>, **kwargs)
```

Bases: `matplotlib.image._ImageBase`

The Image class whose size is determined by the given `bbox`.

`cmap` is a `colors.Colormap` instance `norm` is a `colors.Normalize` instance to map luminance to 0-1

`kwargs` are an optional list of Artist keyword args

`contains(self, mouseevent)`

Test whether the mouse event occurred within the image.

`get_transform(self)`

Return the *Transform* instance used by this artist.

`get_window_extent(self, renderer=None)`

Get the axes bounding box in display space.

The bounding box' width and height are nonnegative.

Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

`interp_at_native`

`make_image(self, renderer, magnification=1.0, unsampled=False)`

Normalize, rescale, and colormap this image's data for rendering using *renderer*, with the given *magnification*.

If *unsampled* is True, the image will not be scaled, but an appropriate affine transformation will be returned instead.

**Returns**

**image** [(M, N, 4) uint8 array] The RGBA image, resampled unless *unsampled* is True.

**x, y** [float] The upper left corner where the image should be drawn, in pixel space.

**trans** [Affine2D] The affine transformation from image to pixel space.

```
class matplotlib.image.FigureImage(fig, cmap=None, norm=None, offsetx=0, offsety=0,
                                   origin=None, **kwargs)
```

Bases: `matplotlib.image._ImageBase`

`cmap` is a `colors.Colormap` instance `norm` is a `colors.Normalize` instance to map luminance to 0-1

`kwargs` are an optional list of Artist keyword args

```
get_extent(self)
```

Get the image extent: left, right, bottom, top

```
make_image(self, renderer, magnification=1.0, unsampled=False)
```

Normalize, rescale, and colormap this image's data for rendering using `renderer`, with the given `magnification`.

If `unsampled` is True, the image will not be scaled, but an appropriate affine transformation will be returned instead.

### Returns

**image** [(M, N, 4) uint8 array] The RGBA image, resampled unless `unsampled` is True.

**x, y** [float] The upper left corner where the image should be drawn, in pixel space.

**trans** [Affine2D] The affine transformation from image to pixel space.

```
set_data(self, A)
```

Set the image array.

```
zorder = 0
```

```
class matplotlib.image.NonUniformImage(ax, *, interpolation='nearest', **kwargs)
```

Bases: `matplotlib.image.AxesImage`

`kwargs` are identical to those for `AxesImage`, except that 'nearest' and 'bilinear' are the only supported 'interpolation' options.

```
get_extent(self)
```

Get the image extent: left, right, bottom, top

```
make_image(self, renderer, magnification=1.0, unsampled=False)
```

Normalize, rescale, and colormap this image's data for rendering using `renderer`, with the given `magnification`.

If `unsampled` is True, the image will not be scaled, but an appropriate affine transformation will be returned instead.

### Returns

**image** [(M, N, 4) uint8 array] The RGBA image, resampled unless `unsampled` is True.

**x, y** [float] The upper left corner where the image should be drawn, in pixel space.

**trans** [Affine2D] The affine transformation from image to pixel space.

`set_array(self, *args)`

Retained for backwards compatibility - use `set_data` instead.

**Parameters**

**A** [array-like]

`set_cmap(self, cmap)`

set the colormap for luminance data

**Parameters**

**cmap** [colormap or registered colormap name]

`set_data(self, x, y, A)`

Set the grid for the pixel centers, and the pixel values.

**x and y are monotonic 1-D ndarrays of lengths N and M,**  
respectively, specifying pixel centers

**A is an (M,N) ndarray or masked array of values to be** colormapped,  
or a (M,N,3) RGB array, or a (M,N,4) RGBA array.

`set_filternorm(self, s)`

Set whether the resize filter normalizes the weights.

See help for `imshow`.

**Parameters**

**filternorm** [bool]

`set_filterrad(self, s)`

Set the resize filter radius only applicable to some interpolation schemes - see help for `imshow`

**Parameters**

**filterrad** [positive float]

`set_interpolation(self, s)`

**Parameters**

**s** [str, None] Either 'nearest', 'bilinear', or None.

`set_norm(self, norm)`

Set the normalization instance.

**Parameters**

**norm** [*Normalize*]

**Notes**

If there are any colorbars using the mappable for this norm, setting the norm of the mappable will reset the norm, locator, and formatters on the colorbar to default.

```
class matplotlib.image.PcolorImage(ax, x=None, y=None, A=None, cmap=None,
                                   norm=None, **kwargs)
```

Bases: `matplotlib.image.AxesImage`

Make a pcolor-style plot with an irregular rectangular grid.

This uses a variation of the original irregular image code, and it is used by pcolorfast for the corresponding grid type.

cmap defaults to its rc setting

cmap is a colors.Colormap instance norm is a colors.Normalize instance to map luminance to 0-1

Additional kwargs are matplotlib.artist properties

`get_cursor_data(self, event)`

Return the image value at the event position or *None* if the event is outside the image.

**See also:**

`matplotlib.artist.Artist.get_cursor_data`

`make_image(self, renderer, magnification=1.0, unsampled=False)`

Normalize, rescale, and colormap this image's data for rendering using *renderer*, with the given *magnification*.

If *unsampled* is True, the image will not be scaled, but an appropriate affine transformation will be returned instead.

**Returns**

**image** [(M, N, 4) uint8 array] The RGBA image, resampled unless *unsampled* is True.

**x, y** [float] The upper left corner where the image should be drawn, in pixel space.

**trans** [Affine2D] The affine transformation from image to pixel space.

`set_array(self, *args)`

Retained for backwards compatibility - use `set_data` instead.

**Parameters**

**A** [array-like]

`set_data(self, x, y, A)`

Set the grid for the rectangle boundaries, and the data values.

**x and y are monotonic 1-D ndarrays of lengths N+1 and M+1,** respectively, specifying rectangle boundaries. If None, they will be created as uniform arrays from 0 through N and 0 through M, respectively.

**A is an (M,N) ndarray or masked array of values to be** colormapped, or a (M,N,3) RGB array, or a (M,N,4) RGBA array.

`matplotlib.image.composite_images(images, renderer, magnification=1.0)`

Composite a number of RGBA images into one. The images are composited in the order in which they appear in the *images* list.

**Parameters**

**images** [list of Images] Each must have a `make_image` method. For each image, `can_composite` should return `True`, though this is not enforced by this function. Each image must have a purely affine transformation with no shear.

**renderer** [RendererBase instance]

**magnification** [float] The additional magnification to apply for the renderer in use.

### Returns

**tuple** [image, offset\_x, offset\_y] Returns the tuple:

- image: A numpy array of the same type as the input images.
- offset\_x, offset\_y: The offset of the image (left, bottom) in the output figure.

`matplotlib.image.imread(fname, format=None)`

Read an image from a file into an array.

### Parameters

**fname** [str or file-like] The image file to read. This can be a filename, a URL or a Python file-like object opened in read-binary mode.

**format** [str, optional] The image file format assumed for reading the data. If not given, the format is deduced from the filename. If nothing can be deduced, PNG is tried.

### Returns

**imagedata** [numpy.array] The image data. The returned array has shape

- (M, N) for grayscale images.
- (M, N, 3) for RGB images.
- (M, N, 4) for RGBA images.

### Notes

Matplotlib can only read PNGs natively. Further image formats are supported via the optional dependency on Pillow. Note, URL strings are not compatible with Pillow. Check the [Pillow documentation](#) for more information.

`matplotlib.image.imsave(fname, arr, vmin=None, vmax=None, cmap=None, format=None, origin=None, dpi=100)`

Save an array as an image file.

### Parameters

**fname** [str or PathLike file-like] A path or a Python file-like object to store the image in. If *format* is not set, then the output format is inferred from the extension of *fname*, if any, and from `rcParams["savefig.format"]` otherwise. If *format* is set, it determines the output format.

**arr** [array-like] The image data. The shape can be one of MxN (luminance), MxNx3 (RGB) or MxNx4 (RGBA).

**vmin, vmax** [scalar, optional] *vmin* and *vmax* set the color scaling for the image by fixing the values that map to the colormap color limits. If either *vmin* or *vmax* is None, that limit is determined from the *arr* min/max value.

**cmap** [str or *Colormap*, optional] A *Colormap* instance or registered colormap name. The colormap maps scalar data to colors. It is ignored for RGB(A) data. Defaults to `rcParams["image.cmap"]` ('viridis').

**format** [str, optional] The file format, e.g. 'png', 'pdf', 'svg', ... The behavior when this is unset is documented under *fname*.

**origin** [{'upper', 'lower'}, optional] Indicates whether the (0, 0) index of the array is in the upper left or lower left corner of the axes. Defaults to `rcParams["image.origin"]` ('upper').

**dpi** [int] The DPI to store in the metadata of the file. This does not affect the resolution of the output image.

`matplotlib.image.pil_to_array(pillImage)`

Load a [PIL image](#) and return it as a numpy array.

### Returns

**numpy.array** The array shape depends on the image type:

- (M, N) for grayscale images.
- (M, N, 3) for RGB images.
- (M, N, 4) for RGBA images.

`matplotlib.image.thumbnail(infile, thumbfile, scale=0.1, interpolation='bilinear', preview=False)`

Make a thumbnail of image in *infile* with output filename *thumbfile*.

See `/gallery/misc/image_thumbnail_sgskip`.

### Parameters

**infile** [str or file-like] The image file - must be PNG, or Pillow-readable if you have [Pillow](#) installed.

**thumbfile** [str or file-like] The thumbnail filename.

**scale** [float, optional] The scale factor for the thumbnail.

**interpolation** [str, optional] The interpolation scheme used in the resampling. See the *interpolation* parameter of *imshow* for possible values.

**preview** [bool, optional] If True, the default backend (presumably a user interface backend) will be used which will cause a figure to be raised if *show* is called. If it is False, the figure is created using *FigureCanvasBase* and the drawing backend is selected as *savefig* would normally do.

### Returns

**figure** [*Figure*] The figure instance containing the thumbnail.

## 17.27 matplotlib.legend

The legend module defines the *Legend* class, which is responsible for drawing legends associated with axes and/or figures.

**Important:** It is unlikely that you would ever create a Legend instance manually. Most users would normally create a legend via the `legend()` function. For more details on legends there is also a *legend guide*.

---

The Legend class can be considered as a container of legend handles and legend texts. Creation of corresponding legend handles from the plot elements in the axes or figures (e.g., lines, patches, etc.) are specified by the handler map, which defines the mapping between the plot elements and the legend handlers to be used (the default legend handlers are defined in the `legend_handler` module). Note that not all kinds of artist are supported by the legend yet by default but it is possible to extend the legend handler's capabilities to support arbitrary objects. See the *legend guide* for more information.

```
class matplotlib.legend.DraggableLegend(legend, use_blit=False, update='loc')
```

Bases: `matplotlib.offsetbox.DraggableOffsetBox`

Wrapper around a *Legend* to support mouse dragging.

### Parameters

**legend** [*Legend*] The *Legend* instance to wrap.

**use\_blit** [bool, optional] Use blitting for faster image composition. For details see *FuncAnimation*.

**update** [{'loc', 'bbox'}, optional] If "loc", update the *loc* parameter of the legend upon finalizing. If "bbox", update the *bbox\_to\_anchor* parameter.

```
artist_picker(self, legend, evt)
```

```
finalize_offset(self)
```

```
class matplotlib.legend.Legend(parent, handles, labels, loc=None, numpoints=None,
                               markerscale=None, markerfirst=True, scatterpoints=None,
                               scatteryoffsets=None, prop=None, fontsize=None, borderpad=None,
                               labelspacing=None, handlelength=None, handleheight=None,
                               handletextpad=None, borderaxespadd=None, columnspacing=None,
                               ncol=1, mode=None, fancybox=None, shadow=None, title=None,
                               title_fontsize=None, framealpha=None, edgecolor=None,
                               facecolor=None, bbox_to_anchor=None, bbox_transform=None,
                               frameon=None, handler_map=None)
```

Bases: `matplotlib.artist.Artist`

Place a legend on the axes at location *loc*.

### Parameters

**parent** [*Axes* or *Figure*] The artist that contains the legend.

**handles** [sequence of *Artist*] A list of Artists (lines, patches) to be added to the legend.

**labels** [sequence of strings] A list of labels to show next to the artists. The length of handles and labels should be the same. If they are not, they are truncated to the smaller of both lengths.

### Other Parameters

**loc** [str or pair of floats, default: `rcParams["legend.loc"]`] ('best' for axes, 'upper right' for figures)] The location of the legend.

The strings 'upper left', 'upper right', 'lower left', 'lower right' place the legend at the corresponding corner of the axes/figure.

The strings 'upper center', 'lower center', 'center left', 'center right' place the legend at the center of the corresponding edge of the axes/figure.

The string 'center' places the legend at the center of the axes/figure.

The string 'best' places the legend at the location, among the nine locations defined so far, with the minimum overlap with other drawn artists. This option can be quite slow for plots with large amounts of data; your plotting speed may benefit from providing a specific location.

The location can also be a 2-tuple giving the coordinates of the lower-left corner of the legend in axes coordinates (in which case `bbox_to_anchor` will be ignored).

For back-compatibility, 'center right' (but no other location) can also be spelled 'right', and each "string" locations can also be given as a numeric value:

Location String	Location Code
'best'	0
'upper right'	1
'upper left'	2
'lower left'	3
'lower right'	4
'right'	5
'center left'	6
'center right'	7
'lower center'	8
'upper center'	9
'center'	10

**bbox\_to\_anchor** [*BboxBase*, 2-tuple, or 4-tuple of floats] Box that is used to position the legend in conjunction with `loc`. Defaults to `axes.bbox` (if called as a method to `Axes.legend`) or `figure.bbox` (if `Figure.legend`). This argument allows arbitrary placement of the legend.

Bbox coordinates are interpreted in the coordinate system given by `bbox_transform`, with the default transform Axes or Figure coordinates, depending on which legend is called.

If a 4-tuple or *BboxBase* is given, then it specifies the bbox (`x`, `y`, `width`, `height`) that the legend is placed in. To put the legend in the best location in the bottom right quadrant of the axes (or figure):

```
loc='best', bbox_to_anchor=(0.5, 0., 0.5, 0.5)
```

A 2-tuple (`x`, `y`) places the corner of the legend specified by `loc` at `x`, `y`. For example, to put the legend's upper right-hand corner in the center of the axes (or figure) the following keywords can be used:

```
loc='upper right', bbox_to_anchor=(0.5, 0.5)
```

- ncol** [integer] The number of columns that the legend has. Default is 1.
- prop** [None or `matplotlib.font_manager.FontProperties` or dict] The font properties of the legend. If None (default), the current `matplotlib.rcParams` will be used.
- fontsize** [int or float or {'xx-small', 'x-small', 'small', 'medium', 'large', 'x-large', 'xx-large'}] Controls the font size of the legend. If the value is numeric the size will be the absolute font size in points. String values are relative to the current default font size. This argument is only used if `prop` is not specified.
- numpoints** [None or int] The number of marker points in the legend when creating a legend entry for a `Line2D` (line). Default is None, which will take the value from `rcParams["legend.numpoints"]`.
- scatterpoints** [None or int] The number of marker points in the legend when creating a legend entry for a `PathCollection` (scatter plot). Default is None, which will take the value from `rcParams["legend.scatterpoints"]`.
- scatteryoffsets** [iterable of floats] The vertical offset (relative to the font size) for the markers created for a scatter plot legend entry. 0.0 is at the base the legend text, and 1.0 is at the top. To draw all markers at the same height, set to [0.5]. Default is [0.375, 0.5, 0.3125].
- markerscale** [None or int or float] The relative size of legend markers compared with the originally drawn ones. Default is None, which will take the value from `rcParams["legend.markerscale"]`.
- markerfirst** [bool] If `True`, legend marker is placed to the left of the legend label. If `False`, legend marker is placed to the right of the legend label. Default is `True`.
- frameon** [None or bool] Control whether the legend should be drawn on a patch (frame). Default is None, which will take the value from `rcParams["legend.frameon"]`.
- fancybox** [None or bool] Control whether round edges should be enabled around the `FancyBboxPatch` which makes up the legend's background. Default is None, which will take the value from `rcParams["legend.fancybox"]`.
- shadow** [None or bool] Control whether to draw a shadow behind the legend. Default is None, which will take the value from `rcParams["legend.shadow"]`.
- framealpha** [None or float] Control the alpha transparency of the legend's background. Default is None, which will take the value from `rcParams["legend.framealpha"]`. If shadow is activated and `framealpha` is None, the default value is ignored.
- facecolor** [None or "inherit" or a color spec] Control the legend's background color. Default is None, which will take the value from `rcParams["legend.facecolor"]`. If "inherit", it will take `rcParams["axes.facecolor"]`.

**edgecolor** [None or "inherit" or a color spec] Control the legend's background patch edge color. Default is None, which will take the value from `rcParams["legend.edgecolor"]`. If "inherit", it will take `rcParams["axes.edgecolor"]`.

**mode** [{"expand", None}] If mode is set to "expand" the legend will be horizontally expanded to fill the axes area (or `bbox_to_anchor` if defines the legend's size).

**bbox\_transform** [None or `matplotlib.transforms.Transform`] The transform for the bounding box (`bbox_to_anchor`). For a value of None (default) the Axes' `transAxes` transform will be used.

**title** [str or None] The legend's title. Default is no title (None).

**title\_fontsize: str or None** The fontsize of the legend's title. Default is the default fontsize.

**borderpad** [float or None] The fractional whitespace inside the legend border. Measured in font-size units. Default is None, which will take the value from `rcParams["legend.borderpad"]`.

**labelspacing** [float or None] The vertical space between the legend entries. Measured in font-size units. Default is None, which will take the value from `rcParams["legend.labelspacing"]`.

**handlelength** [float or None] The length of the legend handles. Measured in font-size units. Default is None, which will take the value from `rcParams["legend.handlelength"]`.

**handletextpad** [float or None] The pad between the legend handle and text. Measured in font-size units. Default is None, which will take the value from `rcParams["legend.handletextpad"]`.

**borderaxespad** [float or None] The pad between the axes and legend border. Measured in font-size units. Default is None, which will take the value from `rcParams["legend.borderaxespad"]`.

**columnspacing** [float or None] The spacing between columns. Measured in font-size units. Default is None, which will take the value from `rcParams["legend.columnspacing"]`.

**handler\_map** [dict or None] The custom dictionary mapping instances or types to a legend handler. This `handler_map` updates the default handler map found at `matplotlib.legend.Legend.get_legend_handler_map()`.

## Notes

Users can specify any arbitrary location for the legend using the `bbox_to_anchor` keyword argument. `bbox_to_anchor` can be an instance of `BboxBase` (or its derivatives) or a tuple of 2 or 4 floats. See `set_bbox_to_anchor()` for more detail.

The legend location can be specified by setting `loc` with a tuple of 2 floats, which is interpreted as the lower-left corner of the legend in the normalized axes coordinate.

```
codes = {'best': 0, 'center': 10, 'center left': 6, 'center right': 7, 'lower center': 8, 'lower
```

```
contains(self, event)
```

```
    Test whether the artist contains the mouse event.
```

**Parameters**

**mouseevent** [*matplotlib.backend\_bases.MouseEvent*]

**Returns**

**contains** [bool] Whether any values are within the radius.

**details** [dict] An artist-specific dictionary of details of the event context, such as which points are contained in the pick radius. See the individual Artist subclasses for details.

**See also:**

`set_contains`, `get_contains`

`draw(self, renderer)`

Draw everything that belongs to the legend.

`draw_frame(self, b)`

Set draw frame to b.

**Parameters**

**b** [bool]

`get_bbox_to_anchor(self)`

Return the bbox that the legend will be anchored to.

`get_children(self)`

Return a list of child artists.

`classmethod get_default_handler_map()`

A class method that returns the default handler map.

`get_draggable(self)`

Return True if the legend is draggable, False otherwise.

`get_frame(self)`

Return the *Rectangle* instances used to frame the legend.

`get_frame_on(self)`

Get whether the legend box patch is drawn.

`static get_legend_handler(legend_handler_map, orig_handle)`

Return a legend handler from *legend\_handler\_map* that corresponds to *orig\_handler*.

*legend\_handler\_map* should be a dictionary object (that is returned by the `get_legend_handler_map` method).

It first checks if the *orig\_handle* itself is a key in the *legend\_handler\_map* and return the associated value. Otherwise, it checks for each of the classes in its method-resolution-order. If no matching key is found, it returns None.

`get_legend_handler_map(self)`

Return the handler map.

`get_lines(self)`

Return a list of *Line2D* instances in the legend.

`get_patches(self)`

Return a list of *Patch* instances in the legend.

`get_texts(self)`  
Return a list of *Text* instances in the legend.

`get_tightbbox(self, renderer)`  
Like *Legend.get\_window\_extent*, but uses the box for the legend.

#### Parameters

**renderer** [*RendererBase* instance] renderer that will be used to draw the figures (i.e. `fig.canvas.get_renderer()`)

#### Returns

**‘.BboxBase’** [containing the bounding box in figure pixel coordinates.]

`get_title(self)`  
Return the *Text* instance for the legend title.

`get_window_extent(self, renderer=None)`  
Return extent of the legend.

`set_bbox_to_anchor(self, bbox, transform=None)`  
Set the bbox that the legend will be anchored to.

*bbox* can be

- A *BboxBase* instance
- A tuple of (left, bottom, width, height) in the given transform (normalized axes coordinate if None)
- A tuple of (left, bottom) where the width and height will be assumed to be zero.

classmethod `set_default_handler_map(handler_map)`  
A class method to set the default handler map.

`set_draggable(self, state, use_blit=False, update='loc')`  
Enable or disable mouse dragging support of the legend.

#### Parameters

**state** [bool] Whether mouse dragging is enabled.

**use\_blit** [bool, optional] Use blitting for faster image composition. For details see *FuncAnimation*.

**update** [{‘loc’, ‘bbox’}, optional] The legend parameter to be changed when dragged:

- ‘loc’: update the *loc* parameter of the legend
- ‘bbox’: update the *bbox\_to\_anchor* parameter of the legend

#### Returns

**If *state* is True this returns the *DraggableLegend* helper instance. Otherwise this returns *None*.**

`set_frame_on(self, b)`  
Set whether the legend box patch is drawn.

#### Parameters

**b** [bool]

```
set_title(self, title, prop=None)
    Set the legend title. Fontproperties can be optionally set with prop parameter.

classmethod update_default_handler_map(handler_map)
    A class method to update the default handler map.

zorder = 5
```

## 17.28 matplotlib.legend\_handler

This module defines default legend handlers.

It is strongly encouraged to have read the *legend guide* before this documentation.

Legend handlers are expected to be a callable object with a following signature.

```
legend_handler(legend, orig_handle, fontsize, handlebox)
```

Where *legend* is the legend itself, *orig\_handle* is the original plot, *fontsize* is the fontsize in pixels, and *handlebox* is a `OffsetBox` instance. Within the call, you should create relevant artists (using relevant properties from the *legend* and/or *orig\_handle*) and add them into the handlebox. The artists needs to be scaled according to the fontsize (note that the size is in pixel, i.e., this is dpi-scaled value).

This module includes definition of several legend handler classes derived from the base class (`HandlerBase`) with the following method:

```
def legend_artist(self, legend, orig_handle, fontsize, handlebox)
```

```
class matplotlib.legend_handler.HandlerBase(xpad=0.0, ypad=0.0, update_func=None)
    A Base class for default legend handlers.
```

The derived classes are meant to override `create_artists` method, which has a following signature.:

```
def create_artists(self, legend, orig_handle,
                  xdescent, ydescent, width, height, fontsize,
                  trans):
```

The overridden method needs to create artists of the given transform that fits in the given dimension (`xdescent`, `ydescent`, `width`, `height`) that are scaled by `fontsize` if necessary.

```
adjust_drawing_area(self, legend, orig_handle, xdescent, ydescent, width, height,
                   fontsize)
```

```
create_artists(self, legend, orig_handle, xdescent, ydescent, width, height, font-
              size, trans)
```

```
legend_artist(self, legend, orig_handle, fontsize, handlebox)
```

Return the artist that this `HandlerBase` generates for the given original artist/handle.

### Parameters

**legend** [`matplotlib.legend.Legend` instance] The legend for which these legend artists are being created.

**orig\_handle** [`matplotlib.artist.Artist` or similar] The object for which these legend artists are being created.

**fontsize** [float or int] The fontsize in pixels. The artists being created should be scaled according to the given fontsize.

**handlebox** [*matplotlib.offsetbox.OffsetBox* instance] The box which has been created to hold this legend entry's artists. Artists created in the *legend\_artist* method must be added to this handlebox inside this method.

```
update_prop(self, legend_handle, orig_handle, legend)
```

```
class matplotlib.legend_handler.HandlerCircleCollection(yoffsets=None, sizes=None,
**kw)
```

Handler for *CircleCollections*.

```
create_collection(self, orig_handle, sizes, offsets, transOffset)
```

```
class matplotlib.legend_handler.HandlerErrorbar(xerr_size=0.5, yerr_size=None,
marker_pad=0.3, numpoints=None,
**kw)
```

Handler for *Errorbars*.

```
create_artists(self, legend, orig_handle, xdescent, ydescent, width, height, font-
size, trans)
```

```
get_err_size(self, legend, xdescent, ydescent, width, height, fontsize)
```

```
class matplotlib.legend_handler.HandlerLine2D(marker_pad=0.3, numpoints=None,
**kw)
```

Handler for *Line2D* instances.

### Parameters

**marker\_pad** [float] Padding between points in legend entry.

**numpoints** [int] Number of points to show in legend entry.

### Notes

Any other keyword arguments are given to *HandlerNpoints*.

```
create_artists(self, legend, orig_handle, xdescent, ydescent, width, height, font-
size, trans)
```

```
class matplotlib.legend_handler.HandlerLineCollection(marker_pad=0.3, num-
points=None, **kw)
```

Handler for *LineCollection* instances.

### Parameters

**marker\_pad** [float] Padding between points in legend entry.

**numpoints** [int] Number of points to show in legend entry.

### Notes

Any other keyword arguments are given to *HandlerNpoints*.

```
create_artists(self, legend, orig_handle, xdescent, ydescent, width, height, font-
size, trans)
```

```
get_numpoints(self, legend)
```

```
class matplotlib.legend_handler.HandlerNpoints(marker_pad=0.3, numpoints=None,
                                              **kw)
```

A legend handler that shows *numpoints* points in the legend entry.

#### Parameters

**marker\_pad** [float] Padding between points in legend entry.

**numpoints** [int] Number of points to show in legend entry.

#### Notes

Any other keyword arguments are given to *HandlerBase*.

```
get_numpoints(self, legend)
```

```
get_xdata(self, legend, xdescent, ydescent, width, height, fontsize)
```

```
class matplotlib.legend_handler.HandlerNpointsYoffsets(numpoints=None, yoff-
                                                       sets=None, **kw)
```

A legend handler that shows *numpoints* in the legend, and allows them to be individually offset in the y-direction.

#### Parameters

**numpoints** [int] Number of points to show in legend entry.

**yoffsets** [array of floats] Length *numpoints* list of y offsets for each point in legend entry.

#### Notes

Any other keyword arguments are given to *HandlerNpoints*.

```
get_ydata(self, legend, xdescent, ydescent, width, height, fontsize)
```

```
class matplotlib.legend_handler.HandlerPatch(patch_func=None, **kw)
```

Handler for *Patch* instances.

#### Parameters

**patch\_func** [callable, optional] The function that creates the legend key artist. *patch\_func* should have the signature:

```
def patch_func(legend=legend, orig_handle=orig_handle,
               xdescent=xdescent, ydescent=ydescent,
               width=width, height=height, fontsize=fontsize)
```

Subsequently the created artist will have its `update_prop` method called and the appropriate transform will be applied.

#### Notes

Any other keyword arguments are given to *HandlerBase*.

```
create_artists(self, legend, orig_handle, xdescent, ydescent, width, height, font-
               size, trans)
```

```
class matplotlib.legend_handler.HandlerPathCollection(yoffsets=None, sizes=None,
                                                    **kw)
    Handler for PathCollections, which are used by scatter.
    create_collection(self, orig_handle, sizes, offsets, transOffset)

class matplotlib.legend_handler.HandlerPolyCollection(xpad=0.0, ypad=0.0, update_func=None)
    Handler for PolyCollection used in fill_between and stackplot.
    create_artists(self, legend, orig_handle, xdescent, ydescent, width, height, font-size, trans)

class matplotlib.legend_handler.HandlerRegularPolyCollection(yoffsets=None, sizes=None, **kw)
    Handler for RegularPolyCollections.
    create_artists(self, legend, orig_handle, xdescent, ydescent, width, height, font-size, trans)
    create_collection(self, orig_handle, sizes, offsets, transOffset)
    get_numpoints(self, legend)
    get_sizes(self, legend, orig_handle, xdescent, ydescent, width, height, fontsize)
    update_prop(self, legend_handle, orig_handle, legend)

class matplotlib.legend_handler.HandlerStem(marker_pad=0.3, numpoints=None, bottom=None, yoffsets=None, **kw)
    Handler for plots produced by stem.
```

### Parameters

- marker\_pad** [float] Padding between points in legend entry. Default is 0.3.
- numpoints** [int, optional] Number of points to show in legend entry.
- bottom** [float, optional]
- yoffsets** [array of floats, optional] Length *numpoints* list of y offsets for each point in legend entry.

### Notes

Any other keyword arguments are given to *HandlerNpointsYoffsets*.

```
create_artists(self, legend, orig_handle, xdescent, ydescent, width, height, font-size, trans)
get_ydata(self, legend, xdescent, ydescent, width, height, fontsize)
```

```
class matplotlib.legend_handler.HandlerTuple(ndivide=1, pad=None, **kwargs)
    Handler for Tuple.
```

Additional kwargs are passed through to *HandlerBase*.

### Parameters

- ndivide** [int, optional] The number of sections to divide the legend area into. If None, use the length of the input tuple. Default is 1.
- pad** [float, optional] If None, fall back to `legend.borderpad` as the default. In units of fraction of font size. Default is None.

```
create_artists(self, legend, orig_handle, xdescent, ydescent, width, height, font-size, trans)
```

```
matplotlib.legend_handler.update_from_first_child(tgt, src)
```

## 17.29 matplotlib.lines

This module contains all the 2D line class which can draw with a variety of line styles, markers and colors.

### 17.29.1 Classes

<i>Line2D</i> ( <i>xdata</i> , <i>ydata</i> [, <i>linewidth</i> , <i>linestyle</i> , ...])	A line - the line can have both a solid linestyle connecting all the vertices, and a marker at each vertex.
--	---

<i>VertexSelector</i> ( <i>line</i> )	Manage the callbacks to maintain a list of selected vertices for <i>matplotlib.lines.Line2D</i> .
---------------------------------------	---

#### matplotlib.lines.Line2D

```
class matplotlib.lines.Line2D(xdata, ydata, linewidth=None, linestyle=None,
                               color=None, marker=None, markersize=None, markeredgewidth=None,
                               markeredgecolor=None, markerfacecolor=None, markerfacecoloralt='none',
                               fillstyle=None, antialiased=None, dash_capstyle=None, solid_capstyle=None,
                               dash_joinstyle=None, solid_joinstyle=None, pickradius=5, drawstyle=None,
                               markevery=None, **kwargs)
```

Bases: *matplotlib.artist.Artist*

A line - the line can have both a solid linestyle connecting all the vertices, and a marker at each vertex. Additionally, the drawing of the solid line is influenced by the drawstyle, e.g., one can create "stepped" lines in various styles.

Create a *Line2D* instance with x and y data in sequences *xdata*, *ydata*.

The kwargs are *Line2D* properties:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<i>alpha</i>		float
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i>		bool
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>color</i> or <i>c</i>		color
<i>contains</i>		callable
<i>dash_capstyle</i>		{'butt', 'round', 'projecting'}
<i>dash_joinstyle</i>		{'miter', 'round', 'bevel'}

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Property	Description
<i>dashes</i>	sequence of floats (on/off ink in points) or (None, None)
<i>drawstyle</i> or <i>ds</i>	{'default', 'steps', 'steps-pre', 'steps-mid', 'steps-post'}, default: 'default'
<i>figure</i>	<i>Figure</i>
<i>fillstyle</i>	{'full', 'left', 'right', 'bottom', 'top', 'none'}
<i>gid</i>	str
<i>in_layout</i>	bool
<i>label</i>	object
<i>linestyle</i> or <i>ls</i>	{'-', '--', '-.', ':', "", (offset, on-off-seq), ...}
<i>linewidth</i> or <i>lw</i>	float
<i>marker</i>	marker style
<i>markeredgecolor</i> or <i>mec</i>	color
<i>markeredgewidth</i> or <i>mew</i>	float
<i>markerfacecolor</i> or <i>mfc</i>	color
<i>markerfacecoloralt</i> or <i>mfcalt</i>	color
<i>markersize</i> or <i>ms</i>	float
<i>markevery</i>	None or int or (int, int) or slice or List[int] or float or (float, float)
<i>path_effects</i>	<i>AbstractPathEffect</i>
<i>picker</i>	float or callable[[Artist, Event], Tuple[bool, dict]]
<i>pickradius</i>	float
<i>rasterized</i>	bool or None
<i>sketch_params</i>	(scale: float, length: float, randomness: float)
<i>snap</i>	bool or None
<i>solid_capstyle</i>	{'butt', 'round', 'projecting'}
<i>solid_joinstyle</i>	{'miter', 'round', 'bevel'}
<i>transform</i>	<i>matplotlib.transforms.Transform</i>
<i>url</i>	str
<i>visible</i>	bool
<i>xdata</i>	1D array
<i>ydata</i>	1D array
<i>zorder</i>	float

See *set\_linestyle()* for a description of the line styles, *set\_marker()* for a description of the markers, and *set\_drawstyle()* for a description of the draw styles.

#### axes

The *Axes* instance the artist resides in, or *None*.

#### contains(*self*, *mouseevent*)

Test whether the mouse event occurred on the line. The pick radius determines the precision of the location test (usually within five points of the value). Use *get\_pickradius()* or *set\_pickradius()* to view or modify it.

#### Parameters

**mouseevent** [*matplotlib.backend\_bases.MouseEvent*]

#### Returns

**contains** [bool] Whether any values are within the radius.

**details** [dict] A dictionary {'ind': *pointlist*}, where *pointlist* is a list of points of the line that are within the pickradius around the event position.

TODO: sort returned indices by distance

`draw(self, renderer)`

Draw the Artist using the given renderer.

This method will be overridden in the Artist subclasses. Typically, it is implemented to not have any effect if the Artist is not visible (*Artist.get\_visible* is *False*).

### Parameters

**renderer** [*RendererBase* subclass.]

`drawStyleKeys = ['default', 'steps-mid', 'steps-pre', 'steps-post', 'steps']`

`drawStyles = {'default': '_draw_lines', 'steps': '_draw_steps_pre', 'steps-mid': '_draw_steps_mid'}`

`fillStyles = ('full', 'left', 'right', 'bottom', 'top', 'none')`

`filled_markers = ('o', 'v', '^', '<', '>', '8', 's', 'p', '*', 'h', 'H', 'D', 'd', 'P', 'X')`

`get_aa(self)`

Alias for *get\_antialiased*.

`get_antialiased(self)`

Return whether antialiased rendering is used.

`get_c(self)`

Alias for *get\_color*.

`get_color(self)`

Return the line color.

See also *set\_color*.

`get_dash_capstyle(self)`

Return the cap style for dashed lines.

See also *set\_dash\_capstyle*.

`get_dash_joinstyle(self)`

Return the join style for dashed lines.

See also *set\_dash\_joinstyle*.

`get_data(self, orig=True)`

Return the xdata, ydata.

If *orig* is *True*, return the original data.

`get_drawstyle(self)`

Return the drawstyle.

See also *set\_drawstyle*.

`get_ds(self)`

Alias for *get\_drawstyle*.

`get_fillstyle(self)`

Return the marker fill style.

See also *set\_fillstyle*.

`get_linestyle(self)`

Return the linestyle.

See also *set\_linestyle*.

`get_linewidth(self)`  
Return the linewidth in points.  
See also `set_linewidth`.

`get_ls(self)`  
Alias for `get_linestyle`.

`get_lw(self)`  
Alias for `get_linewidth`.

`get_marker(self)`  
Return the line marker.  
See also `set_marker`.

`get_markedgcolor(self)`  
Return the marker edge color.  
See also `set_markedgcolor`.

`get_markedgwidth(self)`  
Return the marker edge width in points.  
See also `set_markedgwidth`.

`get_markerfacecolor(self)`  
Return the marker face color.  
See also `set_markerfacecolor`.

`get_markerfacecoloralt(self)`  
Return the alternate marker face color.  
See also `set_markerfacecoloralt`.

`get_markersize(self)`  
Return the marker size in points.  
See also `set_markersize`.

`get_markevery(self)`  
Return the markevery setting for marker subsampling.  
See also `set_markevery`.

`get_mec(self)`  
Alias for `get_markedgcolor`.

`get_mew(self)`  
Alias for `get_markedgwidth`.

`get_mfc(self)`  
Alias for `get_markerfacecolor`.

`get_mfcalt(self)`  
Alias for `get_markerfacecoloralt`.

`get_ms(self)`  
Alias for `get_markersize`.

`get_path(self)`  
Return the *Path* object associated with this line.

`get_pickradius(self)`

Return the pick radius used for containment tests.

See *contains* for more details.

`get_solid_capstyle(self)`

Return the cap style for solid lines.

See also *set\_solid\_capstyle*.

`get_solid_joinstyle(self)`

Return the join style for solid lines.

See also *set\_solid\_joinstyle*.

`get_window_extent(self, renderer)`

Get the axes bounding box in display space.

The bounding box' width and height are nonnegative.

Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

`get_xdata(self, orig=True)`

Return the xdata.

If *orig* is *True*, return the original data, else the processed data.

`get_xydata(self)`

Return the xy data as a Nx2 numpy array.

`get_ydata(self, orig=True)`

Return the ydata.

If *orig* is *True*, return the original data, else the processed data.

`is_dashed(self)`

Return whether line has a dashed linestyle.

See also *set\_linestyle*.

`lineStyles = {'': '_draw_nothing', ' ': '_draw_nothing', '-': '_draw_solid', '--': '_draw_dashed'`

`markers = {'.': 'point', ',': 'pixel', 'o': 'circle', 'v': 'triangle_down', '^': 'triangle_up', '`

`recache(self, always=False)`

`recache_always(self)`

`set_aa(self, b)`

Alias for *set\_antialiased*.

`set_antialiased(self, b)`

Set whether to use antialiased rendering.

### Parameters

**b** [bool]

`set_c(self, color)`  
Alias for `set_color`.

`set_color(self, color)`  
Set the color of the line.

**Parameters**

**color** [color]

`set_dash_capstyle(self, s)`  
Set the cap style for dashed lines.

**Parameters**

**s** [{'butt', 'round', 'projecting'}]

`set_dash_joinstyle(self, s)`  
Set the join style for dashed lines.

**Parameters**

**s** [{'miter', 'round', 'bevel'}] For examples see [/gallery/lines\\_bars\\_and\\_markers/joinstyle](#).

`set_dashes(self, seq)`  
Set the dash sequence.

The dash sequence is a sequence of floats of even length describing the length of dashes and spaces in points.

For example, (5, 2, 1, 2) describes a sequence of 5 point and 1 point dashes separated by 2 point spaces.

**Parameters**

**seq** [sequence of floats (on/off ink in points) or (None, None)] If `seq` is empty or (None, None), the linestyle will be set to solid.

`set_data(self, *args)`  
Set the x and y data.

**Parameters**

**\*args** [(2, N) array or two 1D arrays]

`set_drawstyle(self, drawstyle)`  
Set the drawstyle of the plot.

The drawstyle determines how the points are connected.

**Parameters**

**drawstyle** [{'default', 'steps', 'steps-pre', 'steps-mid', 'steps-post'}, default: 'default'] For 'default', the points are connected with straight lines.

The steps variants connect the points with step-like lines, i.e. horizontal lines with vertical steps. They differ in the location of the step:

- 'steps-pre': The step is at the beginning of the line segment, i.e. the line will be at the y-value of point to the right.
- 'steps-mid': The step is halfway between the points.

- 'steps-post': The step is at the end of the line segment, i.e. the line will be at the y-value of the point to the left.
- 'steps' is equal to 'steps-pre' and is maintained for backward-compatibility.

`set_ds(self, drawstyle)`  
 Alias for `set_drawstyle`.

`set_fillstyle(self, fs)`  
 Set the marker fill style.

**Parameters**

**fs** [{'full', 'left', 'right', 'bottom', 'top', 'none'}] Possible values:

- 'full': Fill the whole marker with the *markerfacecolor*.
- 'left', 'right', 'bottom', 'top': Fill the marker half at the given side with the *markerfacecolor*. The other half of the marker is filled with *markerfacecoloralt*.
- 'none': No filling.

For examples see [/gallery/lines\\_bars\\_and\\_markers/marker\\_fillstyle\\_reference](/gallery/lines_bars_and_markers/marker_fillstyle_reference).

`set_linestyle(self, ls)`  
 Set the linestyle of the line.

**Parameters**

**ls** [{'-', '--', '-.', ':', '', (offset, on-off-seq), ...}] Possible values:

- A string:

Linestyle	Description
'-' or 'solid'	solid line
'--' or 'dashed'	dashed line
'-.' or 'dashdot'	dash-dotted line
':' or 'dotted'	dotted line
'None' or ' ' or ''	draw nothing

Optionally, the string may be preceded by a drawstyle, e.g. 'steps--'. See `set_drawstyle()` for details.

- Alternatively a dash tuple of the following form can be provided:

(offset, onoffseq)
--------------------

where *onoffseq* is an even length tuple of on and off ink in points. See also `set_dashes()`.

`set_linewidth(self, w)`  
 Set the line width in points.

**Parameters**

**w** [float]

`set_ls(self, ls)`  
 Alias for `set_linestyle`.

`set_lw(self, w)`  
Alias for `set_linewidth`.

`set_marker(self, marker)`  
Set the line marker.

**Parameters**

**marker** [marker style] See *markers* for full description of possible arguments.

`set_markeredgecolor(self, ec)`  
Set the marker edge color.

**Parameters**

**ec** [color]

`set_markeredgewidth(self, ew)`  
Set the marker edge width in points.

**Parameters**

**ew** [float]

`set_markerfacecolor(self, fc)`  
Set the marker face color.

**Parameters**

**fc** [color]

`set_markerfacecoloralt(self, fc)`  
Set the alternate marker face color.

**Parameters**

**fc** [color]

`set_markersize(self, sz)`  
Set the marker size in points.

**Parameters**

**sz** [float]

`set_markevery(self, every)`  
Set the markevery property to subsample the plot when using markers.  
e.g., if `every=5`, every 5-th marker will be plotted.

**Parameters**

**every** [None or int or (int, int) or slice or List[int] or float or (float, float)] Which markers to plot.

- `every=None`, every point will be plotted.
- `every=N`, every N-th marker will be plotted starting with marker 0.
- `every=(start, N)`, every N-th marker, starting at point `start`, will be plotted.
- `every=slice(start, end, N)`, every N-th marker, starting at point `start`, up to but not including point `end`, will be plotted.

- `every=[i, j, m, n]`, only markers at points `i`, `j`, `m`, and `n` will be plotted.
- `every=0.1`, (i.e. a float) then markers will be spaced at approximately equal distances along the line; the distance along the line between markers is determined by multiplying the display-coordinate distance of the axes bounding-box diagonal by the value of `every`.
- `every=(0.5, 0.1)` (i.e. a length-2 tuple of float), the same functionality as `every=0.1` is exhibited but the first marker will be 0.5 multiplied by the display-coordinate-diagonal-distance along the line.

### Notes

Setting the `markevery` property will only show markers at actual data points. When using float arguments to set the `markevery` property on irregularly spaced data, the markers will likely not appear evenly spaced because the actual data points do not coincide with the theoretical spacing between markers.

When using a start offset to specify the first marker, the offset will be from the first data point which may be different from the first the visible data point if the plot is zoomed in.

If zooming in on a plot when using float arguments then the actual data points that have markers will change because the distance between markers is always determined from the display-coordinates axes-bounding-box-diagonal regardless of the actual axes data limits.

`set_mec(self, ec)`  
Alias for `set_markeredgecolor`.

`set_mew(self, ew)`  
Alias for `set_markeredgewidth`.

`set_mfc(self, fc)`  
Alias for `set_markerfacecolor`.

`set_mfcalt(self, fc)`  
Alias for `set_markerfacecoloralt`.

`set_ms(self, sz)`  
Alias for `set_markersize`.

`set_picker(self, p)`  
Sets the event picker details for the line.

### Parameters

**p** [float or callable[[Artist, Event], Tuple[bool, dict]]] If a float, it is used as the pick radius in points.

`set_pickradius(self, d)`  
Set the pick radius used for containment tests.  
See `contains` for more details.

### Parameters

**d** [float] Pick radius, in points.

`set_solid_capstyle(self, s)`

Set the cap style for solid lines.

**Parameters**

**s** [{'butt', 'round', 'projecting'}]

`set_solid_joinstyle(self, s)`

Set the join style for solid lines.

**Parameters**

**s** [{'miter', 'round', 'bevel'}] For examples see  
/gallery/lines\_bars\_and\_markers/joinstyle.

`set_transform(self, t)`

Set the Transformation instance used by this artist.

**Parameters**

**t** [*matplotlib.transforms.Transform*]

`set_xdata(self, x)`

Set the data array for x.

**Parameters**

**x** [1D array]

`set_ydata(self, y)`

Set the data array for y.

**Parameters**

**y** [1D array]

`update_from(self, other)`

Copy properties from other to self.

`validCap = ('butt', 'round', 'projecting')`

`validJoin = ('miter', 'round', 'bevel')`

`verticalOffset`

`zorder = 2`

**Examples using `matplotlib.lines.Line2D`**

- `sphx_glr_gallery_text_labels_and_annotations_custom_legends.py`
- `sphx_glr_gallery_text_labels_and_annotations_legend_demo.py`
- `sphx_glr_gallery_text_labels_and_annotations_line_with_text.py`
- `sphx_glr_gallery_pyplots_fig_axes_customize_simple.py`
- `sphx_glr_gallery_pyplots_fig_x.py`
- `sphx_glr_gallery_shapes_and_collections_artist_reference.py`
- *Oscilloscope*
- `sphx_glr_gallery_event_handling_pick_event_demo.py`
- `sphx_glr_gallery_event_handling_poly_editor.py`

- sphx\_glr\_gallery\_units\_artist\_tests.py
- *Pyplot tutorial*
- *Artist tutorial*
- *Legend guide*

### matplotlib.lines.VertexSelector

class matplotlib.lines.VertexSelector(*line*)

Bases: object

Manage the callbacks to maintain a list of selected vertices for *matplotlib.lines.Line2D*. Derived classes should override *process\_selected()* to do something with the picks.

Here is an example which highlights the selected verts with red circles:

```
import numpy as np
import matplotlib.pyplot as plt
import matplotlib.lines as lines

class HighlightSelected(lines.VertexSelector):
    def __init__(self, line, fmt='ro', **kwargs):
        lines.VertexSelector.__init__(self, line)
        self.markers, = self.axes.plot([], [], fmt, **kwargs)

    def process_selected(self, ind, xs, ys):
        self.markers.set_data(xs, ys)
        self.canvas.draw()

fig, ax = plt.subplots()
x, y = np.random.rand(2, 30)
line, = ax.plot(x, y, 'bs-', picker=5)

selector = HighlightSelected(line)
plt.show()
```

Initialize the class with a *matplotlib.lines.Line2D* instance. The line should already be added to some *matplotlib.axes.Axes* instance and should have the picker property set.

*onpick(self, event)*

When the line is picked, update the set of selected indices.

*process\_selected(self, ind, xs, ys)*

Default "do nothing" implementation of the *process\_selected()* method.

*ind* are the indices of the selected vertices. *xs* and *ys* are the coordinates of the selected vertices.

## 17.29.2 Functions

---

```
segment_hits(cx, cy, x, y, radius)
```

Return the indices of the segments in the polyline with coordinates  $(cx, cy)$  that are within a distance  $radius$  of the point  $(x, y)$ .

---

### matplotlib.lines.segment\_hits

```
matplotlib.lines.segment_hits(cx, cy, x, y, radius)
```

Return the indices of the segments in the polyline with coordinates  $(cx, cy)$  that are within a distance  $radius$  of the point  $(x, y)$ .

## 17.30 matplotlib.markers

This module contains functions to handle markers. Used by both the marker functionality of *plot* and *scatter*.

All possible markers are defined here:

marker	symbol	description
"."		point
","		pixel
"o"		circle
"v"		triangle_down
"^"		triangle_up
"<"		triangle_left
">"		triangle_right
"1"		tri_down
"2"		tri_up
"3"		tri_left
"4"		tri_right
"8"		octagon
"s"		square
"p"		pentagon
"P"		plus (filled)
"*"		star
"h"		hexagon1
"H"		hexagon2
"+"		plus
"x"		x
"X"		x (filled)

Continued on next page

Table 145 – continued from previous page

marker	symbol	description
"D"		diamond
"d"		thin_diamond
" "		vline
"_"		hline
0 (TICKLEFT)		tickleft
1 (TICKRIGHT)		tickright
2 (TICKUP)		tickup
3 (TICKDOWN)		tickdown
4 (CARETLEFT)		caretleft
5 (CARETRIGHT)		caretright
6 (CARETUP)		caretup
7 (CARETDOWN)		caretdown
8 (CARETLEFTBASE)		caretleft (centered at base)
9 (CARETRIGHTBASE)		caretright (centered at base)
10 (CARETUPBASE)		caretup (centered at base)
11 (CARETDOWNBASE)		caretdown (centered at base)
"None", " " or ""		nothing
'\$...\$'		Render the string using <code>mathtext</code> . E.g. "\$f\$" for marker showing the letter <i>f</i> .
verts		A list of (x, y) pairs used for Path vertices. The center of the marker is located at (0,0) and the size is normalized, such that the created path is encapsulated inside the unit cell.
path		A <i>Path</i> instance.

Continued on next page

Table 145 – continued from previous page

marker	symbol	description
(numsides, style, angle)		<p>The marker can also be a tuple (numsides, style, angle), which will create a custom, regular symbol.</p> <p><b>numsides:</b> the number of sides</p> <p><b>style:</b> the style of the regular symbol:</p> <ul style="list-style-type: none"> <li>• 0: a regular polygon</li> <li>• 1: a star-like symbol</li> <li>• 2: an asterisk</li> <li>• 3: a circle (numsides and angle is ignored); deprecated.</li> </ul> <p><b>angle:</b> the angle of rotation of the symbol</p>

For backward compatibility, the form (verts, 0) is also accepted, but it is deprecated and equivalent to just verts for giving a raw set of vertices that define the shape.

None is the default which means ‘nothing’, however this table is referred to from other docs for the valid inputs from marker inputs and in those cases None still means ‘default’.

Note that special symbols can be defined via the *STIX math font*, e.g. "\$\$". For an overview over the STIX font symbols refer to the [STIX font table](#). Also see the [/gallery/text\\_labels\\_and\\_annotations/stix\\_fonts\\_demo](#).

Integer numbers from 0 to 11 create lines and triangles. Those are equally accessible via capitalized variables, like CARETDOWNBASE. Hence the following are equivalent:

```
plt.plot([1,2,3], marker=11)
plt.plot([1,2,3], marker=matplotlib.markers.CARETDOWNBASE)
```

Examples showing the use of markers:

- [/gallery/lines\\_bars\\_and\\_markers/marker\\_reference](#)
- [/gallery/lines\\_bars\\_and\\_markers/marker\\_fillstyle\\_reference](#)
- [/gallery/shapes\\_and\\_collections/marker\\_path](#)

### 17.30.1 Classes

*MarkerStyle*([marker, fillstyle])**Parameters****matplotlib.markers.MarkerStyle**class matplotlib.markers.MarkerStyle(*marker=None, fillstyle=None*)Bases: `object`**Parameters****marker** [string or array\_like, optional, default: None] See the descriptions of possible markers in the module docstring.**fillstyle** [string, optional, default: 'full'] 'full', 'left', 'right', 'bottom', 'top', 'none'**Attributes****markers** [list of known marks]**fillstyles** [list of known fillstyles]**filled\_markers** [list of known filled markers.]

filled\_markers = ('o', 'v', '^', '&lt;', '&gt;', '8', 's', 'p', '\*', 'h', 'H', 'D', 'd', 'P', 'X')

fillstyles = ('full', 'left', 'right', 'bottom', 'top', 'none')

get\_alt\_path(*self*)get\_alt\_transform(*self*)get\_capstyle(*self*)get\_fillstyle(*self*)get\_joinstyle(*self*)get\_marker(*self*)get\_path(*self*)get\_snap\_threshold(*self*)get\_transform(*self*)is\_filled(*self*)

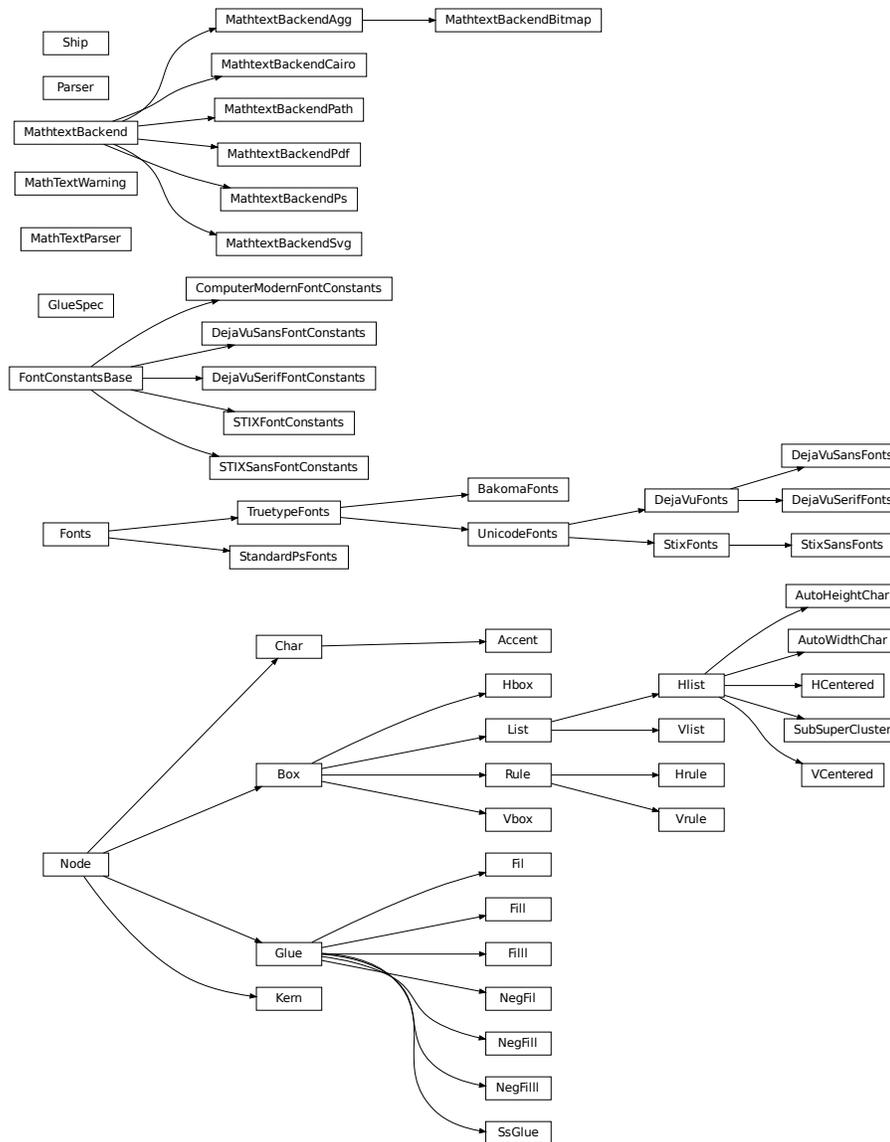
markers = {'.': 'point', ',': 'pixel', 'o': 'circle', 'v': 'triangle\_down', '^': 'triangle\_up', 'x': 'x'}

set\_fillstyle(*self, fillstyle*)

Sets fillstyle

**Parameters****fillstyle** [string amongst known fillstyles]set\_marker(*self, marker*)

## 17.31 matplotlib.mathtext



`matplotlib.mathtext` is a module for parsing a subset of the TeX math syntax and drawing them to a matplotlib backend.

For a tutorial of its usage see *Writing mathematical expressions*. This document is primarily concerned with implementation details.

The module uses `pyparsing` to parse the TeX expression.

The Bakoma distribution of the TeX Computer Modern fonts, and STIX fonts are supported. There is experimental support for using arbitrary fonts, but results may vary without proper

tweaking and metrics for those fonts.

```
class matplotlib.mathtext.Accent(c, state, math=True)
```

```
    Bases: matplotlib.mathtext.Char
```

The font metrics need to be dealt with differently for accents, since they are already offset correctly from the baseline in TrueType fonts.

```
grow(self)
```

Grows one level larger. There is no limit to how big something can get.

```
render(self, x, y)
```

Render the character to the canvas.

```
shrink(self)
```

Shrinks one level smaller. There are only three levels of sizes, after which things will no longer get smaller.

```
class matplotlib.mathtext.AutoHeightChar(c, height, depth, state, always=False, factor=None)
```

```
    Bases: matplotlib.mathtext.HList
```

*AutoHeightChar* will create a character as close to the given height and depth as possible. When using a font with multiple height versions of some characters (such as the BaKoMa fonts), the correct glyph will be selected, otherwise this will always just return a scaled version of the glyph.

```
class matplotlib.mathtext.AutoWidthChar(c, width, state, always=False, char_class=<class matplotlib.mathtext.Char>)
```

```
    Bases: matplotlib.mathtext.HList
```

*AutoWidthChar* will create a character as close to the given width as possible. When using a font with multiple width versions of some characters (such as the BaKoMa fonts), the correct glyph will be selected, otherwise this will always just return a scaled version of the glyph.

```
class matplotlib.mathtext.BakomaFonts(*args, **kwargs)
```

```
    Bases: matplotlib.mathtext.TruetypeFonts
```

Use the Bakoma TrueType fonts for rendering.

Symbols are strewn about a number of font files, each of which has its own proprietary 8-bit encoding.

```
alias = '\\\]
```

```
get_sized_alternatives_for_symbol(self, fontname, sym)
```

Override if your font provides multiple sizes of the same symbol. Should return a list of symbols matching *sym* in various sizes. The expression renderer will select the most appropriate size for a given situation from this list.

```
target = ']
```

```
class matplotlib.mathtext.Box(width, height, depth)
```

```
    Bases: matplotlib.mathtext.Node
```

Represents any node with a physical location.

```
grow(self)
```

Grows one level larger. There is no limit to how big something can get.

```
render(self, x1, y1, x2, y2)
```

`shrink(self)`

Shrinks one level smaller. There are only three levels of sizes, after which things will no longer get smaller.

```
class matplotlib.mathtext.Char(c, state, math=True)
```

Bases: `matplotlib.mathtext.Node`

Represents a single character. Unlike TeX, the font information and metrics are stored with each *Char* to make it easier to lookup the font metrics when needed. Note that TeX boxes have a width, height, and depth, unlike Type1 and Truetype which use a full bounding box and an advance in the x-direction. The metrics must be converted to the TeX way, and the advance (if different from width) must be converted into a *Kern* node when the *Char* is added to its parent *Hlist*.

`get_kerning(self, next)`

Return the amount of kerning between this and the given character. Called when characters are strung together into *Hlist* to create *Kern* nodes.

`grow(self)`

Grows one level larger. There is no limit to how big something can get.

`is_slanted(self)`

`render(self, x, y)`

Render the character to the canvas

`shrink(self)`

Shrinks one level smaller. There are only three levels of sizes, after which things will no longer get smaller.

```
class matplotlib.mathtext.ComputerModernFontConstants
```

Bases: `matplotlib.mathtext.FontConstantsBase`

`delta = 0.075`

`delta_integral = 0.3`

`delta_slanted = 0.3`

`script_space = 0.075`

`sub1 = 0.2`

`sub2 = 0.3`

`subdrop = 0.2`

`sup1 = 0.45`

```
class matplotlib.mathtext.DejaVuFonts(*args, **kwargs)
```

Bases: `matplotlib.mathtext.UnicodeFonts`

`use_cmex = False`

```
class matplotlib.mathtext.DejaVuSansFontConstants
```

Bases: `matplotlib.mathtext.FontConstantsBase`

```
class matplotlib.mathtext.DejaVuSansFonts(*args, **kwargs)
```

Bases: `matplotlib.mathtext.DejaVuFonts`

A font handling class for the DejaVu Sans fonts

If a glyph is not found it will fallback to Stix Sans

```
class matplotlib.mathtext.DejaVuSerifFontConstants
```

```
    Bases: matplotlib.mathtext.FontConstantsBase
```

```
class matplotlib.mathtext.DejaVuSerifFonts(*args, **kwargs)
```

```
    Bases: matplotlib.mathtext.DejaVuFonts
```

A font handling class for the DejaVu Serif fonts

If a glyph is not found it will fallback to Stix Serif

```
matplotlib.mathtext.Error(msg)
```

Helper class to raise parser errors.

```
class matplotlib.mathtext.Fil
```

```
    Bases: matplotlib.mathtext.Glue
```

```
class matplotlib.mathtext.Fill
```

```
    Bases: matplotlib.mathtext.Glue
```

```
class matplotlib.mathtext.Fill1
```

```
    Bases: matplotlib.mathtext.Glue
```

```
class matplotlib.mathtext.FontConstantsBase
```

```
    Bases: object
```

A set of constants that controls how certain things, such as sub- and superscripts are laid out. These are all metrics that can't be reliably retrieved from the font metrics in the font itself.

```
delta = 0.025
```

```
delta_integral = 0.1
```

```
delta_slanted = 0.2
```

```
script_space = 0.05
```

```
sub1 = 0.3
```

```
sub2 = 0.5
```

```
subdrop = 0.4
```

```
sup1 = 0.7
```

```
class matplotlib.mathtext.Fonts(default_font_prop, mathtext_backend)
```

```
    Bases: object
```

An abstract base class for a system of fonts to use for mathtext.

The class must be able to take symbol keys and font file names and return the character metrics. It also delegates to a backend class to do the actual drawing.

*default\_font\_prop*: A *FontProperties* object to use for the default non-math font, or the base font for Unicode (generic) font rendering.

*mathtext\_backend*: A subclass of *MathTextBackend* used to delegate the actual rendering.

```
destroy(self)
```

Fix any cyclical references before the object is about to be destroyed.

```
get_kern(self, font1, fontclass1, sym1, fontsize1, font2, fontclass2, sym2, fontsize2, dpi)
```

Get the kerning distance for font between *sym1* and *sym2*.

*fontX*: one of the TeX font names:

```
tt, it, rm, cal, sf, bf or default/regular (non-math)
```

*fontclassX*: TODO

*symX*: a symbol in raw TeX form. e.g., '1', 'x' or 'sigma'

*fontsizeX*: the fontsize in points

*dpi*: the current dots-per-inch

`get_metrics(self, font, font_class, sym, fontsize, dpi, math=True)`

*font*: one of the TeX font names:

```
tt, it, rm, cal, sf, bf or default/regular (non-math)
```

*font\_class*: TODO

*sym*: a symbol in raw TeX form. e.g., '1', 'x' or 'sigma'

*fontsize*: font size in points

*dpi*: current dots-per-inch

*math*: whether sym is a math character

Returns an object with the following attributes:

- *advance*: The advance distance (in points) of the glyph.
- *height*: The height of the glyph in points.
- *width*: The width of the glyph in points.
- *xmin*, *xmax*, *ymin*, *ymax* - the ink rectangle of the glyph
- *iceberg* - the distance from the baseline to the top of the glyph. This corresponds to TeX's definition of "height".

`get_results(self, box)`

Get the data needed by the backend to render the math expression. The return value is backend-specific.

`get_sized_alternatives_for_symbol(self, fontname, sym)`

Override if your font provides multiple sizes of the same symbol. Should return a list of symbols matching *sym* in various sizes. The expression renderer will select the most appropriate size for a given situation from this list.

`get_underline_thickness(self, font, fontsize, dpi)`

Get the line thickness that matches the given font. Used as a base unit for drawing lines such as in a fraction or radical.

`get_used_characters(self)`

Get the set of characters that were used in the math expression. Used by backends that need to subset fonts so they know which glyphs to include.

`get_xheight(self, font, fontsize, dpi)`

Get the xheight for the given *font* and *fontsize*.

`render_glyph(self, ox, oy, facename, font_class, sym, fontsize, dpi)`

Draw a glyph at

- *ox*, *oy*: position

- *facename*: One of the TeX face names
- *font\_class*:
- *sym*: TeX symbol name or single character
- *fontsize*: fontsize in points
- *dpi*: The dpi to draw at.

`render_rect_filled(self, x1, y1, x2, y2)`

Draw a filled rectangle from (x1, y1) to (x2, y2).

`set_canvas_size(self, w, h, d)`

Set the size of the buffer used to render the math expression. Only really necessary for the bitmap backends.

`class matplotlib.mathtext.Glue(glue_type, copy=False)`

Bases: `matplotlib.mathtext.Node`

Most of the information in this object is stored in the underlying `GlueSpec` class, which is shared between multiple glue objects. (This is a memory optimization which probably doesn't matter anymore, but it's easier to stick to what TeX does.)

`grow(self)`

Grows one level larger. There is no limit to how big something can get.

`shrink(self)`

Shrinks one level smaller. There are only three levels of sizes, after which things will no longer get smaller.

`class matplotlib.mathtext.GlueSpec(width=0.0, stretch=0.0, stretch_order=0, shrink=0.0, shrink_order=0)`

Bases: `object`

See `Glue`.

`copy(self)`

`classmethod factory(glue_type)`

`class matplotlib.mathtext.HCentered(elements)`

Bases: `matplotlib.mathtext.Hlist`

A convenience class to create an `Hlist` whose contents are centered within its enclosing box.

`class matplotlib.mathtext.Hbox(width)`

Bases: `matplotlib.mathtext.Box`

A box with only width (zero height and depth).

`class matplotlib.mathtext.Hlist(elements, w=0.0, m='additional', do_kern=True)`

Bases: `matplotlib.mathtext.List`

A horizontal list of boxes.

`hpack(self, w=0.0, m='additional')`

The main duty of `hpack()` is to compute the dimensions of the resulting boxes, and to adjust the glue if one of those dimensions is pre-specified. The computed sizes normally enclose all of the material inside the new box; but some items may stick out if negative glue is used, if the box is overfull, or if a `\vbox` includes other boxes that have been shifted left.

- *w*: specifies a width

- *m*: is either 'exactly' or 'additional'.

Thus, `hpack(w, 'exactly')` produces a box whose width is exactly *w*, while `hpack(w, 'additional')` yields a box whose width is the natural width plus *w*. The default values produce a box with the natural width.

`kern(self)`

Insert *Kern* nodes between *Char* nodes to set kerning. The *Char* nodes themselves determine the amount of kerning they need (in `get_kerning()`), and this function just creates the linked list in the correct way.

```
class matplotlib.mathtext.Hrule(state, thickness=None)
```

Bases: `matplotlib.mathtext.Rule`

Convenience class to create a horizontal rule.

```
class matplotlib.mathtext.Kern(width)
```

Bases: `matplotlib.mathtext.Node`

A *Kern* node has a *width* field to specify a (normally negative) amount of spacing. This spacing correction appears in horizontal lists between letters like A and V when the font designer said that it looks better to move them closer together or further apart. A kern node can also appear in a vertical list, when its *width* denotes additional spacing in the vertical direction.

`depth = 0`

`grow(self)`

Grows one level larger. There is no limit to how big something can get.

`height = 0`

`shrink(self)`

Shrinks one level smaller. There are only three levels of sizes, after which things will no longer get smaller.

```
class matplotlib.mathtext.List(elements)
```

Bases: `matplotlib.mathtext.Box`

A list of nodes (either horizontal or vertical).

`grow(self)`

Grows one level larger. There is no limit to how big something can get.

`shrink(self)`

Shrinks one level smaller. There are only three levels of sizes, after which things will no longer get smaller.

```
class matplotlib.mathtext.MathTextParser(output)
```

Bases: `object`

Create a `MathTextParser` for the given backend *output*.

```
get_depth(self, texstr, dpi=120, fontsize=14)
```

#### Parameters

**texstr** [str] A valid mathtext string, e.g., `r'IQ:  $\sigma_i=15$ '`.

**dpi** [float] The dots-per-inch setting used to render the text.

#### Returns

**depth** [int] Offset of the baseline from the bottom of the image, in pixels.

`parse(self, s, dpi=72, prop=None)`

Parse the given math expression *s* at the given *dpi*. If *prop* is provided, it is a *FontProperties* object specifying the "default" font to use in the math expression, used for all non-math text.

The results are cached, so multiple calls to *parse()* with the same expression should be fast.

`to_mask(self, texstr, dpi=120, fontsize=14)`

#### Parameters

**texstr** [str] A valid mathtext string, e.g., `r'IQ:  $\sigma_i=15$ $'`.

**dpi** [float] The dots-per-inch setting used to render the text.

**fontsize** [int] The font size in points

#### Returns

**array** [2D uint8 alpha] Mask array of rasterized tex.

**depth** [int] Offset of the baseline from the bottom of the image, in pixels.

`to_png(self, filename, texstr, color='black', dpi=120, fontsize=14)`

Render a tex expression to a PNG file.

#### Parameters

**filename** A writable filename or fileobject.

**texstr** [str] A valid mathtext string, e.g., `r'IQ:  $\sigma_i=15$ $'`.

**color** [color] The text color.

**dpi** [float] The dots-per-inch setting used to render the text.

**fontsize** [int] The font size in points.

#### Returns

**depth** [int] Offset of the baseline from the bottom of the image, in pixels.

`to_rgba(self, texstr, color='black', dpi=120, fontsize=14)`

#### Parameters

**texstr** [str] A valid mathtext string, e.g., `r'IQ:  $\sigma_i=15$ $'`.

**color** [color] The text color.

**dpi** [float] The dots-per-inch setting used to render the text.

**fontsize** [int] The font size in points.

#### Returns

**array** [(M, N, 4) array] RGBA color values of rasterized tex, colorized with *color*.

**depth** [int] Offset of the baseline from the bottom of the image, in pixels.

exception `matplotlib.mathtext.MathTextWarning`

Bases: `Warning`

```
class matplotlib.mathtext.MathtextBackend
```

```
    Bases: object
```

The base class for the mathtext backend-specific code. The purpose of *MathtextBackend* subclasses is to interface between mathtext and a specific matplotlib graphics backend.

Subclasses need to override the following:

- *render\_glyph()*
- *render\_rect\_filled()*
- *get\_results()*

And optionally, if you need to use a FreeType hinting style:

- *get\_hinting\_type()*

```
get_hinting_type(self)
```

Get the FreeType hinting type to use with this particular backend.

```
get_results(self, box)
```

Return a backend-specific tuple to return to the backend after all processing is done.

```
render_glyph(self, ox, oy, info)
```

Draw a glyph described by *info* to the reference point (*ox*, *oy*).

```
render_rect_filled(self, x1, y1, x2, y2)
```

Draw a filled black rectangle from (*x1*, *y1*) to (*x2*, *y2*).

```
set_canvas_size(self, w, h, d)
```

Dimension the drawing canvas

```
class matplotlib.mathtext.MathtextBackendAgg
```

```
    Bases: matplotlib.mathtext.MathtextBackend
```

Render glyphs and rectangles to an FTImage buffer, which is later transferred to the Agg image by the Agg backend.

```
get_hinting_type(self)
```

Get the FreeType hinting type to use with this particular backend.

```
get_results(self, box, used_characters)
```

Return a backend-specific tuple to return to the backend after all processing is done.

```
render_glyph(self, ox, oy, info)
```

Draw a glyph described by *info* to the reference point (*ox*, *oy*).

```
render_rect_filled(self, x1, y1, x2, y2)
```

Draw a filled black rectangle from (*x1*, *y1*) to (*x2*, *y2*).

```
set_canvas_size(self, w, h, d)
```

Dimension the drawing canvas

```
class matplotlib.mathtext.MathtextBackendBitmap
```

```
    Bases: matplotlib.mathtext.MathtextBackendAgg
```

```
get_results(self, box, used_characters)
```

Return a backend-specific tuple to return to the backend after all processing is done.

```
class matplotlib.mathtext.MathtextBackendCairo
```

```
    Bases: matplotlib.mathtext.MathtextBackend
```

Store information to write a mathtext rendering to the Cairo backend.

`get_results(self, box, used_characters)`

Return a backend-specific tuple to return to the backend after all processing is done.

`render_glyph(self, ox, oy, info)`

Draw a glyph described by *info* to the reference point (*ox*, *oy*).

`render_rect_filled(self, x1, y1, x2, y2)`

Draw a filled black rectangle from (*x1*, *y1*) to (*x2*, *y2*).

`class matplotlib.mathtext.MathtextBackendPath`

Bases: `matplotlib.mathtext.MathtextBackend`

Store information to write a mathtext rendering to the text path machinery.

`get_results(self, box, used_characters)`

Return a backend-specific tuple to return to the backend after all processing is done.

`render_glyph(self, ox, oy, info)`

Draw a glyph described by *info* to the reference point (*ox*, *oy*).

`render_rect_filled(self, x1, y1, x2, y2)`

Draw a filled black rectangle from (*x1*, *y1*) to (*x2*, *y2*).

`class matplotlib.mathtext.MathtextBackendPdf`

Bases: `matplotlib.mathtext.MathtextBackend`

Store information to write a mathtext rendering to the PDF backend.

`get_results(self, box, used_characters)`

Return a backend-specific tuple to return to the backend after all processing is done.

`render_glyph(self, ox, oy, info)`

Draw a glyph described by *info* to the reference point (*ox*, *oy*).

`render_rect_filled(self, x1, y1, x2, y2)`

Draw a filled black rectangle from (*x1*, *y1*) to (*x2*, *y2*).

`class matplotlib.mathtext.MathtextBackendPs`

Bases: `matplotlib.mathtext.MathtextBackend`

Store information to write a mathtext rendering to the PostScript backend.

`get_results(self, box, used_characters)`

Return a backend-specific tuple to return to the backend after all processing is done.

`render_glyph(self, ox, oy, info)`

Draw a glyph described by *info* to the reference point (*ox*, *oy*).

`render_rect_filled(self, x1, y1, x2, y2)`

Draw a filled black rectangle from (*x1*, *y1*) to (*x2*, *y2*).

`class matplotlib.mathtext.MathtextBackendSvg`

Bases: `matplotlib.mathtext.MathtextBackend`

Store information to write a mathtext rendering to the SVG backend.

`get_results(self, box, used_characters)`

Return a backend-specific tuple to return to the backend after all processing is done.

`render_glyph(self, ox, oy, info)`

Draw a glyph described by *info* to the reference point (*ox*, *oy*).

`render_rect_filled(self, x1, y1, x2, y2)`

Draw a filled black rectangle from (*x1*, *y1*) to (*x2*, *y2*).

---

```

class matplotlib.mathtext.NegFil
    Bases: matplotlib.mathtext.Glue
class matplotlib.mathtext.NegFill
    Bases: matplotlib.mathtext.Glue
class matplotlib.mathtext.NegFilll
    Bases: matplotlib.mathtext.Glue
class matplotlib.mathtext.Node
    Bases: object
    A node in the TeX box model
    get_kerning(self, next)
    grow(self)
        Grows one level larger. There is no limit to how big something can get.
    render(self, x, y)
    shrink(self)
        Shrinks one level smaller. There are only three levels of sizes, after which things
        will no longer get smaller.
class matplotlib.mathtext.Parser
    Bases: object
    This is the pyparsing-based parser for math expressions. It actually parses full strings
    containing math expressions, in that raw text may also appear outside of pairs of $.
    The grammar is based directly on that in TeX, though it cuts a few corners.
class State(font_output, font, font_class, fontsize, dpi)
    Bases: object
    Stores the state of the parser.
    States are pushed and popped from a stack as necessary, and the "current" state is
    always at the top of the stack.
    copy(self)
    font
    accent(self, s, loc, toks)
    auto_delim(self, s, loc, toks)
    binom(self, s, loc, toks)
    c_over_c(self, s, loc, toks)
    customspace(self, s, loc, toks)
    dfrac(self, s, loc, toks)
    end_group(self, s, loc, toks)
    font(self, s, loc, toks)
    frac(self, s, loc, toks)
    function(self, s, loc, toks)
    genfrac(self, s, loc, toks)

```

`get_state(self)`  
Get the current *State* of the parser.

`group(self, s, loc, toks)`

`is_between_brackets(self, s, loc)`

`is_dropsub(self, nucleus)`

`is_overunder(self, nucleus)`

`is_slanted(self, nucleus)`

`main(self, s, loc, toks)`

`math(self, s, loc, toks)`

`math_string(self, s, loc, toks)`

`non_math(self, s, loc, toks)`

`operatorname(self, s, loc, toks)`

`overline(self, s, loc, toks)`

`parse(self, s, fonts_object, fontsize, dpi)`  
Parse expression *s* using the given *fonts\_object* for output, at the given *fontsize* and *dpi*.  
Returns the parse tree of *Node* instances.

`pop_state(self)`  
Pop a *State* off of the stack.

`push_state(self)`  
Push a new *State* onto the stack which is just a copy of the current state.

`required_group(self, s, loc, toks)`

`simple_group(self, s, loc, toks)`

`snowflake(self, s, loc, toks)`

`space(self, s, loc, toks)`

`sqrt(self, s, loc, toks)`

`stackrel(self, s, loc, toks)`  
[*Deprecated*]

### Notes

Deprecated since version 3.1:

`start_group(self, s, loc, toks)`

`subsuper(self, s, loc, toks)`

`symbol(self, s, loc, toks)`

`unknown_symbol(self, s, loc, toks)`

`class matplotlib.mathtext.Rule(width, height, depth, state)`  
Bases: `matplotlib.mathtext.Box`

A *Rule* node stands for a solid black rectangle; it has *width*, *depth*, and *height* fields just as in an *Hlist*. However, if any of these dimensions is *inf*, the actual value will be determined by running the rule up to the boundary of the innermost enclosing box. This is called a "running dimension." The width is never running in an *Hlist*; the height and depth are never running in a *Vlist*.

```
render(self, x, y, w, h)
```

```
class matplotlib.mathtext.STIXFontConstants
    Bases: matplotlib.mathtext.FontConstantsBase
```

```
    delta = 0.05
```

```
    delta_integral = 0.3
```

```
    delta_slanted = 0.3
```

```
    script_space = 0.1
```

```
    sub2 = 0.6
```

```
    sup1 = 0.8
```

```
class matplotlib.mathtext.STIXSansFontConstants
    Bases: matplotlib.mathtext.FontConstantsBase
```

```
    delta_integral = 0.3
```

```
    delta_slanted = 0.6
```

```
    script_space = 0.05
```

```
    sup1 = 0.8
```

```
class matplotlib.mathtext.Ship
    Bases: object
```

Once the boxes have been set up, this sends them to output. Since boxes can be inside of boxes inside of boxes, the main work of *Ship* is done by two mutually recursive routines, *hlist\_out()* and *vlist\_out()*, which traverse the *Hlist* nodes and *Vlist* nodes inside of horizontal and vertical boxes. The global variables used in TeX to store state as it processes have become member variables here.

```
    static clamp(value)
```

```
    hlist_out(self, box)
```

```
    vlist_out(self, box)
```

```
class matplotlib.mathtext.SsGlue
    Bases: matplotlib.mathtext.Glue
```

```
class matplotlib.mathtext.StandardPsFonts(default_font_prop)
    Bases: matplotlib.mathtext.Fonts
```

Use the standard postscript fonts for rendering to backend<sub>ps</sub>

Unlike the other font classes, *BakomaFont* and *UnicodeFont*, this one requires the Ps backend.

```
basepath = '/home/pi/.virtualenvs/mpl311-doc/lib/python3.7/site-packages/matplotlib/mpl-data/fonts/'
```

```
fontmap = {'cal': 'pzcmi8a', 'rm': 'pncr8a', 'tt': 'pcrr8a', 'it': 'pncr8a', 'sf': 'phvr8a', 'bf'
```

`get_kern(self, font1, fontclass1, sym1, fontsize1, font2, fontclass2, sym2, fontsize2, dpi)`

Get the kerning distance for font between *sym1* and *sym2*.

*fontX*: one of the TeX font names:

tt, it, rm, cal, sf, bf or default/regular (non-math)
---

*fontclassX*: TODO

*symX*: a symbol in raw TeX form. e.g., '1', 'x' or 'sigma'

*fontsizeX*: the fontsize in points

*dpi*: the current dots-per-inch

`get_underline_thickness(self, font, fontsize, dpi)`

Get the line thickness that matches the given font. Used as a base unit for drawing lines such as in a fraction or radical.

`get_xheight(self, font, fontsize, dpi)`

Get the xheight for the given *font* and *fontsize*.

`class matplotlib.mathtext.StixFonts(*args, **kwargs)`

Bases: `matplotlib.mathtext.UnicodeFonts`

A font handling class for the STIX fonts.

In addition to what `UnicodeFonts` provides, this class:

- supports "virtual fonts" which are complete alpha numeric character sets with different font styles at special Unicode code points, such as "Blackboard".
- handles sized alternative characters for the `STIXSizeX` fonts.

`cm_fallback = False`

`get_sized_alternatives_for_symbol(self, fontname, sym)`

Override if your font provides multiple sizes of the same symbol. Should return a list of symbols matching *sym* in various sizes. The expression renderer will select the most appropriate size for a given situation from this list.

`use_cmex = False`

`class matplotlib.mathtext.StixSansFonts(*args, **kwargs)`

Bases: `matplotlib.mathtext.StixFonts`

A font handling class for the STIX fonts (that uses sans-serif characters by default).

`class matplotlib.mathtext.SubSuperCluster`

Bases: `matplotlib.mathtext.HList`

`SubSuperCluster` is a sort of hack to get around that fact that this code do a two-pass parse like TeX. This lets us store enough information in the `hlist` itself, namely the nucleus, sub- and super-script, such that if another script follows that needs to be attached, it can be reconfigured on the fly.

`class matplotlib.mathtext.TruetypeFonts(default_font_prop, mathtext_backend)`

Bases: `matplotlib.mathtext.Fonts`

A generic base class for all font setups that use Truetype fonts (through `FT2Font`).

`destroy(self)`

Fix any cyclical references before the object is about to be destroyed.

`get_kern(self, font1, fontclass1, sym1, fontsize1, font2, fontclass2, sym2, fontsize2, dpi)`

Get the kerning distance for font between *sym1* and *sym2*.

*fontX*: one of the TeX font names:

tt, it, rm, cal, sf, bf or default/regular (non-math)
---

*fontclassX*: TODO

*symX*: a symbol in raw TeX form. e.g., '1', 'x' or 'sigma'

*fontsizeX*: the fontsize in points

*dpi*: the current dots-per-inch

`get_underline_thickness(self, font, fontsize, dpi)`

Get the line thickness that matches the given font. Used as a base unit for drawing lines such as in a fraction or radical.

`get_xheight(self, fontname, fontsize, dpi)`

Get the xheight for the given *font* and *fontsize*.

`class matplotlib.mathtext.UnicodeFonts(*args, **kwargs)`

Bases: `matplotlib.mathtext.TruetypeFonts`

An abstract base class for handling Unicode fonts.

While some reasonably complete Unicode fonts (such as DejaVu) may work in some situations, the only Unicode font I'm aware of with a complete set of math symbols is STIX.

This class will "fallback" on the Bakoma fonts when a required symbol can not be found in the font.

`get_sized_alternatives_for_symbol(self, fontname, sym)`

Override if your font provides multiple sizes of the same symbol. Should return a list of symbols matching *sym* in various sizes. The expression renderer will select the most appropriate size for a given situation from this list.

`use_cmex = True`

`class matplotlib.mathtext.VCentered(elements)`

Bases: `matplotlib.mathtext.Hlist`

A convenience class to create a *vlist* whose contents are centered within its enclosing box.

`class matplotlib.mathtext.Vbox(height, depth)`

Bases: `matplotlib.mathtext.Box`

A box with only height (zero width).

`class matplotlib.mathtext.Vlist(elements, h=0.0, m='additional')`

Bases: `matplotlib.mathtext.List`

A vertical list of boxes.

`vpack(self, h=0.0, m='additional', l=inf)`

The main duty of `vpack()` is to compute the dimensions of the resulting boxes, and to adjust the glue if one of those dimensions is pre-specified.

- *h*: specifies a height
- *m*: is either 'exactly' or 'additional'.

- *l*: a maximum height

Thus, `vpack(h, 'exactly')` produces a box whose height is exactly *h*, while `vpack(h, 'additional')` yields a box whose height is the natural height plus *h*. The default values produce a box with the natural width.

```
class matplotlib.mathtext.Vrule(state)
```

```
    Bases: matplotlib.mathtext.Rule
```

Convenience class to create a vertical rule.

```
matplotlib.mathtext.get_unicode_index(symbol, math=True)
```

Return the integer index (from the Unicode table) of *symbol*.

### Parameters

**symbol** [str] A single unicode character, a TeX command (e.g. `r'pi'`) or a Type1 symbol name (e.g. `'phi'`).

**math** [bool, default is True] If False, always treat as a single unicode character.

```
matplotlib.mathtext.math_to_image(s, filename_or_obj, prop=None, dpi=None, format=None)
```

Given a math expression, renders it in a closely-clipped bounding box to an image file.

**s** A math expression. The math portion should be enclosed in dollar signs.

**filename\_or\_obj** A filepath or writable file-like object to write the image data to.

**prop** If provided, a `FontProperties()` object describing the size and style of the text.

**dpi** Override the output dpi, otherwise use the default associated with the output format.

**format** The output format, e.g., `'svg'`, `'pdf'`, `'ps'` or `'png'`. If not provided, will be deduced from the filename.

## 17.32 matplotlib.mlab

Numerical python functions written for compatibility with MATLAB commands with the same names. Most numerical python functions can be found in the `numpy` and `scipy` libraries. What remains here is code for performing spectral computations.

### 17.32.1 Spectral functions

*cohere* Coherence (normalized cross spectral density)

*csd* Cross spectral density using Welch's average periodogram

*detrend* Remove the mean or best fit line from an array

*psd* Power spectral density using Welch's average periodogram

*specgram* Spectrogram (spectrum over segments of time)

*complex\_spectrum* Return the complex-valued frequency spectrum of a signal

*magnitude\_spectrum* Return the magnitude of the frequency spectrum of a signal

*angle\_spectrum* Return the angle (wrapped phase) of the frequency spectrum of a signal

*phase\_spectrum* Return the phase (unwrapped angle) of the frequency spectrum of a signal

*detrend\_mean* Remove the mean from a line.

*detrend\_linear* Remove the best fit line from a line.

*detrend\_none* Return the original line.

*stride\_windows* Get all windows in an array in a memory-efficient manner

*stride\_repeat* Repeat an array in a memory-efficient manner

*apply\_window* Apply a window along a given axis

class `matplotlib.mlab.GaussianKDE(dataset, bw_method=None)`

Bases: `object`

Representation of a kernel-density estimate using Gaussian kernels.

### Parameters

**dataset** [array\_like] Datapoints to estimate from. In case of univariate data this is a 1-D array, otherwise a 2-D array with shape (# of dims, # of data).

**bw\_method** [str, scalar or callable, optional] The method used to calculate the estimator bandwidth. This can be 'scott', 'silverman', a scalar constant or a callable. If a scalar, this will be used directly as `kde.factor`. If a callable, it should take a *GaussianKDE* instance as only parameter and return a scalar. If None (default), 'scott' is used.

### Attributes

**dataset** [ndarray] The dataset with which `gaussian_kde` was initialized.

**dim** [int] Number of dimensions.

**num\_dp** [int] Number of datapoints.

**factor** [float] The bandwidth factor, obtained from `kde.covariance_factor`, with which the covariance matrix is multiplied.

**covariance** [ndarray] The covariance matrix of `dataset`, scaled by the calculated bandwidth (`kde.factor`).

**inv\_cov** [ndarray] The inverse of `covariance`.

### Methods

<b>kde.evaluate(points)</b>	(ndarray) Evaluate the estimated pdf on a provided set of points.
<b>kde(points)</b>	(ndarray) Same as <code>kde.evaluate(points)</code>

`covariance_factor(self)`

`evaluate(self, points)`

Evaluate the estimated pdf on a set of points.

### Parameters

**points** [(# of dimensions, # of points)-array] Alternatively, a (# of dimensions,) vector can be passed in and treated as a single point.

**Returns**

**values** [(# of points,)-array] The values at each point.

**Raises**

**ValueError** [if the dimensionality of the input points is different] than the dimensionality of the KDE.

`scotts_factor(self)`

`silverman_factor(self)`

`matplotlib.mlab.angle_spectrum(x, Fs=None, window=None, pad_to=None, sides=None)`

Compute the angle of the frequency spectrum (wrapped phase spectrum) of  $x$ . Data is padded to a length of `pad_to` and the windowing function `window` is applied to the signal.

**Parameters**

**x** [1-D array or sequence] Array or sequence containing the data

**Fs** [scalar] The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, `freqs`, in cycles per time unit. The default value is 2.

**window** [callable or ndarray] A function or a vector of length `NFFT`. To create window vectors see `window_hanning`, `window_none`, `numpy.blackman`, `numpy.hamming`, `numpy.bartlett`, `scipy.signal`, `scipy.signal.get_window`, etc. The default is `window_hanning`. If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.

**sides** [{'default', 'onesided', 'twosided'}] Specifies which sides of the spectrum to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. 'onesided' forces the return of a one-sided spectrum, while 'twosided' forces two-sided.

**pad\_to** [int] The number of points to which the data segment is padded when performing the FFT. While not increasing the actual resolution of the spectrum (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the  $n$  parameter in the call to `fft()`. The default is `None`, which sets `pad_to` equal to the length of the input signal (i.e. no padding).

**Returns**

**spectrum** [1-D array] The values for the angle spectrum in radians (real valued)

**freqs** [1-D array] The frequencies corresponding to the elements in `spectrum`

**See also:**

`complex_spectrum` This function returns the angle value of `complex_spectrum`.

`magnitude_spectrum` Returns the magnitudes of the corresponding frequencies.

`phase_spectrum` Returns the phase (unwrapped angle) of the corresponding frequencies.

`specgram` Can return the complex spectrum of segments within the signal.

`matplotlib.mlab.apply_window(x, window, axis=0, return_window=None)`

Apply the given window to the given 1D or 2D array along the given axis.

### Parameters

**x** [1D or 2D array or sequence] Array or sequence containing the data.

**window** [function or array.] Either a function to generate a window or an array with length `x.shape[axis]`

**axis** [integer] The axis over which to do the repetition. Must be 0 or 1. The default is 0

**return\_window** [bool] If true, also return the 1D values of the window that was applied

`matplotlib.mlab.cohere(x, y, NFFT=256, Fs=2, detrend=<function detrend_none at 0x7f69881a1378>, window=<function window_hanning at 0x7f6988216bf8>, noverlap=0, pad_to=None, sides='default', scale_by_freq=None)`

The coherence between  $x$  and  $y$ . Coherence is the normalized cross spectral density:

$$C_{xy} = \frac{|P_{xy}|^2}{P_{xx}P_{yy}}$$

### Parameters

**x, y** Array or sequence containing the data

**Fs** [scalar] The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, `freqs`, in cycles per time unit. The default value is 2.

**window** [callable or ndarray] A function or a vector of length `NFFT`. To create window vectors see `window_hanning`, `window_none`, `numpy.blackman`, `numpy.hamming`, `numpy.bartlett`, `scipy.signal`, `scipy.signal.get_window`, etc. The default is `window_hanning`. If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.

**sides** [{'default', 'onesided', 'twosided'}] Specifies which sides of the spectrum to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. 'onesided' forces the return of a one-sided spectrum, while 'twosided' forces two-sided.

**pad\_to** [int] The number of points to which the data segment is padded when performing the FFT. This can be different from `NFFT`, which specifies the number of data points used. While not increasing the actual resolution of the spectrum (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the  $n$  parameter in the call to `fft()`. The default is `None`, which sets `pad_to` equal to `NFFT`

**NFFT** [int] The number of data points used in each block for the FFT. A power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use `pad_to` for this instead.

**detrend** [{'none', 'mean', 'linear'} or callable, default 'none'] The function applied to each segment before `fft`-ing, designed to remove the

mean or linear trend. Unlike in MATLAB, where the *detrend* parameter is a vector, in Matplotlib it is a function. The *mlab* module defines *detrend\_none*, *detrend\_mean*, and *detrend\_linear*, but you can use a custom function as well. You can also use a string to choose one of the functions: 'none' calls *detrend\_none*. 'mean' calls *detrend\_mean*. 'linear' calls *detrend\_linear*.

**scale\_by\_freq** [bool, optional] Specifies whether the resulting density values should be scaled by the scaling frequency, which gives density in units of  $\text{Hz}^{-1}$ . This allows for integration over the returned frequency values. The default is True for MATLAB compatibility.

**noverlap** [integer] The number of points of overlap between blocks. The default value is 0 (no overlap).

### Returns

**The return value is the tuple ( $C_{xy}$ ,  $f$ ), where  $f$  are the frequencies of the coherence vector. For *cohere*, scaling the individual densities by the sampling frequency has no effect, since the factors cancel out.**

### See also:

*psd()*, *csd()* For information about the methods used to compute  $P_{xy}$ ,  $P_{xx}$  and  $P_{yy}$ .

`matplotlib.mlab.complex_spectrum(x, Fs=None, window=None, pad_to=None, sides=None)`

Compute the complex-valued frequency spectrum of  $x$ . Data is padded to a length of *pad\_to* and the windowing function *window* is applied to the signal.

### Parameters

**x** [1-D array or sequence] Array or sequence containing the data

**Fs** [scalar] The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, *freqs*, in cycles per time unit. The default value is 2.

**window** [callable or ndarray] A function or a vector of length *NFFT*. To create window vectors see *window\_hanning*, *window\_none*, `numpy.blackman`, `numpy.hamming`, `numpy.bartlett`, `scipy.signal`, `scipy.signal.get_window`, etc. The default is *window\_hanning*. If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.

**sides** [{'default', 'onesided', 'twosided'}] Specifies which sides of the spectrum to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. 'onesided' forces the return of a one-sided spectrum, while 'twosided' forces two-sided.

**pad\_to** [int] The number of points to which the data segment is padded when performing the FFT. While not increasing the actual resolution of the spectrum (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the *n* parameter in the call to `fft()`. The default is None, which sets *pad\_to* equal to the length of the input signal (i.e. no padding).

### Returns

**spectrum** [1-D array] The values for the complex spectrum (complex valued)

**freqs** [1-D array] The frequencies corresponding to the elements in *spectrum*

**See also:**

*magnitude\_spectrum* Returns the absolute value of this function.

*angle\_spectrum* Returns the angle of this function.

*phase\_spectrum* Returns the phase (unwrapped angle) of this function.

*specgram* Can return the complex spectrum of segments within the signal.

`matplotlib.mlab.csd(x, y, NFFT=None, Fs=None, detrend=None, window=None, noverlap=None, pad_to=None, sides=None, scale_by_freq=None)`  
Compute the cross-spectral density.

The cross spectral density  $P_{xy}$  by Welch's average periodogram method. The vectors  $x$  and  $y$  are divided into  $NFFT$  length segments. Each segment is detrended by function *detrend* and windowed by function *window*. *noverlap* gives the length of the overlap between segments. The product of the direct FFTs of  $x$  and  $y$  are averaged over each segment to compute  $P_{xy}$ , with a scaling to correct for power loss due to windowing.

If  $\text{len}(x) < NFFT$  or  $\text{len}(y) < NFFT$ , they will be zero padded to  $NFFT$ .

**Parameters**

**x, y** [1-D arrays or sequences] Arrays or sequences containing the data

**Fs** [scalar] The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, *freqs*, in cycles per time unit. The default value is 2.

**window** [callable or ndarray] A function or a vector of length  $NFFT$ . To create window vectors see *window\_hanning*, *window\_none*, `numpy.blackman`, `numpy.hamming`, `numpy.bartlett`, `scipy.signal`, `scipy.signal.get_window`, etc. The default is *window\_hanning*. If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.

**sides** [{'default', 'onesided', 'twosided'}] Specifies which sides of the spectrum to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. 'onesided' forces the return of a one-sided spectrum, while 'twosided' forces two-sided.

**pad\_to** [int] The number of points to which the data segment is padded when performing the FFT. This can be different from  $NFFT$ , which specifies the number of data points used. While not increasing the actual resolution of the spectrum (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the  $n$  parameter in the call to `fft()`. The default is `None`, which sets *pad\_to* equal to  $NFFT$

**NFFT** [int] The number of data points used in each block for the FFT. A power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use *pad\_to* for this instead.

**detrend** [{'none', 'mean', 'linear'} or callable, default 'none'] The function applied to each segment before fft-ing, designed to remove the mean or linear trend. Unlike in MATLAB, where the *detrend* parameter is a vector, in Matplotlib it is a function. The *mlab* module defines *detrend\_none*, *detrend\_mean*, and *detrend\_linear*, but you can use a custom function as well. You can also use a string to choose one of the functions: 'none' calls *detrend\_none*. 'mean' calls *detrend\_mean*. 'linear' calls *detrend\_linear*.

**scale\_by\_freq** [bool, optional] Specifies whether the resulting density values should be scaled by the scaling frequency, which gives density in units of  $\text{Hz}^{-1}$ . This allows for integration over the returned frequency values. The default is True for MATLAB compatibility.

**noverlap** [integer] The number of points of overlap between segments. The default value is 0 (no overlap).

### Returns

**Pxy** [1-D array] The values for the cross spectrum  $P_{\{xy\}}$  before scaling (real valued)

**freqs** [1-D array] The frequencies corresponding to the elements in  $Pxy$

### See also:

*psd* equivalent to setting  $y = x$ .

### References

Bendat & Piersol - Random Data: Analysis and Measurement Procedures, John Wiley & Sons (1986)

`matplotlib.mlab.demean(x, axis=0)`  
[*Deprecated*] Return x minus its mean along the specified axis.

### Parameters

**x** [array or sequence] Array or sequence containing the data Can have any dimensionality

**axis** [integer] The axis along which to take the mean. See `numpy.mean` for a description of this argument.

### See also:

*detrend\_mean* Same as *demean* except for the default *axis*.

### Notes

Deprecated since version 3.1.

`matplotlib.mlab.detrend(x, key=None, axis=None)`  
Return x with its trend removed.

### Parameters

**x** [array or sequence] Array or sequence containing the data.

**key** [[ 'default' | 'constant' | 'mean' | 'linear' | 'none' ] or function] Specifies the detrend algorithm to use. 'default' is 'mean', which is the same as *detrend\_mean*. 'constant' is the same. 'linear' is the same as *detrend\_linear*. 'none' is the same as *detrend\_none*. The default is 'mean'. See the corresponding functions for more details regarding the algorithms. Can also be a function that carries out the detrend operation.

**axis** [integer] The axis along which to do the detrending.

**See also:**

*detrend\_mean* Implementation of the 'mean' algorithm.

*detrend\_linear* Implementation of the 'linear' algorithm.

*detrend\_none* Implementation of the 'none' algorithm.

`matplotlib.mlab.detrend_linear(y)`  
Return x minus best fit line; 'linear' detrending.

**Parameters**

**y** [0-D or 1-D array or sequence] Array or sequence containing the data

**axis** [integer] The axis along which to take the mean. See `numpy.mean` for a description of this argument.

**See also:**

*detrend\_mean* Another detrend algorithm.

*detrend\_none* Another detrend algorithm.

*detrend* A wrapper around all the detrend algorithms.

`matplotlib.mlab.detrend_mean(x, axis=None)`  
Return x minus the mean(x).

**Parameters**

**x** [array or sequence] Array or sequence containing the data Can have any dimensionality

**axis** [integer] The axis along which to take the mean. See `numpy.mean` for a description of this argument.

**See also:**

*detrend\_linear* Another detrend algorithm.

*detrend\_none* Another detrend algorithm.

*detrend* A wrapper around all the detrend algorithms.

`matplotlib.mlab.detrend_none(x, axis=None)`  
Return x: no detrending.

**Parameters**

**x** [any object] An object containing the data

**axis** [integer] This parameter is ignored. It is included for compatibility with `detrend_mean`

**See also:**

`detrend_mean` Another detrend algorithm.

`detrend_linear` Another detrend algorithm.

`detrend` A wrapper around all the detrend algorithms.

`matplotlib.mlab.magnitude_spectrum(x, Fs=None, window=None, pad_to=None, sides=None)`

Compute the magnitude (absolute value) of the frequency spectrum of `x`. Data is padded to a length of `pad_to` and the windowing function `window` is applied to the signal.

**Parameters**

**x** [1-D array or sequence] Array or sequence containing the data

**Fs** [scalar] The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, `freqs`, in cycles per time unit. The default value is 2.

**window** [callable or ndarray] A function or a vector of length `NFFT`. To create window vectors see `window_hanning`, `window_none`, `numpy.blackman`, `numpy.hamming`, `numpy.bartlett`, `scipy.signal`, `scipy.signal.get_window`, etc. The default is `window_hanning`. If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.

**sides** [{'default', 'onesided', 'twosided'}] Specifies which sides of the spectrum to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. 'onesided' forces the return of a one-sided spectrum, while 'twosided' forces two-sided.

**pad\_to** [int] The number of points to which the data segment is padded when performing the FFT. While not increasing the actual resolution of the spectrum (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the `n` parameter in the call to `fft()`. The default is `None`, which sets `pad_to` equal to the length of the input signal (i.e. no padding).

**Returns**

**spectrum** [1-D array] The values for the magnitude spectrum (real valued)

**freqs** [1-D array] The frequencies corresponding to the elements in `spectrum`

**See also:**

`psd` Returns the power spectral density.

`complex_spectrum` This function returns the absolute value of `complex_spectrum`.

`angle_spectrum` Returns the angles of the corresponding frequencies.

`phase_spectrum` Returns the phase (unwrapped angle) of the corresponding frequencies.

`specgram` Can return the complex spectrum of segments within the signal.

`matplotlib.mlab.phase_spectrum(x, Fs=None, window=None, pad_to=None, sides=None)`

Compute the phase of the frequency spectrum (unwrapped angle spectrum) of  $x$ . Data is padded to a length of `pad_to` and the windowing function `window` is applied to the signal.

### Parameters

**x** [1-D array or sequence] Array or sequence containing the data

**Fs** [scalar] The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, `freqs`, in cycles per time unit. The default value is 2.

**window** [callable or ndarray] A function or a vector of length `NFFT`. To create window vectors see `window_hanning`, `window_none`, `numpy.blackman`, `numpy.hamming`, `numpy.bartlett`, `scipy.signal`, `scipy.signal.get_window`, etc. The default is `window_hanning`. If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.

**sides** [{'default', 'onesided', 'twosided'}] Specifies which sides of the spectrum to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. 'onesided' forces the return of a one-sided spectrum, while 'twosided' forces two-sided.

**pad\_to** [int] The number of points to which the data segment is padded when performing the FFT. While not increasing the actual resolution of the spectrum (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the  $n$  parameter in the call to `fft()`. The default is `None`, which sets `pad_to` equal to the length of the input signal (i.e. no padding).

### Returns

**spectrum** [1-D array] The values for the phase spectrum in radians (real valued)

**freqs** [1-D array] The frequencies corresponding to the elements in `spectrum`

### See also:

`complex_spectrum` This function returns the phase value of `complex_spectrum`.

`magnitude_spectrum` Returns the magnitudes of the corresponding frequencies.

`angle_spectrum` Returns the angle (wrapped phase) of the corresponding frequencies.

`specgram` Can return the complex spectrum of segments within the signal.

`matplotlib.mlab.psd(x, NFFT=None, Fs=None, detrend=None, window=None, noverlap=None, pad_to=None, sides=None, scale_by_freq=None)`

Compute the power spectral density.

The power spectral density  $P_{xx}$  by Welch's average periodogram method. The vector  $x$  is divided into `NFFT` length segments. Each segment is detrended by function `detrend` and windowed by function `window`. `noverlap` gives the length of the overlap between segments. The  $|\text{fft}(i)|^2$  of each segment  $i$  are averaged to compute  $P_{xx}$ .

If  $\text{len}(x) < NFFT$ , it will be zero padded to `NFFT`.

### Parameters

**x** [1-D array or sequence] Array or sequence containing the data

**Fs** [scalar] The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, `freqs`, in cycles per time unit. The default value is 2.

**window** [callable or ndarray] A function or a vector of length `NFFT`. To create window vectors see `window_hanning`, `window_none`, `numpy.blackman`, `numpy.hamming`, `numpy.bartlett`, `scipy.signal`, `scipy.signal.get_window`, etc. The default is `window_hanning`. If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.

**sides** [{'default', 'onesided', 'twosided'}] Specifies which sides of the spectrum to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. 'onesided' forces the return of a one-sided spectrum, while 'twosided' forces two-sided.

**pad\_to** [int] The number of points to which the data segment is padded when performing the FFT. This can be different from `NFFT`, which specifies the number of data points used. While not increasing the actual resolution of the spectrum (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the `n` parameter in the call to `fft()`. The default is `None`, which sets `pad_to` equal to `NFFT`

**NFFT** [int] The number of data points used in each block for the FFT. A power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use `pad_to` for this instead.

**detrend** [{'none', 'mean', 'linear'} or callable, default 'none'] The function applied to each segment before `fft`-ing, designed to remove the mean or linear trend. Unlike in MATLAB, where the `detrend` parameter is a vector, in Matplotlib it is a function. The `mlab` module defines `detrend_none`, `detrend_mean`, and `detrend_linear`, but you can use a custom function as well. You can also use a string to choose one of the functions: 'none' calls `detrend_none`. 'mean' calls `detrend_mean`. 'linear' calls `detrend_linear`.

**scale\_by\_freq** [bool, optional] Specifies whether the resulting density values should be scaled by the scaling frequency, which gives density in units of  $\text{Hz}^{-1}$ . This allows for integration over the returned frequency values. The default is `True` for MATLAB compatibility.

**noverlap** [integer] The number of points of overlap between segments. The default value is 0 (no overlap).

### Returns

**Pxx** [1-D array] The values for the power spectrum `P_{xx}` (real valued)

**freqs** [1-D array] The frequencies corresponding to the elements in `Pxx`

### See also:

`specgram` `specgram` differs in the default overlap; in not returning the mean of the segment periodograms; and in returning the times of the segments.

`magnitude_spectrum` returns the magnitude spectrum.

*csd* returns the spectral density between two signals.

## References

Bendat & Piersol - Random Data: Analysis and Measurement Procedures, John Wiley & Sons (1986)

```
matplotlib.mlab.specgram(x, NFFT=None, Fs=None, detrend=None, win-
                        dow=None, noverlap=None, pad_to=None, sides=None,
                        scale_by_freq=None, mode=None)
```

Compute a spectrogram.

Compute and plot a spectrogram of data in *x*. Data are split into *NFFT* length segments and the spectrum of each section is computed. The windowing function *window* is applied to each segment, and the amount of overlap of each segment is specified with *noverlap*.

## Parameters

**x** [array\_like] 1-D array or sequence.

**Fs** [scalar] The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, *freqs*, in cycles per time unit. The default value is 2.

**window** [callable or ndarray] A function or a vector of length *NFFT*. To create window vectors see *window\_hanning*, *window\_none*, `numpy.blackman`, `numpy.hamming`, `numpy.bartlett`, `scipy.signal`, `scipy.signal.get_window`, etc. The default is *window\_hanning*. If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.

**sides** [{'default', 'onesided', 'twosided'}] Specifies which sides of the spectrum to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. 'onesided' forces the return of a one-sided spectrum, while 'twosided' forces two-sided.

**pad\_to** [int] The number of points to which the data segment is padded when performing the FFT. This can be different from *NFFT*, which specifies the number of data points used. While not increasing the actual resolution of the spectrum (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the *n* parameter in the call to `fft()`. The default is `None`, which sets *pad\_to* equal to *NFFT*

**NFFT** [int] The number of data points used in each block for the FFT. A power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use *pad\_to* for this instead.

**detrend** [{'none', 'mean', 'linear'} or callable, default 'none'] The function applied to each segment before `fft`-ing, designed to remove the mean or linear trend. Unlike in MATLAB, where the *detrend* parameter is a vector, in Matplotlib it is a function. The *mlab* module defines *detrend\_none*, *detrend\_mean*, and *detrend\_linear*, but you can use a custom function as well. You can also use a string to choose one of the functions: 'none' calls *detrend\_none*. 'mean' calls *detrend\_mean*. 'linear' calls *detrend\_linear*.

**scale\_by\_freq** [bool, optional] Specifies whether the resulting density values should be scaled by the scaling frequency, which gives density in units of  $\text{Hz}^{-1}$ . This allows for integration over the returned frequency values. The default is True for MATLAB compatibility.

**noverlap** [int, optional] The number of points of overlap between blocks. The default value is 128.

**mode** [str, optional]

**What sort of spectrum to use, default is 'psd'.**

**'psd'** Returns the power spectral density.

**'complex'** Returns the complex-valued frequency spectrum.

**'magnitude'** Returns the magnitude spectrum.

**'angle'** Returns the phase spectrum without unwrapping.

**'phase'** Returns the phase spectrum with unwrapping.

### Returns

**spectrum** [array\_like] 2-D array, columns are the periodograms of successive segments.

**freqs** [array\_like] 1-D array, frequencies corresponding to the rows in *spectrum*.

**t** [array\_like] 1-D array, the times corresponding to midpoints of segments (i.e the columns in *spectrum*).

### See also:

*psd* differs in the overlap and in the return values.

*complex\_spectrum* similar, but with complex valued frequencies.

*magnitude\_spectrum* similar single segment when mode is 'magnitude'.

*angle\_spectrum* similar to single segment when mode is 'angle'.

*phase\_spectrum* similar to single segment when mode is 'phase'.

### Notes

detrend and scale\_by\_freq only apply when *mode* is set to 'psd'.

`matplotlib.mlab.stride_repeat(x, n, axis=0)`

Repeat the values in an array in a memory-efficient manner. Array *x* is stacked vertically *n* times.

**Warning:** It is not safe to write to the output array. Multiple elements may point to the same piece of memory, so modifying one value may change others.

### Parameters

**x** [1D array or sequence] Array or sequence containing the data.

**n** [integer] The number of time to repeat the array.

**axis** [integer] The axis along which the data will run.

#### References

[stackoverflow: Repeat NumPy array without replicating data?](#)

`matplotlib.mlab.stride_windows(x, n, noverlap=None, axis=0)`

Get all windows of `x` with length `n` as a single array, using strides to avoid data duplication.

**Warning:** It is not safe to write to the output array. Multiple elements may point to the same piece of memory, so modifying one value may change others.

#### Parameters

**x** [1D array or sequence] Array or sequence containing the data.

**n** [integer] The number of data points in each window.

**noverlap** [integer] The overlap between adjacent windows. Default is 0 (no overlap)

**axis** [integer] The axis along which the windows will run.

#### References

[stackoverflow: Rolling window for 1D arrays in Numpy?](#) [stackoverflow: Using strides for an efficient moving average filter](#)

`matplotlib.mlab.window_hanning(x)`

Return `x` times the hanning window of `len(x)`.

#### See also:

`window_none` Another window algorithm.

`matplotlib.mlab.window_none(x)`

No window function; simply return `x`.

#### See also:

`window_hanning` Another window algorithm.

## 17.33 matplotlib.offsetbox

The `OffsetBox` is a simple container artist. The child artist are meant to be drawn at a relative position to its parent. The `[VH]Packer`, `DrawingArea` and `TextArea` are derived from the `OffsetBox`.

The `[VH]Packer` automatically adjust the relative positions of their children, which should be instances of the `OffsetBox`. This is used to align similar artists together, e.g., in legend.

The DrawingArea can contain any Artist as a child. The DrawingArea has a fixed width and height. The position of children relative to the parent is fixed. The TextArea contains a single Text instance. The width and height of the TextArea instance is the width and height of the its child text.

```
class matplotlib.offsetbox.AnchoredOffsetbox(loc, pad=0.4, borderpad=0.5,
                                             child=None, prop=None,
                                             frameon=True, bbox_to_anchor=None,
                                             bbox_transform=None, **kwargs)
```

Bases: `matplotlib.offsetbox.OffsetBox`

An offset box placed according to the legend location `loc`. `AnchoredOffsetbox` has a single child. When multiple children is needed, use other `OffsetBox` class to enclose them. By default, the offset box is anchored against its parent axes. You may explicitly specify the `bbox_to_anchor`.

`loc` is a string or an integer specifying the legend location. The valid location codes are:

```
'upper right' : 1,
'upper left'  : 2,
'lower left'  : 3,
'lower right' : 4,
'right'       : 5, (same as 'center right', for back-compatibility)
'center left' : 6,
'center right': 7,
'lower center': 8,
'upper center': 9,
'center'      : 10,
```

**pad** [pad around the child for drawing a frame. given in] fraction of fontsize.

`borderpad` : pad between offsetbox frame and the `bbox_to_anchor`,

`child` : `OffsetBox` instance that will be anchored.

`prop` : font property. This is only used as a reference for paddings.

`frameon` : draw a frame box if True.

`bbox_to_anchor` : bbox to anchor. Use `self.axes.bbox` if None.

`bbox_transform` : with which the `bbox_to_anchor` will be transformed.

`codes` = {'center': 10, 'center left': 6, 'center right': 7, 'lower center': 8, 'lower left': 3, 'lower right': 4, 'upper center': 9, 'upper left': 2, 'upper right': 1, 'right': 5}

`draw(self, renderer)`  
draw the artist

`get_bbox_to_anchor(self)`  
return the bbox that the legend will be anchored

`get_child(self)`  
return the child

`get_children(self)`  
return the list of children

`get_extent(self, renderer)`  
return the extent of the artist. The extent of the child added with the pad is returned

`get_window_extent(self, renderer)`  
get the bounding box in display space.

`set_bbox_to_anchor(self, bbox, transform=None)`  
set the bbox that the child will be anchored.

*bbox* can be a Bbox instance, a list of [left, bottom, width, height], or a list of [left, bottom] where the width and height will be assumed to be zero. The bbox will be transformed to display coordinate by the given transform.

`set_child(self, child)`  
set the child to be anchored

`update_frame(self, bbox, fontsize=None)`

`zorder = 5`

```
class matplotlib.offsetbox.AnchoredText(s, loc, pad=0.4, borderpad=0.5, prop=None,
                                       **kwargs)
```

Bases: `matplotlib.offsetbox.AnchoredOffsetbox`

AnchoredOffsetbox with Text.

### Parameters

**s** [string] Text.

**loc** [str] Location code.

**pad** [float, optional] Pad between the text and the frame as fraction of the font size.

**borderpad** [float, optional] Pad between the frame and the axes (or *bbox\_to\_anchor*).

**prop** [dictionary, optional, default: None] Dictionary of keyword parameters to be passed to the *Text* instance contained inside AnchoredText.

### Notes

Other keyword parameters of *AnchoredOffsetbox* are also allowed.

```
class matplotlib.offsetbox.AnnotationBbox(offsetbox, xy, xybox=None, xycoords='data',
                                          boxcoords=None,
                                          frameon=True, pad=0.4, annotation_clip=None,
                                          box_alignment=(0.5, 0.5),
                                          bboxprops=None, arrowprops=None, font-size=None,
                                          **kwargs)
```

Bases: `matplotlib.artist.Artist`, `matplotlib.text._AnnotationBase`

Annotation-like class, but with offsetbox instead of Text.

*offsetbox* : OffsetBox instance

**xycoords** [same as Annotation but can be a tuple of two] strings which are interpreted as x and y coordinates.

**boxcoords** [similar to textcoords as Annotation but can be a] tuple of two strings which are interpreted as x and y coordinates.

**box\_alignment** [a tuple of two floats for a vertical and] horizontal alignment of the offset box w.r.t. the *boxcoords*. The lower-left corner is (0.0) and upper-right corner is (1.1).

other parameters are identical to that of `Annotation`.

`anncoords`

`contains(self, event)`

Test whether the artist contains the mouse event.

#### Parameters

**mouseevent** [`matplotlib.backend_bases.MouseEvent`]

#### Returns

**contains** [bool] Whether any values are within the radius.

**details** [dict] An artist-specific dictionary of details of the event context, such as which points are contained in the pick radius. See the individual `Artist` subclasses for details.

#### See also:

`set_contains`, `get_contains`

`draw(self, renderer)`

Draw the `Annotation` object to the given `renderer`.

`get_children(self)`

Return a list of the child `Artists` of this `Artist`.

`get_fontsize(self, s=None)`

return fontsize in points

`set_figure(self, fig)`

Set the `Figure` instance the artist belongs to.

#### Parameters

**fig** [`Figure`]

`set_fontsize(self, s=None)`

set fontsize in points

`update_positions(self, renderer)`

Update the pixel positions of the annotated point and the text.

`xyann`

`zorder = 3`

`class matplotlib.offsetbox.AuxTransformBox(aux_transform)`

Bases: `matplotlib.offsetbox.OffsetBox`

Offset Box with the `aux_transform`. Its children will be transformed with the `aux_transform` first then will be offseted. The absolute coordinate of the `aux_transform` is meaning as it will be automatically adjust so that the left-lower corner of the bounding box of children will be set to (0,0) before the offset transform.

It is similar to drawing area, except that the extent of the box is not predetermined but calculated from the window extent of its children. Furthermore, the extent of the children will be calculated in the transformed coordinate.

`add_artist(self, a)`

Add any `Artist` to the container box

```

draw(self, renderer)
    Draw the children

get_extent(self, renderer)
    Return with, height, xdescent, ydescent of box

get_offset(self)
    return offset of the container.

get_transform(self)
    Return the Transform applied to the children

get_window_extent(self, renderer)
    get the bounding box in display space.

set_offset(self, xy)
    Set the offset of the container.

```

### Parameters

**xy** [(float, float)] The (x,y) coordinates of the offset in display units.

```

set_transform(self, t)
    set_transform is ignored.

```

```

class matplotlib.offsetbox.DraggableAnnotation(annotation, use_blit=False)

```

Bases: `matplotlib.offsetbox.DraggableBase`

```

save_offset(self)

```

```

update_offset(self, dx, dy)

```

```

class matplotlib.offsetbox.DraggableBase(ref_artist, use_blit=False)

```

Bases: `object`

Helper base class for a draggable artist (legend, offsetbox).

Derived classes must override the following methods:

```

def save_offset(self):
    '''
    Called when the object is picked for dragging; should save the
    reference position of the artist.
    '''

def update_offset(self, dx, dy):
    '''
    Called during the dragging; (*dx*, *dy*) is the pixel offset from
    the point where the mouse drag started.
    '''

```

Optionally, you may override the following methods:

```

def artist_picker(self, artist, evt):
    '''The picker method that will be used.'''
    return self.ref_artist.contains(evt)

def finalize_offset(self):
    '''Called when the mouse is released.'''

```

In the current implementation of `DraggableLegend` and `DraggableAnnotation`, `update_offset` places the artists in display coordinates, and `finalize_offset` recalculates their position in axes coordinate and set a relevant attribute.

`artist_picker(self, artist, evt)`

`disconnect(self)`

Disconnect the callbacks.

`finalize_offset(self)`

`on_motion(self, evt)`

`on_motion_blit(self, evt)`

`on_pick(self, evt)`

`on_release(self, event)`

`save_offset(self)`

`update_offset(self, dx, dy)`

`class matplotlib.offsetbox.DraggableOffsetBox(ref_artist, offsetbox, use_blit=False)`

Bases: `matplotlib.offsetbox.DraggableBase`

`get_loc_in_canvas(self)`

`save_offset(self)`

`update_offset(self, dx, dy)`

`class matplotlib.offsetbox.DrawingArea(width, height, xdescent=0.0, ydescent=0.0, clip=False)`

Bases: `matplotlib.offsetbox.OffsetBox`

The `DrawingArea` can contain any `Artist` as a child. The `DrawingArea` has a fixed width and height. The position of children relative to the parent is fixed. The children can be clipped at the boundaries of the parent.

`width, height` : width and height of the container box. `xdescent, ydescent` : descent of the box in x- and y-direction. `clip` : Whether to clip the children

`add_artist(self, a)`

Add any `Artist` to the container box

`clip_children`

If the children of this `DrawingArea` should be clipped by `DrawingArea` bounding box.

`draw(self, renderer)`

Draw the children

`get_extent(self, renderer)`

Return with, height, xdescent, ydescent of box

`get_offset(self)`

return offset of the container.

`get_transform(self)`

Return the `Transform` applied to the children

`get_window_extent(self, renderer)`

get the bounding box in display space.

`set_offset(self, xy)`  
Set the offset of the container.

### Parameters

**xy** [(float, float)] The (x,y) coordinates of the offset in display units.

`set_transform(self, t)`  
`set_transform` is ignored.

```
class matplotlib.offsetbox.HPacker(pad=None, sep=None, width=None, height=None,
                                   align='baseline', mode='fixed', children=None)
```

Bases: `matplotlib.offsetbox.PackerBase`

The HPacker has its children packed horizontally. It automatically adjusts the relative positions of children at draw time.

### Parameters

**pad** [float, optional] Boundary pad.

**sep** [float, optional] Spacing between items.

**width** [float, optional]

**height** [float, optional] Width and height of the container box, calculated if `None`.

**align** [str] Alignment of boxes.

**mode** [str] Packing mode.

### Notes

`pad` and `sep` need to be given in points and will be scaled with the renderer dpi, while `width` and `height` need to be in pixels.

`get_extent_offsets(self, renderer)`  
update offset of children and return the extents of the box

```
class matplotlib.offsetbox.OffsetBox(*args, **kwargs)
```

Bases: `matplotlib.artist.Artist`

The OffsetBox is a simple container artist. The child artists are meant to be drawn at a relative position to its parent.

### axes

The `Axes` instance the artist resides in, or `None`.

`contains(self, mouseevent)`  
Test whether the artist contains the mouse event.

### Parameters

**mouseevent** [`matplotlib.backend_bases.MouseEvent`]

### Returns

**contains** [bool] Whether any values are within the radius.

**details** [dict] An artist-specific dictionary of details of the event context, such as which points are contained in the pick radius. See the individual Artist subclasses for details.

**See also:**

`set_contains`, `get_contains`

`draw(self, renderer)`

Update the location of children if necessary and draw them to the given *renderer*.

`get_children(self)`

Return a list of artists it contains.

`get_extent(self, renderer)`

Return with, height, xdescent, ydescent of box

`get_extent_offsets(self, renderer)`

`get_offset(self, width, height, xdescent, ydescent, renderer)`

Get the offset

accepts extent of the box

`get_visible_children(self)`

Return a list of visible artists it contains.

`get_window_extent(self, renderer)`

get the bounding box in display space.

`set_figure(self, fig)`

Set the figure

accepts a class:*Figure* instance

`set_height(self, height)`

Set the height

accepts float

`set_offset(self, xy)`

Set the offset.

**Parameters**

**xy** [(float, float) or callable] The (x,y) coordinates of the offset in display units. A callable must have the signature:

```
def offset(width, height, xdescent, ydescent, renderer) ->
    (float, float)
```

`set_width(self, width)`

Set the width

accepts float

```
class matplotlib.offsetbox.OffsetImage(arr, zoom=1, cmap=None, norm=None,
    interpolation=None, origin=None, filternorm=1,
    filterrad=4.0, resample=False, dpi_cor=True,
    **kwargs)
```

Bases: *matplotlib.offsetbox.OffsetBox*

`draw(self, renderer)`

Draw the children

`get_children(self)`

Return a list of artists it contains.

```

get_data(self)
get_extent(self, renderer)
    Return with, height, xdescent, ydescent of box
get_offset(self)
    return offset of the container.
get_window_extent(self, renderer)
    get the bounding box in display space.
get_zoom(self)
set_data(self, arr)
set_zoom(self, zoom)

```

```

class matplotlib.offsetbox.PackerBase(pad=None, sep=None, width=None,
                                     height=None, align=None, mode=None, children=None)
Bases: matplotlib.offsetbox.OffsetBox

```

### Parameters

**pad** [float, optional] Boundary pad.

**sep** [float, optional] Spacing between items.

**width** [float, optional]

**height** [float, optional] Width and height of the container box, calculated if `None`.

**align** [str, optional] Alignment of boxes. Can be one of top, bottom, left, right, center and baseline

**mode** [str, optional] Packing mode.

### Notes

*pad* and *sep* need to given in points and will be scale with the renderer dpi, while *width* and *height* need to be in pixels.

```

class matplotlib.offsetbox.PaddedBox(child, pad=None, draw_frame=False,
                                     patch_attrs=None)
Bases: matplotlib.offsetbox.OffsetBox

```

*pad* : boundary pad

---

**Note:** *pad* need to given in points and will be scale with the renderer dpi, while *width* and *height* need to be in pixels.

---

```

draw(self, renderer)
    Update the location of children if necessary and draw them to the given renderer.
draw_frame(self, renderer)
get_extent_offsets(self, renderer)
    update offset of childrens and return the extents of the box
update_frame(self, bbox, fontsize=None)

```

```
class matplotlib.offsetbox.TextArea(s, textprops=None, multilinebaseline=None, minimumdescent=True)
```

Bases: `matplotlib.offsetbox.OffsetBox`

The TextArea is contains a single Text instance. The text is placed at (0,0) with baseline+left alignment. The width and height of the TextArea instance is the width and height of the its child text.

### Parameters

**s** [str] a string to be displayed.

**textprops** [dictionary, optional, default: None] Dictionary of keyword parameters to be passed to the *Text* instance contained inside TextArea.

**multilinebaseline** [bool, optional] If `True`, baseline for multiline text is adjusted so that it is (approximately) center-aligned with singleline text.

**minimumdescent** [bool, optional] If `True`, the box has a minimum descent of "p".

`draw(self, renderer)`

Draw the children

`get_extent(self, renderer)`

Return with, height, xdescent, ydescent of box

`get_minimumdescent(self)`

get minimumdescent.

`get_multilinebaseline(self)`

get multilinebaseline .

`get_offset(self)`

return offset of the container.

`get_text(self)`

Returns the string representation of this area's text

`get_window_extent(self, renderer)`

get the bounding box in display space.

`set_minimumdescent(self, t)`

Set minimumdescent .

If True, extent of the single line text is adjusted so that it has minimum descent of "p"

`set_multilinebaseline(self, t)`

Set multilinebaseline .

If True, baseline for multiline text is adjusted so that it is (approximately) center-aligned with single-line text.

`set_offset(self, xy)`

Set the offset of the container.

### Parameters

**xy** [(float, float)] The (x,y) coordinates of the offset in display units.

`set_text(self, s)`

Set the text of this area as a string.

```
set_transform(self, t)
    set_transform is ignored.
```

```
class matplotlib.offsetbox.VPacker(pad=None, sep=None, width=None, height=None,
                                   align='baseline', mode='fixed', children=None)
    Bases: matplotlib.offsetbox.PackerBase
```

The VPacker has its children packed vertically. It automatically adjust the relative positions of children in the drawing time.

### Parameters

- pad** [float, optional] Boundary pad.
- sep** [float, optional] Spacing between items.
- width** [float, optional]
- height** [float, optional] width and height of the container box, calculated if `None`.
- align** [str, optional] Alignment of boxes.
- mode** [str, optional] Packing mode.

### Notes

`pad` and `sep` need to given in points and will be scale with the renderer dpi, while `width` and `height` need to be in pixels.

```
get_extent_offsets(self, renderer)
    update offset of childrens and return the extents of the box
```

```
matplotlib.offsetbox.bbox_artist(*args, **kwargs)
```

## 17.34 matplotlib.patches

### 17.34.1 Classes

<code>Arc(xy, width, height[, angle, theta1, theta2])</code>	An elliptical arc, i.e.
<code>Arrow(x, y, dx, dy[, width])</code>	An arrow patch.
<code>ArrowStyle</code>	<code>ArrowStyle</code> is a container class which defines several arrowstyle classes, which is used to create an arrow path along a given path.
<code>BoxStyle</code>	<code>BoxStyle</code> is a container class which defines several boxstyle classes, which are used for <code>FancyBboxPatch</code> .
<code>Circle(xy[, radius])</code>	A circle patch.
<code>CirclePolygon(xy[, radius, resolution])</code>	A polygon-approximation of a circle patch.
<code>ConnectionPatch(xyA, xyB, coordsA[, ...])</code>	A <code>ConnectionPatch</code> class is to make connecting lines between two points (possibly in different axes).

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<i>ConnectionStyle</i>	<i>ConnectionStyle</i> is a container class which defines several connectionstyle classes, which is used to create a path between two points.
<i>Ellipse</i> (xy, width, height[, angle])	A scale-free ellipse.
<i>FancyArrow</i> (x, y, dx, dy[, width, ...])	Like Arrow, but lets you set head width and head height independently.
<i>FancyArrowPatch</i> ([posA, posB, path, ...])	A fancy arrow patch.
<i>FancyBboxPatch</i> (xy, width, height[, ...])	A fancy box around a rectangle with lower left at xy = (x, y) with specified width and height.
<i>Patch</i> ([edgecolor, facecolor, color, ...])	A patch is a 2D artist with a face color and an edge color.
<i>PathPatch</i> (path, **kwargs)	A general polycurve path patch.
<i>Polygon</i> (xy[, closed])	A general polygon patch.
<i>Rectangle</i> (xy, width, height[, angle])	A rectangle with lower left at xy = (x, y) with specified <i>width</i> , <i>height</i> and rotation <i>angle</i> .
<i>RegularPolygon</i> (xy, numVertices[, radius, ...])	A regular polygon patch.
<i>Shadow</i> (patch, ox, oy[, props])	Create a shadow of the given <i>patch</i> offset by <i>ox</i> , <i>oy</i> .
<i>Wedge</i> (center, r, theta1, theta2[, width])	Wedge shaped patch.
<i>YAArrow</i> (**kwargs)	[ <i>Deprecated</i> ] Yet another arrow class.

### matplotlib.patches.Arc

```
class matplotlib.patches.Arc(xy, width, height, angle=0.0, theta1=0.0, theta2=360.0,
                             **kwargs)
```

Bases: `matplotlib.patches.Ellipse`

An elliptical arc, i.e. a segment of an ellipse.

Due to internal optimizations, there are certain restrictions on using Arc:

- The arc cannot be filled.
- The arc must be used in an *Axes* instance—it can not be added directly to a *Figure*—because it is optimized to only render the segments that are inside the axes bounding box with high resolution.

#### Parameters

**xy** [(float, float)] The center of the ellipse.

**width** [float] The length of the horizontal axis.

**height** [float] The length of the vertical axis.

**angle** [float] Rotation of the ellipse in degrees (counterclockwise).

**theta1, theta2** [float, optional] Starting and ending angles of the arc in degrees. These values are relative to *angle*, e.g. if *angle* = 45 and *theta1* = 90 the absolute starting angle is 135. Default *theta1* = 0, *theta2* = 360, i.e. a complete ellipse. The arc is drawn in the counterclockwise direction. Angles greater than or equal to 360, or smaller than 0, are represented by an equivalent angle in the range [0, 360), by taking the input value mod 360.

## Other Parameters

**\*\*kwargs** [*Patch* properties] Most *Patch* properties are supported as keyword arguments, with the exception of *fill* and *facecolor* because filling is not supported.

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<i>alpha</i>		float or None
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i>		unknown
<i>capstyle</i>		{'butt', 'round', 'projecting'}
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>color</i>		color
<i>contains</i>		callable
<i>edgecolor</i> or <i>ec</i>		color or None or 'auto'
<i>facecolor</i> or <i>fc</i>		color or None
<i>figure</i>		<i>Figure</i>
<i>fill</i>		bool
<i>gid</i>		str
<i>hatch</i>		{'/', '\\', ' ', '-.', '+', 'x', 'o', 'O', '.', '*'}
<i>in_layout</i>		bool
<i>joinstyle</i>		{'miter', 'round', 'bevel'}
<i>label</i>		object
<i>linestyle</i> or <i>ls</i>		{'-', '--', '-.', ':', '', (offset, on-off-seq), ...}
<i>linewidth</i> or <i>lw</i>		float or None
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		None or bool or float or callable
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>transform</i>		<i>Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>zorder</i>		float

`draw(self, renderer)`

Draw the arc to the given *renderer*.

### Notes

Ellipses are normally drawn using an approximation that uses eight cubic Bezier splines. The error of this approximation is 1.89818e-6, according to this unverified source:

Lancaster, Don. *Approximating a Circle or an Ellipse Using Four Bezier Cubic Splines*.

<http://www.tinaja.com/glib/ellipse4.pdf>

There is a use case where very large ellipses must be drawn with very high accuracy,

and it is too expensive to render the entire ellipse with enough segments (either splines or line segments). Therefore, in the case where either radius of the ellipse is large enough that the error of the spline approximation will be visible (greater than one pixel offset from the ideal), a different technique is used.

In that case, only the visible parts of the ellipse are drawn, with each visible arc using a fixed number of spline segments (8). The algorithm proceeds as follows:

1. The points where the ellipse intersects the axes bounding box are located. (This is done by performing an inverse transformation on the axes bbox such that it is relative to the unit circle - this makes the intersection calculation much easier than doing rotated ellipse intersection directly).

This uses the "line intersecting a circle" algorithm from:

Vince, John. *Geometry for Computer Graphics: Formulae, Examples & Proofs*. London: Springer-Verlag, 2005.

2. The angles of each of the intersection points are calculated.
3. Proceeding counterclockwise starting in the positive x-direction, each of the visible arc-segments between the pairs of vertices are drawn using the Bezier arc approximation technique implemented in `matplotlib.path.Path.arc()`.

#### Examples using `matplotlib.patches.Arc`

- `sphinx_glr_gallery_units_ellipse_with_units.py`

#### `matplotlib.patches.Arrow`

```
class matplotlib.patches.Arrow(x, y, dx, dy, width=1.0, **kwargs)
```

Bases: `matplotlib.patches.Patch`

An arrow patch.

Draws an arrow from (x, y) to (x + dx, y + dy). The width of the arrow is scaled by *width*.

#### Parameters

**x** [scalar] x coordinate of the arrow tail

**y** [scalar] y coordinate of the arrow tail

**dx** [scalar] Arrow length in the x direction

**dy** [scalar] Arrow length in the y direction

**width** [scalar, optional (default: 1)] Scale factor for the width of the arrow.

With a default value of 1, the tail width is 0.2 and head width is 0.6.

**\*\*kwargs** Keyword arguments control the *Patch* properties:

	Property	Description
<code>agg_filter</code>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<code>alpha</code>		float or None
<code>animated</code>		bool
<code>antialiased</code> or <code>aa</code>		unknown
<code>capstyle</code>		{'butt', 'round', 'projecting'}

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Property	Description
<code>clip_box</code>	<i>Bbox</i>
<code>clip_on</code>	bool
<code>clip_path</code>	<code>[(Path, Transform)   Patch   None]</code>
<code>color</code>	color
<code>contains</code>	callable
<code>edgecolor</code> or <code>ec</code>	color or None or 'auto'
<code>facecolor</code> or <code>fc</code>	color or None
<code>figure</code>	<i>Figure</i>
<code>fill</code>	bool
<code>gid</code>	str
<code>hatch</code>	<code>{'/', '\', ' ', '-', '+', 'x', 'o', 'O', '.', '*'}</code>
<code>in_layout</code>	bool
<code>joinstyle</code>	<code>{'miter', 'round', 'bevel'}</code>
<code>label</code>	object
<code>linestyle</code> or <code>ls</code>	<code>{'-', '--', '-.', ':', '', (offset, on-off-seq), ...}</code>
<code>linewidth</code> or <code>lw</code>	float or None
<code>path_effects</code>	<i>AbstractPathEffect</i>
<code>picker</code>	None or bool or float or callable
<code>rasterized</code>	bool or None
<code>sketch_params</code>	(scale: float, length: float, randomness: float)
<code>snap</code>	bool or None
<code>transform</code>	<i>Transform</i>
<code>url</code>	str
<code>visible</code>	bool
<code>zorder</code>	float

**See also:**

*FancyArrow* Patch that allows independent control of the head and tail properties

`get_patch_transform(self)`

Return the *Transform* instance which takes patch coordinates to data coordinates.

For example, one may define a patch of a circle which represents a radius of 5 by providing coordinates for a unit circle, and a transform which scales the coordinates (the patch coordinate) by 5.

`get_path(self)`

Return the path of this patch

**Examples using `matplotlib.patches.Arrow`**

- sphx\_glr\_gallery\_shapes\_and\_collections\_arrow\_guide.py
- sphx\_glr\_gallery\_shapes\_and\_collections\_artist\_reference.py

**`matplotlib.patches.ArrowStyle`**

```
class matplotlib.patches.ArrowStyle
    Bases: matplotlib.patches._Style
```

*ArrowStyle* is a container class which defines several arrowstyle classes, which is used to create an arrow path along a given path. These are mainly used with *FancyArrowPatch*.

A arrowstyle object can be either created as:

```
ArrowStyle.Fancy(head_length=.4, head_width=.4, tail_width=.4)
```

or:

```
ArrowStyle("Fancy", head_length=.4, head_width=.4, tail_width=.4)
```

or:

```
ArrowStyle("Fancy, head_length=.4, head_width=.4, tail_width=.4")
```

The following classes are defined

Class	Name	Attrs
Curve	-	None
CurveB	->	head_length=0.4, head_width=0.2
BracketB	-[	widthB=1.0, lengthB=0.2, angleB=None
Curve-FilledB	- >	head_length=0.4, head_width=0.2
CurveA	<-	head_length=0.4, head_width=0.2
CurveAB	<->	head_length=0.4, head_width=0.2
Curve-FilledA	< -	head_length=0.4, head_width=0.2
Curve-FilledAB	< - >	head_length=0.4, head_width=0.2
BracketA	] -	widthA=1.0, lengthA=0.2, angleA=None
BracketAB	] - [	widthA=1.0, lengthA=0.2, angleA=None, widthB=1.0, lengthB=0.2, angleB=None
Fancy	fancy	head_length=0.4, head_width=0.4, tail_width=0.4
Simple	simple	head_length=0.5, head_width=0.5, tail_width=0.2
Wedge	wedge	tail_width=0.3, shrink_factor=0.5
BarAB	-	widthA=1.0, angleA=None, widthB=1.0, angleB=None

An instance of any arrow style class is a callable object, whose call signature is:

```
__call__(self, path, mutation_size, linewidth, aspect_ratio=1.)
```

and it returns a tuple of a Path instance and a boolean value. *path* is a Path instance along which the arrow will be drawn. *mutation\_size* and *aspect\_ratio* have the same meaning as in *BoxStyle*. *linewidth* is a line width to be stroked. This is meant to be used to correct the location of the head so that it does not overshoot the destination point, but not all classes support it.

return the instance of the subclass with the given style name.

```
class BarAB(widthA=1.0, angleA=None, widthB=1.0, angleB=None)
    Bases: matplotlib.patches._Bracket
```

An arrow with a bar(|) at both ends.

### Parameters

**widthA** [float, optional, default] Width of the bracket

**angleA** [float, optional, default] Angle between the bracket and the line

**widthB** [float, optional, default] Width of the bracket

**angleB** [float, optional, default] Angle between the bracket and the line

```
class BracketA(widthA=1.0, lengthA=0.2, angleA=None)
```

Bases: matplotlib.patches.\_Bracket

An arrow with a bracket() at its end.

#### Parameters

**widthA** [float, optional, default] Width of the bracket

**lengthA** [float, optional, default] Length of the bracket

**angleA** [float, optional, default] Angle between the bracket and the line

```
class BracketAB(widthA=1.0, lengthA=0.2, angleA=None, widthB=1.0, lengthB=0.2, angleB=None)
```

Bases: matplotlib.patches.\_Bracket

An arrow with a bracket() at both ends.

#### Parameters

**widthA** [float, optional, default] Width of the bracket

**lengthA** [float, optional, default] Length of the bracket

**angleA** [float, optional, default] Angle between the bracket and the line

**widthB** [float, optional, default] Width of the bracket

**lengthB** [float, optional, default] Length of the bracket

**angleB** [float, optional, default] Angle between the bracket and the line

```
class BracketB(widthB=1.0, lengthB=0.2, angleB=None)
```

Bases: matplotlib.patches.\_Bracket

An arrow with a bracket() at its end.

#### Parameters

**widthB** [float, optional, default] Width of the bracket

**lengthB** [float, optional, default] Length of the bracket

**angleB** [float, optional, default] Angle between the bracket and the line

```
class Curve
```

Bases: matplotlib.patches.\_Curve

A simple curve without any arrow head.

```
class CurveA(head_length=0.4, head_width=0.2)
```

Bases: matplotlib.patches.\_Curve

An arrow with a head at its begin point.

**Parameters**

**head\_length** [float, optional, default] Length of the arrow head

**head\_width** [float, optional, default] Width of the arrow head

```
class CurveAB(head_length=0.4, head_width=0.2)
```

```
Bases: matplotlib.patches._Curve
```

An arrow with heads both at the begin and the end point.

**Parameters**

**head\_length** [float, optional, default] Length of the arrow head

**head\_width** [float, optional, default] Width of the arrow head

```
class CurveB(head_length=0.4, head_width=0.2)
```

```
Bases: matplotlib.patches._Curve
```

An arrow with a head at its end point.

**Parameters**

**head\_length** [float, optional, default] Length of the arrow head

**head\_width** [float, optional, default] Width of the arrow head

```
class CurveFilledA(head_length=0.4, head_width=0.2)
```

```
Bases: matplotlib.patches._Curve
```

An arrow with filled triangle head at the begin.

**Parameters**

**head\_length** [float, optional, default] Length of the arrow head

**head\_width** [float, optional, default] Width of the arrow head

```
class CurveFilledAB(head_length=0.4, head_width=0.2)
```

```
Bases: matplotlib.patches._Curve
```

An arrow with filled triangle heads at both ends.

**Parameters**

**head\_length** [float, optional, default] Length of the arrow head

**head\_width** [float, optional, default] Width of the arrow head

```
class CurveFilledB(head_length=0.4, head_width=0.2)
```

```
Bases: matplotlib.patches._Curve
```

An arrow with filled triangle head at the end.

**Parameters**

**head\_length** [float, optional, default] Length of the arrow head

**head\_width** [float, optional, default] Width of the arrow head

```
class Fancy(head_length=0.4, head_width=0.4, tail_width=0.4)
```

```
Bases: matplotlib.patches._Base
```

A fancy arrow. Only works with a quadratic Bezier curve.

**Parameters**

**head\_length** [float, optional, default] Length of the arrow head

**head\_width** [float, optional, default] Width of the arrow head

**tail\_width** [float, optional, default] Width of the arrow tail

`transmute(self, path, mutation_size, linewidth)`

The `transmute` method is the very core of the `ArrowStyle` class and must be overridden in the subclasses. It receives the path object along which the arrow will be drawn, and the `mutation_size`, with which the arrow head etc. will be scaled. The `linewidth` may be used to adjust the path so that it does not pass beyond the given points. It returns a tuple of a `Path` instance and a boolean. The boolean value indicate whether the path can be filled or not. The return value can also be a list of paths and list of booleans of a same length.

`class Simple(head_length=0.5, head_width=0.5, tail_width=0.2)`

Bases: `matplotlib.patches._Base`

A simple arrow. Only works with a quadratic Bezier curve.

#### Parameters

**head\_length** [float, optional, default] Length of the arrow head

**head\_width** [float, optional, default] Width of the arrow head

**tail\_width** [float, optional, default] Width of the arrow tail

`transmute(self, path, mutation_size, linewidth)`

The `transmute` method is the very core of the `ArrowStyle` class and must be overridden in the subclasses. It receives the path object along which the arrow will be drawn, and the `mutation_size`, with which the arrow head etc. will be scaled. The `linewidth` may be used to adjust the path so that it does not pass beyond the given points. It returns a tuple of a `Path` instance and a boolean. The boolean value indicate whether the path can be filled or not. The return value can also be a list of paths and list of booleans of a same length.

`class Wedge(tail_width=0.3, shrink_factor=0.5)`

Bases: `matplotlib.patches._Base`

Wedge(?) shape. Only works with a quadratic Bezier curve. The begin point has a width of the `tail_width` and the end point has a width of 0. At the middle, the width is `shrink_factor*tail_width`.

#### Parameters

**tail\_width** [float, optional, default] Width of the tail

**shrink\_factor** [float, optional, default] Fraction of the arrow width at the middle point

`transmute(self, path, mutation_size, linewidth)`

The `transmute` method is the very core of the `ArrowStyle` class and must be overridden in the subclasses. It receives the path object along which the arrow will be drawn, and the `mutation_size`, with which the arrow head etc. will be scaled. The `linewidth` may be used to adjust the path so that it does not pass beyond the given points. It returns a tuple of a `Path` instance and a boolean. The boolean value indicate whether the path can be filled or not. The return value can also be a list of paths and list of booleans of a same length.

Examples using `matplotlib.patches.ArrowStyle`

- `sphinx_glr_gallery_pyplots_whats_new_98_4_fancy.py`

`matplotlib.patches.BoxStyle`

```
class matplotlib.patches.BoxStyle
    Bases: matplotlib.patches._Style
```

*BoxStyle* is a container class which defines several boxstyle classes, which are used for *FancyBoxPatch*.

A style object can be created as:

```
BoxStyle.Round(pad=0.2)
```

or:

```
BoxStyle("Round", pad=0.2)
```

or:

```
BoxStyle("Round, pad=0.2")
```

Following boxstyle classes are defined.

Class	Name	Attrs
Circle	circle	pad=0.3
DArrow	darrow	pad=0.3
LArrow	larrow	pad=0.3
RArrow	rarrow	pad=0.3
Round	round	pad=0.3, rounding_size=None
Round4	round4	pad=0.3, rounding_size=None
Roundtooth	roundtooth	pad=0.3, tooth_size=None
Sawtooth	sawtooth	pad=0.3, tooth_size=None
Square	square	pad=0.3

An instance of any boxstyle class is an callable object, whose call signature is:

```
__call__(self, x0, y0, width, height, mutation_size, aspect_ratio=1.)
```

and returns a `Path` instance. `x0`, `y0`, `width` and `height` specify the location and size of the box to be drawn. `mutation_scale` determines the overall size of the mutation (by which I mean the transformation of the rectangle to the fancy box). `mutation_aspect` determines the aspect-ratio of the mutation.

return the instance of the subclass with the given style name.

```
class Circle(pad=0.3)
    Bases: matplotlib.patches._Base
```

A simple circle box.

### Parameters

**pad** [float] The amount of padding around the original box.

```
transmute(self, x0, y0, width, height, mutation_size)
```

The `transmute` method is a very core of the `BboxTransmuter` class and must be overridden in the subclasses. It receives the location and size of the rectangle, and the `mutation_size`, with which the amount of padding and etc. will be scaled. It returns a `Path` instance.

```
class DArrow(pad=0.3)
```

Bases: `matplotlib.patches._Base`

(Double) Arrow Box

```
transmute(self, x0, y0, width, height, mutation_size)
```

The `transmute` method is a very core of the `BboxTransmuter` class and must be overridden in the subclasses. It receives the location and size of the rectangle, and the `mutation_size`, with which the amount of padding and etc. will be scaled. It returns a `Path` instance.

```
class LArrow(pad=0.3)
```

Bases: `matplotlib.patches._Base`

(left) Arrow Box

```
transmute(self, x0, y0, width, height, mutation_size)
```

The `transmute` method is a very core of the `BboxTransmuter` class and must be overridden in the subclasses. It receives the location and size of the rectangle, and the `mutation_size`, with which the amount of padding and etc. will be scaled. It returns a `Path` instance.

```
class RArrow(pad=0.3)
```

Bases: `matplotlib.patches.LArrow`

(right) Arrow Box

```
transmute(self, x0, y0, width, height, mutation_size)
```

The `transmute` method is a very core of the `BboxTransmuter` class and must be overridden in the subclasses. It receives the location and size of the rectangle, and the `mutation_size`, with which the amount of padding and etc. will be scaled. It returns a `Path` instance.

```
class Round(pad=0.3, rounding_size=None)
```

Bases: `matplotlib.patches._Base`

A box with round corners.

***pad*** amount of padding

***rounding\_size*** rounding radius of corners. *pad* if None

```
transmute(self, x0, y0, width, height, mutation_size)
```

The `transmute` method is a very core of the `BboxTransmuter` class and must be overridden in the subclasses. It receives the location and size of the rectangle, and the `mutation_size`, with which the amount of padding and etc. will be scaled. It returns a `Path` instance.

```
class Round4(pad=0.3, rounding_size=None)
```

Bases: `matplotlib.patches._Base`

Another box with round edges.

***pad*** amount of padding

***rounding\_size*** rounding size of edges. *pad* if None

`transmute(self, x0, y0, width, height, mutation_size)`

The `transmute` method is a very core of the `BboxTransmuter` class and must be overridden in the subclasses. It receives the location and size of the rectangle, and the `mutation_size`, with which the amount of padding and etc. will be scaled. It returns a `Path` instance.

`class Roundtooth(pad=0.3, tooth_size=None)`

Bases: `matplotlib.patches.Sawtooth`

A rounded tooth box.

***pad*** amount of padding

***tooth\_size*** size of the sawtooth. `pad*` if None

`transmute(self, x0, y0, width, height, mutation_size)`

The `transmute` method is a very core of the `BboxTransmuter` class and must be overridden in the subclasses. It receives the location and size of the rectangle, and the `mutation_size`, with which the amount of padding and etc. will be scaled. It returns a `Path` instance.

`class Sawtooth(pad=0.3, tooth_size=None)`

Bases: `matplotlib.patches._Base`

A sawtooth box.

***pad*** amount of padding

***tooth\_size*** size of the sawtooth. `pad*` if None

`transmute(self, x0, y0, width, height, mutation_size)`

The `transmute` method is a very core of the `BboxTransmuter` class and must be overridden in the subclasses. It receives the location and size of the rectangle, and the `mutation_size`, with which the amount of padding and etc. will be scaled. It returns a `Path` instance.

`class Square(pad=0.3)`

Bases: `matplotlib.patches._Base`

A simple square box.

***pad*** amount of padding

`transmute(self, x0, y0, width, height, mutation_size)`

The `transmute` method is a very core of the `BboxTransmuter` class and must be overridden in the subclasses. It receives the location and size of the rectangle, and the `mutation_size`, with which the amount of padding and etc. will be scaled. It returns a `Path` instance.

#### Examples using `matplotlib.patches.BoxStyle`

- `sphinx_glr_gallery_pyplots_whats_new_98_4_fancy.py`
- `sphinx_glr_gallery_shapes_and_collections_artist_reference.py`
- `sphinx_glr_gallery_shapes_and_collections_fancybox_demo.py`

**matplotlib.patches.Circle**

```
class matplotlib.patches.Circle(xy, radius=5, **kwargs)
```

Bases: *matplotlib.patches.Ellipse*

A circle patch.

Create true circle at center  $xy = (x, y)$  with given *radius*. Unlike *CirclePolygon* which is a polygonal approximation, this uses Bezier splines and is much closer to a scale-free circle.

Valid kwargs are:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<i>alpha</i>		float or None
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i>		unknown
<i>capstyle</i>		{'butt', 'round', 'projecting'}
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>color</i>		color
<i>contains</i>		callable
<i>edgecolor</i> or <i>ec</i>		color or None or 'auto'
<i>facecolor</i> or <i>fc</i>		color or None
<i>figure</i>		<i>Figure</i>
<i>fill</i>		bool
<i>gid</i>		str
<i>hatch</i>		{'/', '\\', ' ', '-', '+', 'x', 'o', 'O', '.', '*'}
<i>in_layout</i>		bool
<i>joinstyle</i>		{'miter', 'round', 'bevel'}
<i>label</i>		object
<i>linestyle</i> or <i>ls</i>		{'-', '--', '-.', ':', ''}, (offset, on-off-seq), ...}
<i>linewidth</i> or <i>lw</i>		float or None
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		None or bool or float or callable
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>transform</i>		<i>Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>zorder</i>		float

```
get_radius(self)
```

Return the radius of the circle

```
radius
```

Return the radius of the circle

```
set_radius(self, radius)
```

Set the radius of the circle

## Parameters

**radius** [float]

### Examples using `matplotlib.patches.Circle`

- `sphx_glr_gallery_images_contours_and_fields_image_clip_path.py`
- `sphx_glr_gallery_text_labels_and_annotations_demo_annotation_box.py`
- `sphx_glr_gallery_text_labels_and_annotations_fancyarrow_demo.py`
- `sphx_glr_gallery_pyplots_whats_new_98_4_fancy.py`
- `sphx_glr_gallery_shapes_and_collections_artist_reference.py`
- `sphx_glr_gallery_shapes_and_collections_dolphin.py`
- `sphx_glr_gallery_shapes_and_collections_donut.py`
- `sphx_glr_gallery_shapes_and_collections_patch_collection.py`
- `sphx_glr_gallery_axes_grid1_simple_anchored_artists.py`
- `sphx_glr_gallery_showcase_anatomy.py`
- `sphx_glr_gallery_event_handling_looking_glass.py`
- `sphx_glr_gallery_misc_anchored_artists.py`
- `sphx_glr_gallery_misc_custom_projection.py`
- `sphx_glr_gallery_mplot3d_pathpatch3d.py`
- `sphx_glr_gallery_specialty_plots_radar_chart.py`
- `sphx_glr_gallery_userdemo_anchored_box02.py`
- *Legend guide*
- *Transformations Tutorial*

### `matplotlib.patches.CirclePolygon`

```
class matplotlib.patches.CirclePolygon(xy, radius=5, resolution=20, **kwargs)
```

Bases: `matplotlib.patches.RegularPolygon`

A polygon-approximation of a circle patch.

Create a circle at  $xy = (x, y)$  with given *radius*. This circle is approximated by a regular polygon with *resolution* sides. For a smoother circle drawn with splines, see *Circle*.

Valid kwargs are:

	Property	Description
<code>agg_filter</code>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<code>alpha</code>		float or None
<code>animated</code>		bool
<code>antialiased</code> or <code>aa</code>		unknown
<code>capstyle</code>		{'butt', 'round', 'projecting'}
<code>clip_box</code>		<i>Bbox</i>

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	Property	Description
<code>clip_on</code>		bool
<code>clip_path</code>		<code>[(Path, Transform)   Patch   None]</code>
<code>color</code>		color
<code>contains</code>		callable
<code>edgecolor</code> or <code>ec</code>		color or None or 'auto'
<code>facecolor</code> or <code>fc</code>		color or None
<code>figure</code>		<i>Figure</i>
<code>fill</code>		bool
<code>gid</code>		str
<code>hatch</code>		<code>{'/', '\', ' ', '-.', '+', 'x', 'o', 'O', '.', '*'}</code>
<code>in_layout</code>		bool
<code>joinstyle</code>		<code>{'miter', 'round', 'bevel'}</code>
<code>label</code>		object
<code>linestyle</code> or <code>ls</code>		<code>{'-', '-.', '-:', ':', ''}</code> , (offset, on-off-seq), ...}
<code>linewidth</code> or <code>lw</code>		float or None
<code>path_effects</code>		<i>AbstractPathEffect</i>
<code>picker</code>		None or bool or float or callable
<code>rasterized</code>		bool or None
<code>sketch_params</code>		(scale: float, length: float, randomness: float)
<code>snap</code>		bool or None
<code>transform</code>		<i>Transform</i>
<code>url</code>		str
<code>visible</code>		bool
<code>zorder</code>		float

### matplotlib.patches.ConnectionPatch

```
class matplotlib.patches.ConnectionPatch(xyA, xyB, coordsA, coordsB=None, axesA=None, axesB=None, arrowstyle='-', arrow_transmuter=None, connectionstyle='arc3', connector=None, patchA=None, patchB=None, shrinkA=0.0, shrinkB=0.0, mutation_scale=10.0, mutation_aspect=None, clip_on=False, dpi_cor=1.0, **kwargs)
```

Bases: `matplotlib.patches.FancyArrowPatch`

A `ConnectionPatch` class is to make connecting lines between two points (possibly in different axes).

Connect point `xyA` in `coordsA` with point `xyB` in `coordsB`

Valid keys are

Key	Description
arrowstyle	the arrow style
connectionstyle	the connection style
relpos	default is (0.5, 0.5)
patchA	default is bounding box of the text
patchB	default is None
shrinkA	default is 2 points
shrinkB	default is 2 points
mutation_scale	default is text size (in points)
mutation_aspect	default is 1.
?	any key for <code>matplotlib.patches.PathPatch</code>

`coordsA` and `coordsB` are strings that indicate the coordinates of `xyA` and `xyB`.

Property	Description
'figure points'	points from the lower left corner of the figure
'figure pixels'	pixels from the lower left corner of the figure
'figure fraction'	0,0 is lower left of figure and 1,1 is upper, right
'axes points'	points from lower left corner of axes
'axes pixels'	pixels from lower left corner of axes
'axes fraction'	0,1 is lower left of axes and 1,1 is upper right
'data'	use the coordinate system of the object being annotated (default)
'offset points'	Specify an offset (in points) from the <code>xy</code> value
'polar'	you can specify <i>theta</i> , <i>r</i> for the annotation, even in cartesian plots. Note that if you are using a polar axes, you do not need to specify polar for the coordinate system since that is the native "data" coordinate system.

Alternatively they can be set to any valid *Transform*.

`draw(self, renderer)`

Draw the *Patch* to the given *renderer*.

`get_annotation_clip(self)`

Return *annotation\_clip* attribute. See `set_annotation_clip()` for the meaning of return values.

`get_path_in_displaycoord(self)`

Return the mutated path of the arrow in the display coord

`set_annotation_clip(self, b)`  
 set `annotation_clip` attribute.

- **True:** the annotation will only be drawn when `self.xy` is inside the axes.
- **False:** the annotation will always be drawn regardless of its position.
- **None:** the `self.xy` will be checked only if `xycoords` is "data"

#### Examples using `matplotlib.patches.ConnectionPatch`

- `sphx_glr_gallery_pie_and_polar_charts_bar_of_pie.py`
- `sphx_glr_gallery_userdemo_connect_simple01.py`

#### `matplotlib.patches.ConnectionStyle`

`class matplotlib.patches.ConnectionStyle`  
 Bases: `matplotlib.patches._Style`

*ConnectionStyle* is a container class which defines several connectionstyle classes, which is used to create a path between two points. These are mainly used with *FancyArrowPatch*.

A connectionstyle object can be either created as:

```
ConnectionStyle.Arc3(rad=0.2)
```

or:

```
ConnectionStyle("Arc3", rad=0.2)
```

or:

```
ConnectionStyle("Arc3, rad=0.2")
```

The following classes are defined

Class	Name	Attrs
Angle	angle	angleA=90, angleB=0, rad=0.0
Angle3	angle3	angleA=90, angleB=0
Arc	arc	angleA=0, angleB=0, armA=None, armB=None, rad=0.0
Arc3	arc3	rad=0.0
Bar	bar	armA=0.0, armB=0.0, fraction=0.3, angle=None

An instance of any connection style class is an callable object, whose call signature is:

```
__call__(self, posA, posB,  
         patchA=None, patchB=None,  
         shrinkA=2., shrinkB=2.)
```

and it returns a `Path` instance. `posA` and `posB` are tuples of x,y coordinates of the two points to be connected. `patchA` (or `patchB`) is given, the returned path is clipped so that it start (or end) from the boundary of the patch. The path is further shrunk by `shrinkA` (or `shrinkB`) which is given in points.

return the instance of the subclass with the given style name.

```
class Angle(angleA=90, angleB=0, rad=0.0)
```

```
    Bases: matplotlib.patches._Base
```

Creates a piecewise continuous quadratic Bezier path between two points. The path has a one passing-through point placed at the intersecting point of two lines which cross the start and end point, and have a slope of *angleA* and *angleB*, respectively. The connecting edges are rounded with *rad*.

***angleA*** starting angle of the path

***angleB*** ending angle of the path

***rad*** rounding radius of the edge

```
connect(self, posA, posB)
```

```
class Angle3(angleA=90, angleB=0)
```

```
    Bases: matplotlib.patches._Base
```

Creates a simple quadratic Bezier curve between two points. The middle control points is placed at the intersecting point of two lines which cross the start and end point, and have a slope of *angleA* and *angleB*, respectively.

***angleA*** starting angle of the path

***angleB*** ending angle of the path

```
connect(self, posA, posB)
```

```
class Arc(angleA=0, angleB=0, armA=None, armB=None, rad=0.0)
```

```
    Bases: matplotlib.patches._Base
```

Creates a piecewise continuous quadratic Bezier path between two points. The path can have two passing-through points, a point placed at the distance of *armA* and angle of *angleA* from point A, another point with respect to point B. The edges are rounded with *rad*.

***angleA*** : starting angle of the path

***angleB*** : ending angle of the path

***armA*** : length of the starting arm

***armB*** : length of the ending arm

***rad*** : rounding radius of the edges

```
connect(self, posA, posB)
```

```
class Arc3(rad=0.0)
```

```
    Bases: matplotlib.patches._Base
```

Creates a simple quadratic Bezier curve between two points. The curve is created so that the middle control point (C1) is located at the same distance from the start (C0) and end points(C2) and the distance of the C1 to the line connecting C0-C2 is *rad* times the distance of C0-C2.

***rad*** curvature of the curve.

```
connect(self, posA, posB)
```

```
class Bar(armA=0.0, armB=0.0, fraction=0.3, angle=None)
```

```
    Bases: matplotlib.patches._Base
```

A line with *angle* between A and B with *armA* and *armB*. One of the arms is extended so that they are connected in a right angle. The length of armA is determined by (*armA* + *fraction* x AB distance). Same for armB.

**Parameters**

**armA** [float] minimum length of armA

**armB** [float] minimum length of armB

**fraction** [float] a fraction of the distance between two points that will be added to armA and armB.

**angle** [float or None] angle of the connecting line (if None, parallel to A and B)

`connect(self, posA, posB)`

**matplotlib.patches.Ellipse**

`class matplotlib.patches.Ellipse(xy, width, height, angle=0, **kwargs)`

Bases: `matplotlib.patches.Patch`

A scale-free ellipse.

**Parameters**

**xy** [(float, float)] xy coordinates of ellipse centre.

**width** [float] Total length (diameter) of horizontal axis.

**height** [float] Total length (diameter) of vertical axis.

**angle** [scalar, optional] Rotation in degrees anti-clockwise.

**Notes**

Valid keyword arguments are

	Property	Description
<code>agg_filter</code>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m,
<code>alpha</code>		float or None
<code>animated</code>		bool
<code>antialiased</code> or <code>aa</code>		unknown
<code>capstyle</code>		{'butt', 'round', 'projecting'}
<code>clip_box</code>		<i>Bbox</i>
<code>clip_on</code>		bool
<code>clip_path</code>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<code>color</code>		color
<code>contains</code>		callable
<code>edgecolor</code> or <code>ec</code>		color or None or 'auto'
<code>facecolor</code> or <code>fc</code>		color or None
<code>figure</code>		<i>Figure</i>
<code>fill</code>		bool
<code>gid</code>		str
<code>hatch</code>		{'/', '\\', ' ', '-.', '+', 'x', 'o', 'O', '.', '*'}

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	Property	Description
<i>in_layout</i>	bool	
<i>joinstyle</i>	{'miter', 'round', 'bevel'}	
<i>label</i>	object	
<i>linestyle</i> or <i>ls</i>	{'-', '--', '-.', ':', "", (offset, on-off-seq), ...}	
<i>linewidth</i> or <i>lw</i>	float or None	
<i>path_effects</i>	<i>AbstractPathEffect</i>	
<i>picker</i>	None or bool or float or callable	
<i>rasterized</i>	bool or None	
<i>sketch_params</i>	(scale: float, length: float, randomness: float)	
<i>snap</i>	bool or None	
<i>transform</i>	<i>Transform</i>	
<i>url</i>	str	
<i>visible</i>	bool	
<i>zorder</i>	float	

**center**

Return the center of the ellipse

**get\_center(*self*)**

Return the center of the ellipse

**get\_patch\_transform(*self*)**

Return the *Transform* instance which takes patch coordinates to data coordinates.

For example, one may define a patch of a circle which represents a radius of 5 by providing coordinates for a unit circle, and a transform which scales the coordinates (the patch coordinate) by 5.

**get\_path(*self*)**

Return the vertices of the rectangle

**set\_center(*self*, *xy*)**

Set the center of the ellipse.

**Parameters**

**xy** [(float, float)]

**Examples using `matplotlib.patches.Ellipse`**

- sphx\_glr\_gallery\_statistics\_confidence\_ellipse.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_annotation\_demo.py
- sphx\_glr\_gallery\_shapes\_and\_collections\_artist\_reference.py
- sphx\_glr\_gallery\_shapes\_and\_collections\_ellipse\_demo.py
- sphx\_glr\_gallery\_shapes\_and\_collections\_hatch\_demo.py
- sphx\_glr\_gallery\_misc\_anchored\_artists.py
- sphx\_glr\_gallery\_units\_ellipse\_with\_units.py
- sphx\_glr\_gallery\_userdemo\_anchored\_box03.py

- sphx\_glr\_gallery\_userdemo\_anchored\_box04.py
- sphx\_glr\_gallery\_userdemo\_annotate\_explain.py
- sphx\_glr\_gallery\_userdemo\_simple\_annotate01.py
- *Legend guide*
- *Transformations Tutorial*

### matplotlib.patches.FancyArrow

```
class matplotlib.patches.FancyArrow(x, y, dx, dy, width=0.001,
                                   length_includes_head=False, head_width=None,
                                   head_length=None, shape='full', overhang=0,
                                   head_starts_at_zero=False, **kwargs)
```

Bases: `matplotlib.patches.Polygon`

Like `Arrow`, but lets you set head width and head height independently.

#### Constructor arguments

**width: float (default: 0.001)** width of full arrow tail

**length\_includes\_head: bool (default: False)** True if head is to be counted in calculating the length.

**head\_width: float or None (default: 3\*width)** total width of the full arrow head

**head\_length: float or None (default: 1.5 \* head\_width)** length of arrow head

**shape: ['full', 'left', 'right'] (default: 'full')** draw the left-half, right-half, or full arrow

**overhang: float (default: 0)** fraction that the arrow is swept back (0 overhang means triangular shape). Can be negative or greater than one.

**head\_starts\_at\_zero: bool (default: False)** if True, the head starts being drawn at coordinate 0 instead of ending at coordinate 0.

Other valid kwargs (inherited from `Patch`) are:

	Property	Description
<code>agg_filter</code>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m,
<code>alpha</code>		float or None
<code>animated</code>		bool
<code>antialiased</code> or <code>aa</code>		unknown
<code>capstyle</code>		{'butt', 'round', 'projecting'}
<code>clip_box</code>		<i>Bbox</i>
<code>clip_on</code>		bool
<code>clip_path</code>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<code>color</code>		color
<code>contains</code>		callable
<code>edgecolor</code> or <code>ec</code>		color or None or 'auto'
<code>facecolor</code> or <code>fc</code>		color or None
<code>figure</code>		<i>Figure</i>
<code>fill</code>		bool
<code>gid</code>		str

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	Property	Description
<i>hatch</i>		{'/', '\', ' ', '-', '+', 'x', 'o', 'O', '.', '*'}
<i>in_layout</i>		bool
<i>joinstyle</i>		{'miter', 'round', 'bevel'}
<i>label</i>		object
<i>linestyle</i> or <i>ls</i>		{'-', '--', '-.', ':', '', (offset, on-off-seq), ...}
<i>linewidth</i> or <i>lw</i>		float or None
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		None or bool or float or callable
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>transform</i>		<i>Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>zorder</i>		float

### matplotlib.patches.FancyArrowPatch

```
class matplotlib.patches.FancyArrowPatch(posA=None, posB=None, path=None,
                                         arrowstyle='simple', arrow_transmuter=None,
                                         connectionstyle='arc3', connector=None,
                                         patchA=None, patchB=None, shrinkA=2,
                                         shrinkB=2, mutation_scale=1, muta-
                                         tion_aspect=None, dpi_cor=1, **kwargs)
```

Bases: *matplotlib.patches.Patch*

A fancy arrow patch. It draws an arrow using the *ArrowStyle*.

The head and tail positions are fixed at the specified start and end points of the arrow, but the size and shape (in display coordinates) of the arrow does not change when the axis is moved or zoomed.

If *posA* and *posB* are given, a path connecting two points is created according to *connectionstyle*. The path will be clipped with *patchA* and *patchB* and further shrunken by *shrinkA* and *shrinkB*. An arrow is drawn along this resulting path using the *arrowstyle* parameter.

Alternatively if *path* is provided, an arrow is drawn along this path and *patchA*, *patchB*, *shrinkA*, and *shrinkB* are ignored.

#### Parameters

**posA, posB** [None, tuple, optional (default: None)] (x,y) coordinates of arrow tail and arrow head respectively.

**path** [None, Path (default: None)] *matplotlib.path.Path* instance. If provided, an arrow is drawn along this path and *patchA*, *patchB*, *shrinkA*, and *shrinkB* are ignored.

**arrowstyle** [str or *ArrowStyle*, optional (default: 'simple')]

Describes how the fancy arrow will be drawn. It can be string of the available arrowstyle names, with optional comma-separated

attributes, or an *ArrowStyle* instance. The optional attributes are meant to be scaled with the *mutation\_scale*. The following arrow styles are available:

Class	Name	Attrs
Curve	-	None
CurveB	->	head_length=0.4, head_width=0.2
BracketB	-[	widthB=1.0, lengthB=0.2, angleB=None
Curve-FilledB	- >	head_length=0.4, head_width=0.2
CurveA	<-	head_length=0.4, head_width=0.2
CurveAB	<->	head_length=0.4, head_width=0.2
Curve-FilledA	< -	head_length=0.4, head_width=0.2
Curve-FilledAB	< - >	head_length=0.4, head_width=0.2
BracketA	] -	widthA=1.0, lengthA=0.2, angleA=None
BracketAB	] - [	widthA=1.0, lengthA=0.2, angleA=None, widthB=1.0, lengthB=0.2, angleB=None
Fancy	fancy	head_length=0.4, head_width=0.4, tail_width=0.4
Simple	simple	head_length=0.5, head_width=0.5, tail_width=0.2
Wedge	wedge	tail_width=0.3, shrink_factor=0.5
BarAB	-	widthA=1.0, angleA=None, widthB=1.0, angleB=None

**arrow\_transmuter** Ignored

**connectionstyle** [str, ConnectionStyle, or None, optional]

(default: 'arc3')

Describes how *posA* and *posB* are connected. It can be an instance of the *ConnectionStyle* class or a string of the connectionstyle name, with optional comma-separated attributes. The following connection styles are available:

Class	Name	Attrs
Angle	angle	angleA=90, angleB=0, rad=0.0
Angle3	angle3	angleA=90, angleB=0
Arc	arc	angleA=0, angleB=0, armA=None, armB=None, rad=0.0
Arc3	arc3	rad=0.0
Bar	bar	armA=0.0, armB=0.0, fraction=0.3, angle=None

**connector** Ignored

**patchA, patchB** [None, Patch, optional (default: None)] Head and tail patch respectively. `matplotlib.patch.Patch` instance.

**shrinkA, shrinkB** [scalar, optional (default: 2)] Shrinking factor of the tail and head of the arrow respectively

**mutation\_scale** [scalar, optional (default: 1)] Value with which attributes of *arrowstyle* (e.g., *head\_length*) will be scaled.

**mutation\_aspect** [None, scalar, optional (default: None)] The height of the rectangle will be squeezed by this value before the mutation and the mutated box will be stretched by the inverse of it.

**dpi\_cor** [scalar, optional (default: 1)] *dpi\_cor* is currently used for linewidth-related things and shrink factor. Mutation scale is affected by this.

## Notes

Valid kwargs are:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<i>alpha</i>		float or None
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i>		unknown
<i>capstyle</i>		{'butt', 'round', 'projecting'}
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>color</i>		color
<i>contains</i>		callable
<i>edgecolor</i> or <i>ec</i>		color or None or 'auto'
<i>facecolor</i> or <i>fc</i>		color or None
<i>figure</i>		<i>Figure</i>
<i>fill</i>		bool
<i>gid</i>		str
<i>hatch</i>		{'/', '\\', ' ', '-.', '+', 'x', 'o', 'O', '.', '*'}
<i>in_layout</i>		bool
<i>joinstyle</i>		{'miter', 'round', 'bevel'}
<i>label</i>		object
<i>linestyle</i> or <i>ls</i>		{'-', '--', '-.', ':', '}', (offset, on-off-seq), ...}
<i>linewidth</i> or <i>lw</i>		float or None
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		None or bool or float or callable
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>transform</i>		<i>Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>zorder</i>		float

`draw(self, renderer)`

Draw the *Patch* to the given *renderer*.

`get_arrowstyle(self)`

Return the arrowstyle object.

`get_connectionstyle(self)`

Return the *ConnectionStyle* instance.

`get_dpi_cor(self)`

`dpi_cor` is currently used for linewidth-related things and shrink factor. Mutation scale is affected by this.

### Returns

**dpi\_cor** [scalar]

`get_mutation_aspect(self)`

Return the aspect ratio of the bbox mutation.

`get_mutation_scale(self)`

Return the mutation scale.

### Returns

**scale** [scalar]

`get_path(self)`

Return the path of the arrow in the data coordinates. Use `get_path_in_displaycoord()` method to retrieve the arrow path in display coordinates.

`get_path_in_displaycoord(self)`

Return the mutated path of the arrow in display coordinates.

`set_arrowstyle(self, arrowstyle=None, **kw)`

Set the arrow style. Old attributes are forgotten. Without arguments (or with `arrowstyle=None`) returns available box styles as a list of strings.

### Parameters

**arrowstyle** [None, ArrowStyle, str, optional (default: None)] Can be a string with arrowstyle name with optional comma-separated attributes, e.g.:

```
set_arrowstyle("Fancy,head_length=0.2")
```

Alternatively attributes can be provided as keywords, e.g.:

```
set_arrowstyle("fancy", head_length=0.2)
```

`set_connectionstyle(self, connectionstyle, **kw)`

Set the connection style. Old attributes are forgotten.

### Parameters

**connectionstyle** [None, ConnectionStyle instance, or string] Can be a string with connectionstyle name with optional comma-separated attributes, e.g.:

```
set_connectionstyle("arc,angleA=0,armA=30,rad=10")
```

Alternatively, the attributes can be provided as keywords, e.g.:

```
set_connectionstyle("arc", angleA=0, armA=30, rad=10)
```

Without any arguments (or with `connectionstyle=None`), return available styles as a list of strings.

`set_dpi_cor(self, dpi_cor)`

`dpi_cor` is currently used for linewidth-related things and shrink factor. Mutation scale is affected by this.

#### Parameters

**dpi\_cor** [scalar]

`set_mutation_aspect(self, aspect)`

Set the aspect ratio of the bbox mutation.

#### Parameters

**aspect** [scalar]

`set_mutation_scale(self, scale)`

Set the mutation scale.

#### Parameters

**scale** [scalar]

`set_patchA(self, patchA)`

Set the tail patch.

#### Parameters

**patchA** [Patch] `matplotlib.patch.Patch` instance.

`set_patchB(self, patchB)`

Set the head patch.

#### Parameters

**patchB** [Patch] `matplotlib.patch.Patch` instance.

`set_positions(self, posA, posB)`

Set the begin and end positions of the connecting path.

#### Parameters

**posA, posB** [None, tuple] (x,y) coordinates of arrow tail and arrow head respectively. If `None` use current value.

#### Examples using `matplotlib.patches.FancyArrowPatch`

- `sphinx_glr_gallery_shapes_and_collections_arrow_guide.py`
- `sphinx_glr_gallery_userdemo_connectionstyle_demo.py`

#### `matplotlib.patches.FancyBboxPatch`

```
class matplotlib.patches.FancyBboxPatch(xy, width, height, boxstyle='round',
                                       bbox_transmuter=None, mutation_scale=1.0,
                                       mutation_aspect=None, **kwargs)
```

Bases: `matplotlib.patches.Patch`

A fancy box around a rectangle with lower left at  $xy = (x, y)$  with specified width and height.

*FancyBboxPatch* is similar to *Rectangle*, but it draws a fancy box around the rectangle. The transformation of the rectangle box to the fancy box is delegated to the *BoxTransmuterBase* and its derived classes.

**Parameters**

**xy** [float, float] The lower left corner of the box.

**width** [float] The width of the box.

**height** [float] The height of the box.

**boxstyle** [str or *matplotlib.patches.BoxStyle*]

The style of the fancy box. This can either be a *BoxStyle* instance or a string of the style name and optionally comma separated attributes (e.g. "Round, pad=0.2"). This string is passed to *BoxStyle* to construct a *BoxStyle* object. See there for a full documentation.

The following box styles are available:

Class	Name	Attrs
Circle	circle	pad=0.3
DArrow	darrow	pad=0.3
LArrow	larrow	pad=0.3
RArrow	rarrow	pad=0.3
Round	round	pad=0.3, rounding_size=None
Round4	round4	pad=0.3, rounding_size=None
Roundtooth	roundtooth	pad=0.3, tooth_size=None
Sawtooth	sawtooth	pad=0.3, tooth_size=None
Square	square	pad=0.3

**mutation\_scale** [float, optional, default: 1] Scaling factor applied to the attributes of the box style (e.g. pad or rounding\_size).

**mutation\_aspect** [float, optional] The height of the rectangle will be squeezed by this value before the mutation and the mutated box will be stretched by the inverse of it. For example, this allows different horizontal and vertical padding.

**Other Parameters**

**\*\*kwargs** [*Patch* properties]

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<i>alpha</i>		float or None
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i>		unknown
<i>capstyle</i>		{'butt', 'round', 'projecting'}
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]

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	Property	Description
<i>color</i>	color	
<i>contains</i>	callable	
<i>edgecolor</i> or <i>ec</i>	color or None or 'auto'	
<i>facecolor</i> or <i>fc</i>	color or None	
<i>figure</i>	<i>Figure</i>	
<i>fill</i>	bool	
<i>gid</i>	str	
<i>hatch</i>	{'/', '\', ' ', '-.', '+', 'x', 'o', 'O', ':', '*'}	
<i>in_layout</i>	bool	
<i>joinstyle</i>	{'miter', 'round', 'bevel'}	
<i>label</i>	object	
<i>linestyle</i> or <i>ls</i>	{'-', '-', '-.', ':', "", (offset, on-off-seq), ...}	
<i>linewidth</i> or <i>lw</i>	float or None	
<i>path_effects</i>	<i>AbstractPathEffect</i>	
<i>picker</i>	None or bool or float or callable	
<i>rasterized</i>	bool or None	
<i>sketch_params</i>	(scale: float, length: float, randomness: float)	
<i>snap</i>	bool or None	
<i>transform</i>	<i>Transform</i>	
<i>url</i>	str	
<i>visible</i>	bool	
<i>zorder</i>	float	

`get_bbox(self)`  
Return the *Bbox* of the rectangle.

`get_boxstyle(self)`  
Return the boxstyle object.

`get_height(self)`  
Return the height of the rectangle.

`get_mutation_aspect(self)`  
Return the aspect ratio of the bbox mutation.

`get_mutation_scale(self)`  
Return the mutation scale.

`get_path(self)`  
Return the mutated path of the rectangle.

`get_width(self)`  
Return the width of the rectangle.

`get_x(self)`  
Return the left coord of the rectangle.

`get_y(self)`  
Return the bottom coord of the rectangle.

`set_bounds(self, *args)`  
Set the bounds of the rectangle.

Call signatures:

```
set_bounds(left, bottom, width, height)
set_bounds((left, bottom, width, height))
```

**Parameters**

**left, bottom** [float] The coordinates of the bottom left corner of the rectangle.

**width, height** [float] The width/height of the rectangle.

`set_boxstyle(self, boxstyle=None, **kw)`  
Set the box style.

`boxstyle` can be a string with boxstyle name with optional comma-separated attributes. Alternatively, the attrs can be provided as keywords:

```
set_boxstyle("round,pad=0.2")
set_boxstyle("round", pad=0.2)
```

Old attrs simply are forgotten.

Without argument (or with `boxstyle = None`), it returns available box styles.

The following boxstyles are available:

Class	Name	Attrs
Circle	circle	pad=0.3
DArrow	darrow	pad=0.3
LArrow	larrow	pad=0.3
RArrow	rarrow	pad=0.3
Round	round	pad=0.3, rounding_size=None
Round4	round4	pad=0.3, rounding_size=None
Roundtooth	roundtooth	pad=0.3, tooth_size=None
Sawtooth	sawtooth	pad=0.3, tooth_size=None
Square	square	pad=0.3

ACCEPTS: [ 'circle' | 'darrow' | 'larrow' | 'rarrow' | 'round' | 'round4' | 'roundtooth' | 'sawtooth' | 'square' ]

`set_height(self, h)`  
Set the rectangle height.

**Parameters**

**h** [float]

`set_mutation_aspect(self, aspect)`  
Set the aspect ratio of the bbox mutation.

**Parameters**

**aspect** [float]

`set_mutation_scale(self, scale)`  
Set the mutation scale.

**Parameters**

**scale** [float]

`set_width(self, w)`

Set the rectangle width.

**Parameters**

**w** [float]

`set_x(self, x)`

Set the left coord of the rectangle.

**Parameters**

**x** [float]

`set_y(self, y)`

Set the bottom coord of the rectangle.

**Parameters**

**y** [float]

**Examples using `matplotlib.patches.FancyBboxPatch`**

- sphx\_glr\_gallery\_shapes\_and\_collections\_artist\_reference.py
- sphx\_glr\_gallery\_shapes\_and\_collections\_fancybox\_demo.py

**matplotlib.patches.Patch**

```
class matplotlib.patches.Patch(edgecolor=None, facecolor=None, color=None,
                               linewidth=None, linestyle=None, antialiased=None,
                               hatch=None, fill=True, capstyle=None, join-
                               style=None, **kwargs)
```

Bases: `matplotlib.artist.Artist`

A patch is a 2D artist with a face color and an edge color.

If any of `edgecolor`, `facecolor`, `linewidth`, or `antialiased` are `None`, they default to their rc params setting.

The following kwarg properties are supported

	Property	Description
<code>agg_filter</code>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m,
<code>alpha</code>		float or None
<code>animated</code>		bool
<code>antialiased</code> or <code>aa</code>		unknown
<code>capstyle</code>		{'butt', 'round', 'projecting'}
<code>clip_box</code>		<i>Bbox</i>
<code>clip_on</code>		bool
<code>clip_path</code>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<code>color</code>		color
<code>contains</code>		callable
<code>edgecolor</code> or <code>ec</code>		color or None or 'auto'
<code>facecolor</code> or <code>fc</code>		color or None
<code>figure</code>		<i>Figure</i>

Continued on next page

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	Property	Description
<i>fill</i>	bool	
<i>gid</i>	str	
<i>hatch</i>	{ '/', '\', ' ', '-', '+', 'x', 'o', 'O', '.', '*' }	
<i>in_layout</i>	bool	
<i>joinstyle</i>	{ 'miter', 'round', 'bevel' }	
<i>label</i>	object	
<i>linestyle</i> or <i>ls</i>	{ '-', '-.', '-.', ':', '', (offset, on-off-seq), ... }	
<i>linewidth</i> or <i>lw</i>	float or None	
<i>path_effects</i>	<i>AbstractPathEffect</i>	
<i>picker</i>	None or bool or float or callable	
<i>rasterized</i>	bool or None	
<i>sketch_params</i>	(scale: float, length: float, randomness: float)	
<i>snap</i>	bool or None	
<i>transform</i>	<i>Transform</i>	
<i>url</i>	str	
<i>visible</i>	bool	
<i>zorder</i>	float	

`contains(self, mouseevent, radius=None)`  
 Test whether the mouse event occurred in the patch.

#### Returns

**(bool, empty dict)**

`contains_point(self, point, radius=None)`  
 Returns True if the given *point* is inside the path (transformed with its transform attribute).

*radius* allows the path to be made slightly larger or smaller.

`contains_points(self, points, radius=None)`  
 Returns a bool array which is True if the (closed) path contains the corresponding point. (transformed with its transform attribute).

*points* must be Nx2 array. *radius* allows the path to be made slightly larger or smaller.

`draw(self, renderer)`  
 Draw the *Patch* to the given *renderer*.

`fill`  
 return whether fill is set

`get_aa(self)`  
 Alias for `get_antialiased`.

`get_antialiased(self)`  
 Returns True if the *Patch* is to be drawn with antialiasing.

`get_capstyle(self)`  
 Return the current capstyle

`get_data_transform(self)`  
 Return the *Transform* instance which maps data coordinates to physical coordinates.

`get_ec(self)`  
 Alias for `get_edgecolor`.

`get_edgecolor(self)`  
Return the edge color of the *Patch*.

`get_extents(self)`  
Return a *Bbox* object defining the axis-aligned extents of the *Patch*.

`get_facecolor(self)`  
Return the face color of the *Patch*.

`get_fc(self)`  
Alias for `get_facecolor`.

`get_fill(self)`  
return whether fill is set

`get_hatch(self)`  
Return the current hatching pattern

`get_joinstyle(self)`  
Return the current joinstyle

`get_linestyle(self)`  
Return the linestyle.

`get_linewidth(self)`  
Return the line width in points.

`get_ls(self)`  
Alias for `get_linestyle`.

`get_lw(self)`  
Alias for `get_linewidth`.

`get_patch_transform(self)`  
Return the *Transform* instance which takes patch coordinates to data coordinates.  
  
For example, one may define a patch of a circle which represents a radius of 5 by providing coordinates for a unit circle, and a transform which scales the coordinates (the patch coordinate) by 5.

`get_path(self)`  
Return the path of this patch

`get_transform(self)`  
Return the *Transform* applied to the *Patch*.

`get_verts(self)`  
Return a copy of the vertices used in this patch  
  
If the patch contains Bezier curves, the curves will be interpolated by line segments. To access the curves as curves, use `get_path()`.

`get_window_extent(self, renderer=None)`  
Get the axes bounding box in display space.  
  
The bounding box' width and height are nonnegative.  
  
Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.  
  
Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas

used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

`set_aa(self, aa)`

Alias for `set_antialiased`.

`set_alpha(self, alpha)`

Set the alpha transparency of the patch.

#### Parameters

**alpha** [float or None]

`set_antialiased(self, aa)`

Set whether to use antialiased rendering.

#### Parameters

**b** [bool or None]

`set_capstyle(self, s)`

Set the patch capstyle

#### Parameters

**s** [{'butt', 'round', 'projecting'}]

`set_color(self, c)`

Set both the edgecolor and the facecolor.

#### Parameters

**c** [color]

#### See also:

`Patch.set_facecolor`, `Patch.set_edgecolor` For setting the edge or face color individually.

`set_ec(self, color)`

Alias for `set_edgecolor`.

`set_edgecolor(self, color)`

Set the patch edge color.

#### Parameters

**color** [color or None or 'auto']

`set_facecolor(self, color)`

Set the patch face color.

#### Parameters

**color** [color or None]

`set_fc(self, color)`

Alias for `set_facecolor`.

`set_fill(self, b)`

Set whether to fill the patch.

#### Parameters

**b** [bool]

`set_hatch(self, hatch)`  
 Set the hatching pattern

*hatch* can be one of:

```

/ - diagonal hatching
\ - back diagonal
| - vertical
- - horizontal
+ - crossed
x - crossed diagonal
o - small circle
O - large circle
. - dots
* - stars
    
```

Letters can be combined, in which case all the specified hatchings are done. If same letter repeats, it increases the density of hatching of that pattern.

Hatching is supported in the PostScript, PDF, SVG and Agg backends only.

**Parameters**

**hatch** [{'/', '\\', '|', '-.', '+', 'x', 'o', 'O', '.', '\*'}]

`set_joinstyle(self, s)`  
 Set the patch joinstyle

**Parameters**

**s** [{'miter', 'round', 'bevel'}]

`set_linestyle(self, ls)`  
 Set the patch linestyle.

linestyle	description
'-' or 'solid'	solid line
'--' or 'dashed'	dashed line
'-.' or 'dashdot'	dash-dotted line
':' or 'dotted'	dotted line

Alternatively a dash tuple of the following form can be provided:

```
(offset, onoffseq),
```

where *onoffseq* is an even length tuple of on and off ink in points.

**Parameters**

**ls** [{'-', '-.', '-.-', ':', ' ', (offset, on-off-seq), ...}] The line style.

`set_linewidth(self, w)`  
 Set the patch linewidth in points.

**Parameters**

**w** [float or None]

`set_ls(self, ls)`  
 Alias for *set\_linestyle*.

```

set_lw(self, w)
    Alias for set_linewidth.

update_from(self, other)
    Updates this Patch from the properties of other.

validCap = ('butt', 'round', 'projecting')

validJoin = ('miter', 'round', 'bevel')

zorder = 1

```

### Examples using `matplotlib.patches.Patch`

- `sphx_glr_gallery_text_labels_and_annotations_custom_legends.py`
- *Legend guide*

### `matplotlib.patches.PathPatch`

```
class matplotlib.patches.PathPatch(path, **kwargs)
```

Bases: `matplotlib.patches.Patch`

A general polycurve path patch.

`path` is a `matplotlib.path.Path` object.

Valid kwargs are:

	Property	Description
<code>agg_filter</code>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<code>alpha</code>		float or None
<code>animated</code>		bool
<code>antialiased</code> or <code>aa</code>		unknown
<code>capstyle</code>		{'butt', 'round', 'projecting'}
<code>clip_box</code>		<i>Bbox</i>
<code>clip_on</code>		bool
<code>clip_path</code>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<code>color</code>		color
<code>contains</code>		callable
<code>edgecolor</code> or <code>ec</code>		color or None or 'auto'
<code>facecolor</code> or <code>fc</code>		color or None
<code>figure</code>		<i>Figure</i>
<code>fill</code>		bool
<code>gid</code>		str
<code>hatch</code>		{'/', '\', ' ', '-.', '+', 'x', 'o', 'O', ':', '*'}
<code>in_layout</code>		bool
<code>joinstyle</code>		{'miter', 'round', 'bevel'}
<code>label</code>		object
<code>linestyle</code> or <code>ls</code>		{'-', '-.', '-.-', ':', ' ', (offset, on-off-seq), ...}
<code>linewidth</code> or <code>lw</code>		float or None
<code>path_effects</code>		<i>AbstractPathEffect</i>
<code>picker</code>		None or bool or float or callable
<code>rasterized</code>		bool or None

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	Property	Description
<i>sketch_params</i>	(scale: float, length: float, randomness: float)	
<i>snap</i>	bool or None	
<i>transform</i>	<i>Transform</i>	
<i>url</i>	str	
<i>visible</i>	bool	
<i>zorder</i>	float	

```
get_path(self)
```

Return the path of this patch

#### Examples using `matplotlib.patches.PathPatch`

- `sphx_glr_gallery_images_contours_and_fields_image_demo.py`
- `sphx_glr_gallery_text_labels_and_annotations_demo_text_path.py`
- `sphx_glr_gallery_shapes_and_collections_artist_reference.py`
- `sphx_glr_gallery_shapes_and_collections_compound_path.py`
- `sphx_glr_gallery_shapes_and_collections_dolphin.py`
- `sphx_glr_gallery_shapes_and_collections_donut.py`
- `sphx_glr_gallery_shapes_and_collections_path_patch.py`
- `sphx_glr_gallery_shapes_and_collections_quad_bezier.py`
- `sphx_glr_gallery_showcase_firefox.py`
- *Animated histogram*
- `sphx_glr_gallery_event_handling_path_editor.py`
- `sphx_glr_gallery_misc_histogram_path.py`
- `sphx_glr_gallery_misc_logos2.py`
- `sphx_glr_gallery_mplot3d_pathpatch3d.py`
- *Path Tutorial*

#### `matplotlib.patches.Polygon`

```
class matplotlib.patches.Polygon(xy, closed=True, **kwargs)
```

Bases: `matplotlib.patches.Patch`

A general polygon patch.

`xy` is a numpy array with shape `Nx2`.

If `closed` is `True`, the polygon will be closed so the starting and ending points are the same.

Valid kwargs are:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<i>alpha</i>		float or None
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i>		unknown
<i>capstyle</i>		{'butt', 'round', 'projecting'}
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>color</i>		color
<i>contains</i>		callable
<i>edgecolor</i> or <i>ec</i>		color or None or 'auto'
<i>facecolor</i> or <i>fc</i>		color or None
<i>figure</i>		<i>Figure</i>
<i>fill</i>		bool
<i>gid</i>		str
<i>hatch</i>		{'/', '\\', ' ', '-', '+', 'x', 'o', 'O', '.', '*'}
<i>in_layout</i>		bool
<i>joinstyle</i>		{'miter', 'round', 'bevel'}
<i>label</i>		object
<i>linestyle</i> or <i>ls</i>		{'-', '--', '-.', ':', '', (offset, on-off-seq), ...}
<i>linewidth</i> or <i>lw</i>		float or None
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		None or bool or float or callable
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>transform</i>		<i>Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>zorder</i>		float

`get_closed(self)`

Returns if the polygon is closed

**Returns**

**closed** [bool] If the path is closed

`get_path(self)`

Get the path of the polygon

**Returns**

**path** [*Path*] The *Path* object for the polygon

`get_xy(self)`

Get the vertices of the path.

**Returns**

**vertices** [(N, 2) numpy array] The coordinates of the vertices.

`set_closed(self, closed)`

Set if the polygon is closed

**Parameters**

**closed** [bool] True if the polygon is closed

`set_xy(self, xy)`  
Set the vertices of the polygon.

**Parameters**

**xy** [(N, 2) array-like] The coordinates of the vertices.

**xy**  
The vertices of the path as (N, 2) numpy array.

**Examples using `matplotlib.patches.Polygon`**

- sphx\_glr\_gallery\_statistics\_boxplot\_demo.py
- sphx\_glr\_gallery\_shapes\_and\_collections\_hatch\_demo.py
- sphx\_glr\_gallery\_shapes\_and\_collections\_patch\_collection.py
- sphx\_glr\_gallery\_showcase\_integral.py
- sphx\_glr\_gallery\_event\_handling\_poly\_editor.py
- sphx\_glr\_gallery\_event\_handling\_trifinder\_event\_demo.py
- *Annotations*

**`matplotlib.patches.Rectangle`**

`class matplotlib.patches.Rectangle(xy, width, height, angle=0.0, **kwargs)`

Bases: `matplotlib.patches.Patch`

A rectangle with lower left at `xy = (x, y)` with specified `width`, `height` and rotation `angle`.

**Parameters**

**xy** [(float, float)] The bottom and left rectangle coordinates

**width** [float] Rectangle width

**height** [float] Rectangle height

**angle** [float, optional] rotation in degrees anti-clockwise about `xy` (default is 0.0)

**fill** [bool, optional] Whether to fill the rectangle (default is True)

**Notes**

Valid kwargs are:

	Property	Description
<code>agg_filter</code>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<code>alpha</code>		float or None
<code>animated</code>		bool

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	Property	Description
<i>antialiased</i> or <i>aa</i>	unknown	
<i>capstyle</i>	{'butt', 'round', 'projecting'}	
<i>clip_box</i>	<i>Bbox</i>	
<i>clip_on</i>	bool	
<i>clip_path</i>	[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]	
<i>color</i>	color	
<i>contains</i>	callable	
<i>edgecolor</i> or <i>ec</i>	color or None or 'auto'	
<i>facecolor</i> or <i>fc</i>	color or None	
<i>figure</i>	<i>Figure</i>	
<i>fill</i>	bool	
<i>gid</i>	str	
<i>hatch</i>	{'/', '\', ' ', '-', '+', 'x', 'o', 'O', '.', '*'}	
<i>in_layout</i>	bool	
<i>joinstyle</i>	{'miter', 'round', 'bevel'}	
<i>label</i>	object	
<i>linestyle</i> or <i>ls</i>	{'-', '-', '-.', ':', "", (offset, on-off-seq), ...}	
<i>linewidth</i> or <i>lw</i>	float or None	
<i>path_effects</i>	<i>AbstractPathEffect</i>	
<i>picker</i>	None or bool or float or callable	
<i>rasterized</i>	bool or None	
<i>sketch_params</i>	(scale: float, length: float, randomness: float)	
<i>snap</i>	bool or None	
<i>transform</i>	<i>Transform</i>	
<i>url</i>	str	
<i>visible</i>	bool	
<i>zorder</i>	float	

`get_bbox(self)`

`get_height(self)`

Return the height of the rectangle.

`get_patch_transform(self)`

Return the *Transform* instance which takes patch coordinates to data coordinates.

For example, one may define a patch of a circle which represents a radius of 5 by providing coordinates for a unit circle, and a transform which scales the coordinates (the patch coordinate) by 5.

`get_path(self)`

Return the vertices of the rectangle.

`get_width(self)`

Return the width of the rectangle.

`get_x(self)`

Return the left coord of the rectangle.

`get_xy(self)`

Return the left and bottom coords of the rectangle.

`get_y(self)`  
Return the bottom coord of the rectangle.

`set_bounds(self, *args)`  
Set the bounds of the rectangle: l,b,w,h  
ACCEPTS: (left, bottom, width, height)

`set_height(self, h)`  
Set the height of the rectangle.

`set_width(self, w)`  
Set the width of the rectangle.

`set_x(self, x)`  
Set the left coord of the rectangle.

`set_xy(self, xy)`  
Set the left and bottom coords of the rectangle.

#### Parameters

**xy** [(float, float)]

`set_y(self, y)`  
Set the bottom coord of the rectangle.

**xy**  
Return the left and bottom coords of the rectangle.

#### Examples using `matplotlib.patches.Rectangle`

- `sphx_glr_gallery_statistics_errorbars_and_boxes.py`
- `sphx_glr_gallery_pyplots_text_layout.py`
- `sphx_glr_gallery_shapes_and_collections_artist_reference.py`
- `sphx_glr_gallery_event_handling_pick_event_demo.py`
- `sphx_glr_gallery_event_handling_viewlims.py`
- `sphx_glr_gallery_misc_anchored_artists.py`
- `sphx_glr_gallery_misc_logos2.py`
- `sphx_glr_gallery_units_artist_tests.py`
- `sphx_glr_gallery_widgets_menu.py`
- *Legend guide*
- *Transformations Tutorial*
- *Specifying Colors*
- *Text properties and layout*

#### `matplotlib.patches.RegularPolygon`

```
class matplotlib.patches.RegularPolygon(xy, numVertices, radius=5, orientation=0,
                                       **kwargs)
    Bases: matplotlib.patches.Patch
```

A regular polygon patch.

Constructor arguments:

**xy** A length 2 tuple (x, y) of the center.

**numVertices** the number of vertices.

**radius** The distance from the center to each of the vertices.

**orientation** rotates the polygon (in radians).

Valid kwargs are:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<i>alpha</i>		float or None
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i>		unknown
<i>capstyle</i>		{'butt', 'round', 'projecting'}
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>color</i>		color
<i>contains</i>		callable
<i>edgecolor</i> or <i>ec</i>		color or None or 'auto'
<i>facecolor</i> or <i>fc</i>		color or None
<i>figure</i>		<i>Figure</i>
<i>fill</i>		bool
<i>gid</i>		str
<i>hatch</i>		{'/', '\', ' ', '-.', '+', 'x', 'o', 'O', '.', '*'}
<i>in_layout</i>		bool
<i>joinstyle</i>		{'miter', 'round', 'bevel'}
<i>label</i>		object
<i>linestyle</i> or <i>ls</i>		{'-.', '-', '-.', ':', '', (offset, on-off-seq), ...}
<i>linewidth</i> or <i>lw</i>		float or None
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		None or bool or float or callable
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>transform</i>		<i>Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>zorder</i>		float

`get_patch_transform(self)`

Return the *Transform* instance which takes patch coordinates to data coordinates.

For example, one may define a patch of a circle which represents a radius of 5 by providing coordinates for a unit circle, and a transform which scales the coordinates (the patch coordinate) by 5.

`get_path(self)`

Return the path of this patch

numvertices  
 orientation  
 radius  
 xy

Examples using `matplotlib.patches.RegularPolygon`

- sphx\_glr\_gallery\_shapes\_and\_collections\_artist\_reference.py
- sphx\_glr\_gallery\_specialty\_plots\_radar\_chart.py

`matplotlib.patches.Shadow`

`class matplotlib.patches.Shadow(patch, ox, oy, props=None, **kwargs)`

Bases: `matplotlib.patches.Patch`

Create a shadow of the given *patch* offset by *ox*, *oy*. *props*, if not *None*, is a patch property update dictionary. If *None*, the shadow will have the same color as the face, but darkened.

kwargs are

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m,
<i>alpha</i>		float or None
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i>		unknown
<i>capstyle</i>		{'butt', 'round', 'projecting'}
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>color</i>		color
<i>contains</i>		callable
<i>edgecolor</i> or <i>ec</i>		color or None or 'auto'
<i>facecolor</i> or <i>fc</i>		color or None
<i>figure</i>		<i>Figure</i>
<i>fill</i>		bool
<i>gid</i>		str
<i>hatch</i>		{'/', '\\', ' ', '-.', '+', 'x', 'o', 'O', ':', '*'}
<i>in_layout</i>		bool
<i>joinstyle</i>		{'miter', 'round', 'bevel'}
<i>label</i>		object
<i>linestyle</i> or <i>ls</i>		{'-', '-.', '-.:', ':', '', (offset, on-off-seq), ...}
<i>linewidth</i> or <i>lw</i>		float or None
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		None or bool or float or callable
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None

Continued on next page

Table 161 – continued from previous page

	Property	Description
<i>transform</i>	<i>Transform</i>	
<i>url</i>	str	
<i>visible</i>	bool	
<i>zorder</i>	float	

`draw(self, renderer)`

Draw the *Patch* to the given *renderer*.

`get_patch_transform(self)`

Return the *Transform* instance which takes patch coordinates to data coordinates.

For example, one may define a patch of a circle which represents a radius of 5 by providing coordinates for a unit circle, and a transform which scales the coordinates (the patch coordinate) by 5.

`get_path(self)`

Return the path of this patch

#### Examples using `matplotlib.patches.Shadow`

- `sphx_glr_gallery_text_labels_and_annotations_demo_text_path.py`
- `sphx_glr_gallery_misc_svg_filter_pie.py`

#### `matplotlib.patches.Wedge`

`class matplotlib.patches.Wedge(center, r, theta1, theta2, width=None, **kwargs)`

Bases: `matplotlib.patches.Patch`

Wedge shaped patch.

A wedge centered at *x*, *y* center with radius *r* that sweeps *theta1* to *theta2* (in degrees). If *width* is given, then a partial wedge is drawn from inner radius *r* - *width* to outer radius *r*.

Valid kwargs are:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<i>alpha</i>		float or None
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i>		unknown
<i>capstyle</i>		{'butt', 'round', 'projecting'}
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>color</i>		color
<i>contains</i>		callable
<i>edgecolor</i> or <i>ec</i>		color or None or 'auto'
<i>facecolor</i> or <i>fc</i>		color or None

Continued on next page

Table 162 – continued from previous page

	Property	Description
<i>figure</i>		<i>Figure</i>
<i>fill</i>		bool
<i>gid</i>		str
<i>hatch</i>		{ '/', '\', ' ', '-.', '+', 'x', 'o', 'O', '.', '*' }
<i>in_layout</i>		bool
<i>joinstyle</i>		{ 'miter', 'round', 'bevel' }
<i>label</i>		object
<i>linestyle</i> or <i>ls</i>		{ '-', '-.', '-.-', ':', ' ', (offset, on-off-seq), ... }
<i>linewidth</i> or <i>lw</i>		float or None
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		None or bool or float or callable
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>transform</i>		<i>Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>zorder</i>		float

```

get_path(self)
    Return the path of this patch

set_center(self, center)

set_radius(self, radius)

set_theta1(self, theta1)

set_theta2(self, theta2)

set_width(self, width)

```

#### Examples using `matplotlib.patches.Wedge`

- `sphx_glr_gallery_shapes_and_collections_artist_reference.py`
- `sphx_glr_gallery_shapes_and_collections_patch_collection.py`

#### `matplotlib.patches.YAArrow`

```
class matplotlib.patches.YAArrow(**kwargs)
```

Bases: `matplotlib.patches.Patch`

[*Deprecated*] Yet another arrow class.

This is an arrow that is defined in display space and has a tip at  $x_1, y_1$  and a base at  $x_2, y_2$ .

## Notes

Deprecated since version 3.0.

`get_patch_transform(self)`

Return the *Transform* instance which takes patch coordinates to data coordinates.

For example, one may define a patch of a circle which represents a radius of 5 by providing coordinates for a unit circle, and a transform which scales the coordinates (the patch coordinate) by 5.

`get_path(self)`

Return the path of this patch

`getpoints(self, x1, y1, x2, y2, k)`

For line segment defined by  $(x1, y1)$  and  $(x2, y2)$  return the points on the line that is perpendicular to the line and intersects  $(x2, y2)$  and the distance from  $(x2, y2)$  of the returned points is  $k$ .

## 17.34.2 Functions

`bbox_artist(artist, renderer[, props, fill])`

This is a debug function to draw a rectangle around the bounding box returned by `get_window_extent()` of an artist, to test whether the artist is returning the correct bbox.

`draw_bbox(bbox, renderer[, color, trans])`

This is a debug function to draw a rectangle around the bounding box returned by `get_window_extent()` of an artist, to test whether the artist is returning the correct bbox.

### matplotlib.patches.bbox\_artist

`matplotlib.patches.bbox_artist(artist, renderer, props=None, fill=True)`

This is a debug function to draw a rectangle around the bounding box returned by `get_window_extent()` of an artist, to test whether the artist is returning the correct bbox.

`props` is a dict of rectangle props with the additional property 'pad' that sets the padding around the bbox in points.

### matplotlib.patches.draw\_bbox

`matplotlib.patches.draw_bbox(bbox, renderer, color='k', trans=None)`

This is a debug function to draw a rectangle around the bounding box returned by `get_window_extent()` of an artist, to test whether the artist is returning the correct bbox.

## 17.35 matplotlib.path

A module for dealing with the polylines used throughout Matplotlib.

The primary class for polyline handling in Matplotlib is *Path*. Almost all vector drawing makes use of *Paths* somewhere in the drawing pipeline.

Whilst a *Path* instance itself cannot be drawn, some *Artist* subclasses, such as *PathPatch* and *PathCollection*, can be used for convenient *Path* visualisation.

```
class matplotlib.path.Path(vertices, codes=None, _interpolation_steps=1,
                           closed=False, readonly=False)
```

Bases: `object`

*Path* represents a series of possibly disconnected, possibly closed, line and curve segments.

### The underlying storage is made up of two parallel numpy arrays:

- *vertices*: an Nx2 float array of vertices
- *codes*: an N-length uint8 array of vertex types

These two arrays always have the same length in the first dimension. For example, to represent a cubic curve, you must provide three vertices as well as three codes CURVE3.

The code types are:

- STOP [1 vertex (ignored)] A marker for the end of the entire path (currently not required and ignored)
- MOVETO [1 vertex] Pick up the pen and move to the given vertex.
- LINETO [1 vertex] Draw a line from the current position to the given vertex.
- CURVE3 [1 control point, 1 endpoint] Draw a quadratic Bezier curve from the current position, with the given control point, to the given end point.
- CURVE4 [2 control points, 1 endpoint] Draw a cubic Bezier curve from the current position, with the given control points, to the given end point.
- CLOSEPOLY [1 vertex (ignored)] Draw a line segment to the start point of the current polyline.

Users of *Path* objects should not access the *vertices* and *codes* arrays directly. Instead, they should use *iter\_segments()* or *cleaned()* to get the vertex/code pairs. This is important, since many *Path* objects, as an optimization, do not store a *codes* at all, but have a default one provided for them by *iter\_segments()*.

Some behavior of *Path* objects can be controlled by rcParams. See the rcParams whose keys contain 'path.'

---

**Note:** The *vertices* and *codes* arrays should be treated as immutable - there are a number of optimizations and assumptions made up front in the constructor that will not change when the data changes.

---

Create a new path with the given vertices and codes.

#### Parameters

**vertices** [array\_like] The (n, 2) float array, masked array or sequence of pairs representing the vertices of the path.

If *vertices* contains masked values, they will be converted to NaNs which are then handled correctly by the Agg PathIterator and other consumers of path data, such as *iter\_segments()*.

**codes** [{None, array\_like}, optional] n-length array integers representing the codes of the path. If not None, codes must be the same length as vertices. If None, *vertices* will be treated as a series of line segments.

**\_interpolation\_steps** [int, optional] Used as a hint to certain projections, such as Polar, that this path should be linearly interpolated immediately before drawing. This attribute is primarily an implementation detail and is not intended for public use.

**closed** [bool, optional] If *codes* is None and closed is True, vertices will be treated as line segments of a closed polygon.

**readonly** [bool, optional] Makes the path behave in an immutable way and sets the vertices and codes as read-only arrays.

CLOSEPOLY = 79

CURVE3 = 3

CURVE4 = 4

LINETO = 2

MOVETO = 1

NUM\_VERTICES\_FOR\_CODE = {0: 1, 1: 1, 2: 1, 3: 2, 4: 3, 79: 1}

A dictionary mapping Path codes to the number of vertices that the code expects.

STOP = 0

classmethod `arc(theta1, theta2, n=None, is_wedge=False)`

Return the unit circle arc from angles *theta1* to *theta2* (in degrees).

*theta2* is unwrapped to produce the shortest arc within 360 degrees. That is, if *theta2* > *theta1* + 360, the arc will be from *theta1* to *theta2* - 360 and not a full circle plus some extra overlap.

If *n* is provided, it is the number of spline segments to make. If *n* is not provided, the number of spline segments is determined based on the delta between *theta1* and *theta2*.

Masionobe, L. 2003. [Drawing an elliptical arc using polylines, quadratic or cubic Bezier curves.](#)

classmethod `circle(center=(0.0, 0.0), radius=1.0, readonly=False)`

Return a *Path* representing a circle of a given radius and center.

### Parameters

**center** [pair of floats] The center of the circle. Default (0, 0).

**radius** [float] The radius of the circle. Default is 1.

**readonly** [bool] Whether the created path should have the "readonly" argument set when creating the Path instance.

### Notes

The circle is approximated using 8 cubic Bezier curves, as described in

Lancaster, Don. [Approximating a Circle or an Ellipse Using Four Bezier Cubic Splines.](#)

`cleaned(self, transform=None, remove_nans=False, clip=None, quantize=False, simplify=False, curves=False, stroke_width=1.0, snap=False, sketch=None)`

Return a new `Path` with vertices and codes cleaned according to the parameters.

**See also:**

`Path.iter_segments` for details of the keyword arguments.

`clip_to_bbox(self, bbox, inside=True)`

Clip the path to the given bounding box.

The path must be made up of one or more closed polygons. This algorithm will not behave correctly for unclosed paths.

If `inside` is `True`, clip to the inside of the box, otherwise to the outside of the box.

`code_type`

alias of `numpy.uint8`

`codes`

The list of codes in the `Path` as a 1-D numpy array. Each code is one of `STOP`, `MOVETO`, `LINETO`, `CURVE3`, `CURVE4` or `CLOSEPOLY`. For codes that correspond to more than one vertex (`CURVE3` and `CURVE4`), that code will be repeated so that the length of `self.vertices` and `self.codes` is always the same.

`contains_path(self, path, transform=None)`

Returns whether this (closed) path completely contains the given path.

If `transform` is not `None`, the path will be transformed before performing the test.

`contains_point(self, point, transform=None, radius=0.0)`

Returns whether the (closed) path contains the given point.

If `transform` is not `None`, the path will be transformed before performing the test.

`radius` allows the path to be made slightly larger or smaller.

`contains_points(self, points, transform=None, radius=0.0)`

Returns a bool array which is `True` if the (closed) path contains the corresponding point.

If `transform` is not `None`, the path will be transformed before performing the test.

`radius` allows the path to be made slightly larger or smaller.

`copy(self)`

Returns a shallow copy of the `Path`, which will share the vertices and codes with the source `Path`.

`deepcopy(self, memo=None)`

Returns a deepcopy of the `Path`. The `Path` will not be readonly, even if the source `Path` is.

`get_extents(self, transform=None)`

Returns the extents (`xmin`, `ymin`, `xmax`, `ymax`) of the path.

Unlike computing the extents on the `vertices` alone, this algorithm will take into account the curves and deal with control points appropriately.

`has_nonfinite`

`hatch(hatchpattern, density=6)`

Given a hatch specifier, *hatchpattern*, generates a Path that can be used in a repeated hatching pattern. *density* is the number of lines per unit square.

`interpolated(self, steps)`

Returns a new path resampled to length  $N \times \text{steps}$ . Does not currently handle interpolating curves.

`intersects_bbox(self, bbox, filled=True)`

Returns *True* if this path intersects a given *Bbox*.

*filled*, when *True*, treats the path as if it was filled. That is, if the path completely encloses the bounding box, *intersects\_bbox()* will return *True*.

The bounding box is always considered filled.

`intersects_path(self, other, filled=True)`

Returns *True* if this path intersects another given path.

*filled*, when *True*, treats the paths as if they were filled. That is, if one path completely encloses the other, *intersects\_path()* will return *True*.

`iter_segments(self, transform=None, remove_nans=True, clip=None, snap=False, stroke_width=1.0, simplify=None, curves=True, sketch=None)`

Iterates over all of the curve segments in the path. Each iteration returns a 2-tuple (vertices, code), where vertices is a sequence of 1-3 coordinate pairs, and code is a *Path* code.

Additionally, this method can provide a number of standard cleanups and conversions to the path.

### Parameters

**transform** [None or *Transform*] If not *None*, the given affine transformation will be applied to the path.

**remove\_nans** [bool, optional] Whether to remove all NaNs from the path and skip over them using MOVETO commands.

**clip** [None or (float, float, float, float), optional] If not *None*, must be a four-tuple (x1, y1, x2, y2) defining a rectangle in which to clip the path.

**snap** [None or bool, optional] If *True*, snap all nodes to pixels; if *False*, don't snap them. If *None*, perform snapping if the path contains only segments parallel to the x or y axes, and no more than 1024 of them.

**stroke\_width** [float, optional] The width of the stroke being drawn (used for path snapping).

**simplify** [None or bool, optional] Whether to simplify the path by removing vertices that do not affect its appearance. If *None*, use the *should\_simplify* attribute. See also `rcParams["path.simplify"]` and `rcParams["path.simplify_threshold"]`.

**curves** [bool, optional] If *True*, curve segments will be returned as curve segments. If *False*, all curves will be converted to line segments.

**sketch** [None or sequence, optional] If not *None*, must be a 3-tuple of the form (scale, length, randomness), representing the sketch

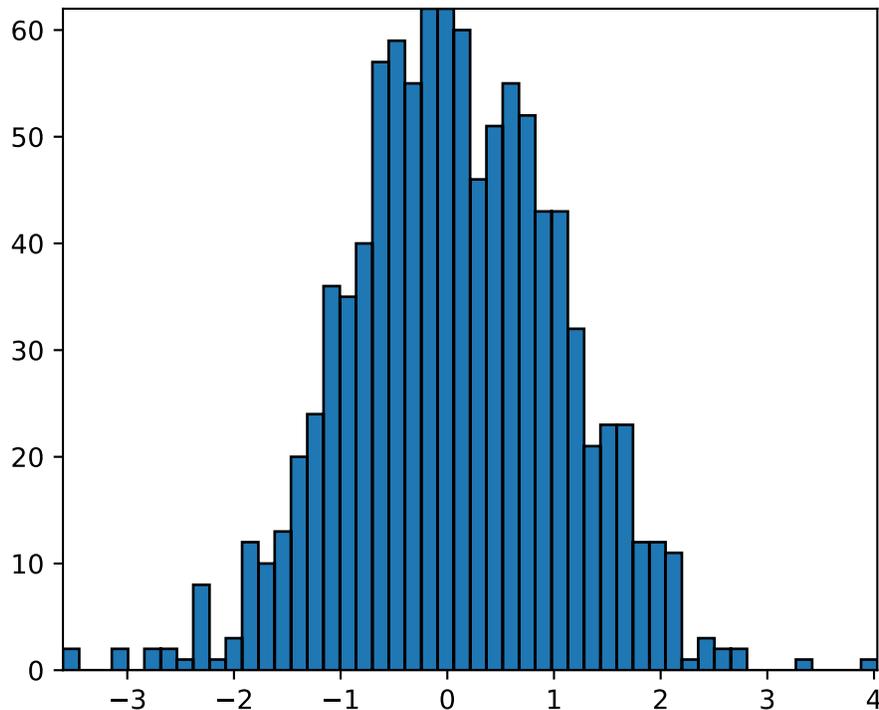
parameters.

`classmethod make_compound_path(*args)`

Make a compound path from a list of Path objects.

`classmethod make_compound_path_from_polys(XY)`

Make a compound path object to draw a number of polygons with equal numbers of sides XY is a (numpolys x numsides x 2) numpy array of vertices. Return object is a *Path*



`readonly`

`True` if the *Path* is read-only.

`should_simplify`

`True` if the vertices array should be simplified.

`simplify_threshold`

The fraction of a pixel difference below which vertices will be simplified out.

`to_polygons(self, transform=None, width=0, height=0, closed_only=True)`

Convert this path to a list of polygons or polylines. Each polygon/polyline is an Nx2 array of vertices. In other words, each polygon has no MOVETO instructions or curves. This is useful for displaying in backends that do not support compound paths or Bezier curves.

If *width* and *height* are both non-zero then the lines will be simplified so that vertices outside of (0, 0), (width, height) will be clipped.

If *closed\_only* is `True` (default), only closed polygons, with the last point being the same as the first point, will be returned. Any unclosed polylines in the path will be

explicitly closed. If *closed\_only* is `False`, any unclosed polygons in the path will be returned as unclosed polygons, and the closed polygons will be returned explicitly closed by setting the last point to the same as the first point.

`transformed(self, transform)`

Return a transformed copy of the path.

**See also:**

`matplotlib.transforms.TransformPath` A specialized path class that will cache the transformed result and automatically update when the transform changes.

`classmethod unit_circle()`

Return the readonly *Path* of the unit circle.

For most cases, `Path.circle()` will be what you want.

`classmethod unit_circle_righthalf()`

Return a *Path* of the right half of a unit circle.

See `Path.circle` for the reference on the approximation used.

`classmethod unit_rectangle()`

Return a *Path* instance of the unit rectangle from (0, 0) to (1, 1).

`classmethod unit_regular_asterisk(numVertices)`

Return a *Path* for a unit regular asterisk with the given *numVertices* and radius of 1.0, centered at (0, 0).

`classmethod unit_regular_polygon(numVertices)`

Return a *Path* instance for a unit regular polygon with the given *numVertices* and radius of 1.0, centered at (0, 0).

`classmethod unit_regular_star(numVertices, innerCircle=0.5)`

Return a *Path* for a unit regular star with the given *numVertices* and radius of 1.0, centered at (0, 0).

`vertices`

The list of vertices in the *Path* as an Nx2 numpy array.

`classmethod wedge(theta1, theta2, n=None)`

Return the unit circle wedge from angles *theta1* to *theta2* (in degrees).

*theta2* is unwrapped to produce the shortest wedge within 360 degrees. That is, if *theta2* > *theta1* + 360, the wedge will be from *theta1* to *theta2* - 360 and not a full circle plus some extra overlap.

If *n* is provided, it is the number of spline segments to make. If *n* is not provided, the number of spline segments is determined based on the delta between *theta1* and *theta2*.

See `Path.arc` for the reference on the approximation used.

`matplotlib.path.get_path_collection_extents(master_transform, paths, transforms, offsets, offset_transform)`

Given a sequence of *Paths*, *Transforms* objects, and offsets, as found in a *PathCollection*, returns the bounding box that encapsulates all of them.

**Parameters**

**master\_transform** [*Transform*] Global transformation applied to all paths.

**paths** [list of *Path*]

**transform** [list of *Affine2D*]

**offsets** [(N, 2) array-like]

**offset\_transform** [*Affine2D*] Transform applied to the offsets before offsetting the path.

#### Notes

The way that *paths*, *transforms* and *offsets* are combined follows the same method as for collections: Each is iterated over independently, so if you have 3 paths, 2 transforms and 1 offset, their combinations are as follows:

(A, A, A), (B, B, A), (C, A, A)

`matplotlib.path.get_paths_extents(paths, transforms=[])`

[*Deprecated*] Given a sequence of *Path* objects and optional *Transform* objects, returns the bounding box that encapsulates all of them.

*paths* is a sequence of *Path* instances.

*transforms* is an optional sequence of *Affine2D* instances to apply to each path.

#### Notes

Deprecated since version 3.1.

## 17.36 matplotlib.patheffects

Defines classes for path effects. The path effects are supported in *Text*, *Line2D* and *Patch*.

`class matplotlib.patheffects.AbstractPathEffect(offset=(0.0, 0.0))`

Bases: `object`

A base class for path effects.

Subclasses should override the `draw_path` method to add effect functionality.

#### Parameters

**offset** [pair of floats] The offset to apply to the path, measured in points.

`draw_path(self, renderer, gc, tpath, affine, rgbFace=None)`

Derived should override this method. The arguments are the same as `matplotlib.backend_bases.RendererBase.draw_path()` except the first argument is a renderer.

`class matplotlib.patheffects.Normal(offset=(0.0, 0.0))`

Bases: `matplotlib.patheffects.AbstractPathEffect`

The "identity" *PathEffect*.

The *Normal PathEffect*'s sole purpose is to draw the original artist with no special path effect.

#### Parameters

**offset** [pair of floats] The offset to apply to the path, measured in points.

```
class matplotlib.patheffects.PathEffectRenderer(path_effects, renderer)
```

Bases: `matplotlib.backend_bases.RendererBase`

Implements a `Renderer` which contains another `renderer`.

This proxy then intercepts draw calls, calling the appropriate `AbstractPathEffect` draw method.

---

**Note:** Not all methods have been overridden on this `RendererBase` subclass. It may be necessary to add further methods to extend the `PathEffects` capabilities further.

---

### Parameters

**path\_effects** [iterable of `AbstractPathEffect`] The path effects which this `renderer` represents.

**renderer** [`matplotlib.backend_bases.RendererBase` instance]

```
copy_with_path_effect(self, path_effects)
```

```
draw_markers(self, gc, marker_path, marker_trans, path, *args, **kwargs)
```

Draws a marker at each of the vertices in `path`. This includes all vertices, including control points on curves. To avoid that behavior, those vertices should be removed before calling this function.

This provides a fallback implementation of `draw_markers` that makes multiple calls to `draw_path()`. Some backends may want to override this method in order to draw the marker only once and reuse it multiple times.

### Parameters

**gc** [`GraphicsContextBase`] The graphics context

**marker\_trans** [`matplotlib.transforms.Transform`] An affine transform applied to the marker.

**trans** [`matplotlib.transforms.Transform`] An affine transform applied to the path.

```
draw_path(self, gc, tpath, affine, rgbFace=None)
```

Draws a `Path` instance using the given affine transform.

```
draw_path_collection(self, gc, master_transform, paths, *args, **kwargs)
```

Draws a collection of paths selecting drawing properties from the lists `facecolors`, `edgecolors`, `linewidths`, `linestyles` and `antialiaseds`. `offsets` is a list of offsets to apply to each of the paths. The offsets in `offsets` are first transformed by `offsetTrans` before being applied. `offset_position` may be either "screen" or "data" depending on the space that the offsets are in.

This provides a fallback implementation of `draw_path_collection()` that makes multiple calls to `draw_path()`. Some backends may want to override this in order to render each set of path data only once, and then reference that path multiple times with the different offsets, colors, styles etc. The generator methods `_iter_collection_raw_paths()` and `_iter_collection()` are provided to help with (and standardize) the implementation across backends. It is highly recommended to use those generators, so that changes to the behavior of `draw_path_collection()` can be made globally.

`new_gc(self)`

Return an instance of a GraphicsContextBase.

`points_to_pixels(self, points)`

Convert points to display units.

You need to override this function (unless your backend doesn't have a dpi, e.g., postscript or svg). Some imaging systems assume some value for pixels per inch:

```
points to pixels = points * pixels_per_inch/72.0 * dpi/72.0
```

### Parameters

**points** [scalar or array\_like] a float or a numpy array of float

### Returns

**Points converted to pixels**

`class matplotlib.patheffects.PathPatchEffect(offset=(0, 0), **kwargs)`

Bases: `matplotlib.patheffects.AbstractPathEffect`

Draws a `PathPatch` instance whose `Path` comes from the original `PathEffect` artist.

### Parameters

**offset** [pair of floats] The offset to apply to the path, in points.

**\*\*kwargs** All keyword arguments are passed through to the `PathPatch` constructor. The properties which cannot be overridden are "path", "clip\_box" "transform" and "clip\_path".

`draw_path(self, renderer, gc, tpath, affine, rgbFace)`

Derived should override this method. The arguments are the same as `matplotlib.backend_bases.RendererBase.draw_path()` except the first argument is a renderer.

`class matplotlib.patheffects.SimpleLineShadow(offset=(2, -2), shadow_color='k', alpha=0.3, rho=0.3, **kwargs)`

Bases: `matplotlib.patheffects.AbstractPathEffect`

A simple shadow via a line.

### Parameters

**offset** [pair of floats] The offset to apply to the path, in points.

**shadow\_color** [color] The shadow color. Default is black. A value of `None` takes the original artist's color with a scale factor of `rho`.

**alpha** [float] The alpha transparency of the created shadow patch. Default is 0.3.

**rho** [float] A scale factor to apply to the `rgbFace` color if `shadow_rgbFace` is `None`. Default is 0.3.

**\*\*kwargs** Extra keywords are stored and passed through to `AbstractPathEffect._update_gc()`.

`draw_path(self, renderer, gc, tpath, affine, rgbFace)`

Overrides the standard `draw_path` to add the shadow offset and necessary color changes for the shadow.

```
class matplotlib.patheffects.SimplePatchShadow(offset=(2, -2), shadow_rgbFace=None,
                                              alpha=None, rho=0.3, **kwargs)
```

Bases: *matplotlib.patheffects.AbstractPathEffect*

A simple shadow via a filled patch.

### Parameters

**offset** [pair of floats] The offset of the shadow in points.

**shadow\_rgbFace** [color] The shadow color.

**alpha** [float] The alpha transparency of the created shadow patch. Default is 0.3. <http://matplotlib.1069221.n5.nabble.com/path-effects-question-td27630.html>

**rho** [float] A scale factor to apply to the rgbFace color if shadow\_rgbFace is not specified. Default is 0.3.

**\*\*kwargs** Extra keywords are stored and passed through to `AbstractPathEffect._update_gc()`.

```
draw_path(self, renderer, gc, tpath, affine, rgbFace)
```

Overrides the standard `draw_path` to add the shadow offset and necessary color changes for the shadow.

```
class matplotlib.patheffects.Stroke(offset=(0, 0), **kwargs)
```

Bases: *matplotlib.patheffects.AbstractPathEffect*

A line based PathEffect which re-draws a stroke.

The path will be stroked with its gc updated with the given keyword arguments, i.e., the keyword arguments should be valid gc parameter values.

```
draw_path(self, renderer, gc, tpath, affine, rgbFace)
```

draw the path with updated gc.

```
class matplotlib.patheffects.withSimplePatchShadow(offset=(2, -2),
                                                  shadow_rgbFace=None,
                                                  alpha=None, rho=0.3, **kwargs)
```

Bases: *matplotlib.patheffects.SimplePatchShadow*

Adds a simple *SimplePatchShadow* and then draws the original Artist to avoid needing to call *Normal*.

### Parameters

**offset** [pair of floats] The offset of the shadow in points.

**shadow\_rgbFace** [color] The shadow color.

**alpha** [float] The alpha transparency of the created shadow patch. Default is 0.3. <http://matplotlib.1069221.n5.nabble.com/path-effects-question-td27630.html>

**rho** [float] A scale factor to apply to the rgbFace color if shadow\_rgbFace is not specified. Default is 0.3.

**\*\*kwargs** Extra keywords are stored and passed through to `AbstractPathEffect._update_gc()`.

```
draw_path(self, renderer, gc, tpath, affine, rgbFace)
```

Overrides the standard `draw_path` to add the shadow offset and necessary color changes for the shadow.

`class matplotlib.patheffects.withStroke(offset=(0, 0), **kwargs)`

Bases: `matplotlib.patheffects.Stroke`

Adds a simple *Stroke* and then draws the original Artist to avoid needing to call *Normal*.

The path will be stroked with its gc updated with the given keyword arguments, i.e., the keyword arguments should be valid gc parameter values.

`draw_path(self, renderer, gc, tpath, affine, rgbFace)`

draw the path with updated gc.

## 17.37 matplotlib.pyplot

### 17.37.1 Pyplot function overview

*pyplot*

*matplotlib.pyplot* is a state-based interface to matplotlib.

---

#### matplotlib.pyplot

*matplotlib.pyplot* is a state-based interface to matplotlib. It provides a MATLAB-like way of plotting.

pyplot is mainly intended for interactive plots and simple cases of programmatic plot generation:

```
import numpy as np
import matplotlib.pyplot as plt

x = np.arange(0, 5, 0.1)
y = np.sin(x)
plt.plot(x, y)
```

The object-oriented API is recommended for more complex plots.

#### Functions

<code>acorr(x, [*], data)</code>	Plot the autocorrelation of <i>x</i> .
<code>angle_spectrum(x[, Fs, Fc, window, pad_to, ...])</code>	Plot the angle spectrum.
<code>annotate(s, xy, [*args, **kwargs])</code>	Annotate the point <i>xy</i> with text <i>text</i> .
<code>arrow(x, y, dx, dy, **kwargs)</code>	Add an arrow to the axes.
<code>autoscale([enable, axis, tight])</code>	Autoscale the axis view to the data (toggle).
<code>autumn()</code>	Set the colormap to "autumn".
<code>axes([arg])</code>	Add an axes to the current figure and make it the current axes.
<code>axhline([y, xmin, xmax])</code>	Add a horizontal line across the axis.
<code>axhspan(ymin, ymax[, xmin, xmax])</code>	Add a horizontal span (rectangle) across the axis.

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<code>axis(*args, **kwargs)</code>	Convenience method to get or set some axis properties.
<code>axvline([x, ymin, ymax])</code>	Add a vertical line across the axes.
<code>axvspan(xmin, xmax[, ymin, ymax])</code>	Add a vertical span (rectangle) across the axes.
<code>bar(x, height[, width, bottom, align, data])</code>	Make a bar plot.
<code>barbs(*args[, data])</code>	Plot a 2D field of barbs.
<code>barh(y, width[, height, left, align])</code>	Make a horizontal bar plot.
<code>bone()</code>	Set the colormap to "bone".
<code>box([on])</code>	Turn the axes box on or off on the current axes.
<code>boxplot(x[, notch, sym, vert, whis, ...])</code>	Make a box and whisker plot.
<code>broken_barh(xranges, yrange, *[, data])</code>	Plot a horizontal sequence of rectangles.
<code>cla()</code>	Clear the current axes.
<code>clabel(CS, *args, **kwargs)</code>	Label a contour plot.
<code>clf()</code>	Clear the current figure.
<code>clim([vmin, vmax])</code>	Set the color limits of the current image.
<code>close([fig])</code>	Close a figure window.
<code>cohere(x, y[, NFFT, Fs, Fc, detrend, ...])</code>	Plot the coherence between x and y.
<code>colorbar([mappable, cax, ax])</code>	Add a colorbar to a plot.
<code>connect(s, func)</code>	Connect event with string <i>s</i> to <i>func</i> .
<code>contour(*args[, data])</code>	Plot contours.
<code>contourf(*args[, data])</code>	Plot contours.
<code>cool()</code>	Set the colormap to "cool".
<code>copper()</code>	Set the colormap to "copper".
<code>csd(x, y[, NFFT, Fs, Fc, detrend, window, ...])</code>	Plot the cross-spectral density.
<code>delaxes([ax])</code>	Remove the Axes <i>ax</i> (defaulting to the current axes) from its figure.
<code>disconnect(cid)</code>	Disconnect callback id <i>cid</i>
<code>draw()</code>	Redraw the current figure.
<code>errorbar(x, y[, yerr, xerr, fmt, ecolor, ...])</code>	Plot y versus x as lines and/or markers with attached errorbars.
<code>eventplot(positions[, orientation, ...])</code>	Plot identical parallel lines at the given positions.
<code>figimage(*args, **kwargs)</code>	Add a non-resampled image to the figure.
<code>figlegend(*args, **kwargs)</code>	Place a legend on the figure.
<code>fignum_exists(num)</code>	Return whether the figure with the given id exists.
<code>figtext(x, y, s, *args, **kwargs)</code>	Add text to figure.
<code>figure([num, figsize, dpi, facecolor, ...])</code>	Create a new figure.
<code>fill(*args[, data])</code>	Plot filled polygons.
<code>fill_between(x, y1[, y2, where, ...])</code>	Fill the area between two horizontal curves.
<code>fill_betweenx(y, x1[, x2, where, step, ...])</code>	Fill the area between two vertical curves.
<code>findobj([o, match, include_self])</code>	Find artist objects.
<code>flag()</code>	Set the colormap to "flag".
<code>gca(**kwargs)</code>	Get the current <i>Axes</i> instance on the current figure matching the given keyword args, or create one.
<code>gcf()</code>	Get the current figure.
<code>gci()</code>	Get the current colorable artist.

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<code>get_current_fig_manager()</code>	Return the figure manager of the current figure.
<code>get_figlabels()</code>	Return a list of existing figure labels.
<code>get_fignums()</code>	Return a list of existing figure numbers.
<code>get_plot_commands()</code>	Get a sorted list of all of the plotting commands.
<code>ginput(\*args, \*\*kwargs)</code>	Blocking call to interact with a figure.
<code>gray()</code>	Set the colormap to "gray".
<code>grid([b, which, axis])</code>	Configure the grid lines.
<code>hexbin(x, y[, C, gridsize, bins, xscale, ...])</code>	Make a hexagonal binning plot.
<code>hist(x[, bins, range, density, weights, ...])</code>	Plot a histogram.
<code>hist2d(x, y[, bins, range, density, ...])</code>	Make a 2D histogram plot.
<code>hlines(y, xmin, xmax[, colors, linestyle, ...])</code>	Plot horizontal lines at each <i>y</i> from <i>xmin</i> to <i>xmax</i> .
<code>hot()</code>	Set the colormap to "hot".
<code>hsv()</code>	Set the colormap to "hsv".
<code>imread(fname[, format])</code>	Read an image from a file into an array.
<code>imsave(fname, arr, \*\*kwargs)</code>	Save an array as an image file.
<code>imshow(X[, cmap, norm, aspect, ...])</code>	Display an image, i.e.
<code>inferno()</code>	Set the colormap to "inferno".
<code>install_repl_displayhook()</code>	Install a repl display hook so that any stale figure are automatically redrawn when control is returned to the repl.
<code>ioff()</code>	Turn the interactive mode off.
<code>ion()</code>	Turn the interactive mode on.
<code>isinteractive()</code>	Return the status of interactive mode.
<code>jet()</code>	Set the colormap to "jet".
<code>legend(\*args, \*\*kwargs)</code>	Place a legend on the axes.
<code>locator_params([axis, tight])</code>	Control behavior of major tick locators.
<code>loglog(\*args, \*\*kwargs)</code>	Make a plot with log scaling on both the <i>x</i> and <i>y</i> axis.
<code>magma()</code>	Set the colormap to "magma".
<code>magnitude_spectrum(x[, Fs, Fc, window, ...])</code>	Plot the magnitude spectrum.
<code>margins(\*margins[, x, y, tight])</code>	Set or retrieve autoscaling margins.
<code>matshow(A[, fignum])</code>	Display an array as a matrix in a new figure window.
<code>minorticks_off()</code>	Remove minor ticks from the axes.
<code>minorticks_on()</code>	Display minor ticks on the axes.
<code>nipy_spectral()</code>	Set the colormap to "nipy_spectral".
<code>pause(interval)</code>	Pause for <i>interval</i> seconds.
<code>pcolor(\*args[, alpha, norm, cmap, vmin, ...])</code>	Create a pseudocolor plot with a non-regular rectangular grid.
<code>pcolormesh(\*args[, alpha, norm, cmap, ...])</code>	Create a pseudocolor plot with a non-regular rectangular grid.
<code>phase_spectrum(x[, Fs, Fc, window, pad_to, ...])</code>	Plot the phase spectrum.
<code>pie(x[, explode, labels, colors, autopct, ...])</code>	Plot a pie chart.
<code>pink()</code>	Set the colormap to "pink".
<code>plasma()</code>	Set the colormap to "plasma".
<code>plot(\*args[, scalex, scaley, data])</code>	Plot <i>y</i> versus <i>x</i> as lines and/or markers.
<code>plot_date(x, y[, fmt, tz, xdate, ydate, data])</code>	Plot data that contains dates.

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<code>plotfile(fname[, cols, plotfuncs, comments, ...])</code>	Plot the data in a file.
<code>polar(*args, **kwargs)</code>	Make a polar plot.
<code>prism()</code>	Set the colormap to "prism".
<code>psd(x[, NFFT, Fs, Fc, detrend, window, ...])</code>	Plot the power spectral density.
<code>quiver(*args[, data])</code>	Plot a 2D field of arrows.
<code>quiverkey(Q, X, Y, U, label, **kw)</code>	Add a key to a quiver plot.
<code>rc(group, **kwargs)</code>	Set the current rc params.
<code>rc_context([rc, fname])</code>	Return a context manager for managing rc settings.
<code>rcdefaults()</code>	Restore the rc params from Matplotlib's internal default style.
<code>rgrids(*args, **kwargs)</code>	Get or set the radial gridlines on the current polar plot.
<code>savefig(*args, **kwargs)</code>	Save the current figure.
<code>sca(ax)</code>	Set the current Axes instance to <i>ax</i> .
<code>scatter(x, y[, s, c, marker, cmap, norm, ...])</code>	A scatter plot of <i>y</i> vs <i>x</i> with varying marker size and/or color.
<code>sci(im)</code>	Set the current image.
<code>semilogx(*args, **kwargs)</code>	Make a plot with log scaling on the x axis.
<code>semilogy(*args, **kwargs)</code>	Make a plot with log scaling on the y axis.
<code>set_cmap(cmap)</code>	Set the default colormap.
<code>setp(obj, *args, **kwargs)</code>	Set a property on an artist object.
<code>show(*args, **kw)</code>	Display a figure.
<code>specgram(x[, NFFT, Fs, Fc, detrend, window, ...])</code>	Plot a spectrogram.
<code>spring()</code>	Set the colormap to "spring".
<code>spy(Z[, precision, marker, markersize, ...])</code>	Plot the sparsity pattern of a 2D array.
<code>stackplot(x, *args[, labels, colors, ...])</code>	Draw a stacked area plot.
<code>stem(*args[, linefmt, markerfmt, basefmt, ...])</code>	Create a stem plot.
<code>step(x, y, *args[, where, data])</code>	Make a step plot.
<code>streamplot(x, y, u, v[, density, linewidth, ...])</code>	Draw streamlines of a vector flow.
<code>subplot(*args, **kwargs)</code>	Add a subplot to the current figure.
<code>subplot2grid(shape, loc[, rowspan, colspan, fig])</code>	Create an axis at specific location inside a regular grid.
<code>subplot_tool([targetfig])</code>	Launch a subplot tool window for a figure.
<code>subplots([nrows, ncols, sharex, sharey, ...])</code>	Create a figure and a set of subplots.
<code>subplots_adjust([left, bottom, right, top, ...])</code>	Tune the subplot layout.
<code>summer()</code>	Set the colormap to "summer".
<code>suptitle(t, **kwargs)</code>	Add a centered title to the figure.
<code>switch_backend(newbackend)</code>	Close all open figures and set the Matplotlib backend.
<code>table([cellText, cellColours, cellLoc, ...])</code>	Add a table to an <i>Axes</i> .
<code>text(x, y, s[, fontdict, withdash])</code>	Add text to the axes.
<code>thetagrids(*args, **kwargs)</code>	Get or set the theta gridlines on the current polar plot.
<code>tick_params([axis])</code>	Change the appearance of ticks, tick labels, and gridlines.
<code>ticklabel_format(*[, axis, style, ...])</code>	Change the <i>ScalarFormatter</i> used by default for linear axes.

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<code>tight_layout(pad, h_pad, w_pad, rect)</code>	Automatically adjust subplot parameters to give specified padding.
<code>title(label[, fontdict, loc, pad])</code>	Set a title for the axes.
<code>tricontour(*args, **kwargs)</code>	Draw contours on an unstructured triangular grid.
<code>tricontourf(*args, **kwargs)</code>	Draw contours on an unstructured triangular grid.
<code>tripcolor(*args[, alpha, norm, cmap, vmin, ...])</code>	Create a pseudocolor plot of an unstructured triangular grid.
<code>tripplot(*args, **kwargs)</code>	Draw a unstructured triangular grid as lines and/or markers.
<code>twinx(ax)</code>	Make and return a second axes that shares the x-axis.
<code>twiny(ax)</code>	Make and return a second axes that shares the y-axis.
<code>uninstall_repl_displayhook()</code>	Uninstall the matplotlib display hook.
<code>violinplot(dataset[, positions, vert, ...])</code>	Make a violin plot.
<code>viridis()</code>	Set the colormap to "viridis".
<code>vlines(x, ymin, ymax[, colors, linestyle, ...])</code>	Plot vertical lines.
<code>waitforbuttonpress(*args, **kwargs)</code>	Blocking call to interact with the figure.
<code>winter()</code>	Set the colormap to "winter".
<code>xcorr(x, y[, normed, detrend, usevlines, ...])</code>	Plot the cross correlation between x and y.
<code>xkcd([scale, length, randomness])</code>	Turn on <code>xkcd</code> sketch-style drawing mode. This will only have effect on things drawn after this function is called..
<code>xlabel(xlabel[, fontdict, labelpad])</code>	Set the label for the x-axis.
<code>xlim(*args, **kwargs)</code>	Get or set the x limits of the current axes.
<code>xscale(value, **kwargs)</code>	Set the x-axis scale.
<code>xticks([ticks, labels])</code>	Get or set the current tick locations and labels of the x-axis.
<code>ylabel(ylabel[, fontdict, labelpad])</code>	Set the label for the y-axis.
<code>ylim(*args, **kwargs)</code>	Get or set the y-limits of the current axes.
<code>yscale(value, **kwargs)</code>	Set the y-axis scale.
<code>yticks([ticks, labels])</code>	Get or set the current tick locations and labels of the y-axis.

**matplotlib.pyplot.acorr**

`matplotlib.pyplot.acorr(x, *, data=None, **kwargs)`

Plot the autocorrelation of `x`.

**Parameters**

**x** [array-like]

**detrend** [callable, optional, default: `mlab.detrend_none`] `x` is detrended by the `detrend` callable. This must be a function `x = detrend(x)` accepting and returning a `numpy.array`. Default is no normalization.

**normed** [bool, optional, default: `True`] If `True`, input vectors are normalised to unit length.

**usevlines** [bool, optional, default: `True`] Determines the plot style.

If `True`, vertical lines are plotted from 0 to the `acorr` value using `Axes.vlines`. Additionally, a horizontal line is plotted at `y=0` using `Axes.axhline`.

If `False`, markers are plotted at the `acorr` values using `Axes.plot`.

**maxlags** [int, optional, default: 10] Number of lags to show. If `None`, will return all  $2 * \text{len}(x) - 1$  lags.

### Returns

**lags** [array (length  $2 * \text{maxlags} + 1$ )] The lag vector.

**c** [array (length  $2 * \text{maxlags} + 1$ )] The auto correlation vector.

**line** [`LineCollection` or `Line2D`] *Artist* added to the axes of the correlation:

- `LineCollection` if `usevlines` is `True`.
- `Line2D` if `usevlines` is `False`.

**b** [`Line2D` or `None`] Horizontal line at 0 if `usevlines` is `True` `None` if `usevlines` is `False`.

### Other Parameters

**linestyle** [`Line2D` property, optional] The linestyle for plotting the data points. Only used if `usevlines` is `False`.

**marker** [str, optional, default: 'o'] The marker for plotting the data points. Only used if `usevlines` is `False`.

### Notes

The cross correlation is performed with `numpy.correlate()` with `mode = "full"`.

---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

### Examples using `matplotlib.pyplot.acorr`

- `sphx_glr_gallery_lines_bars_and_markers_xcorr_acorr_demo.py`

### `matplotlib.pyplot.angle_spectrum`

```
matplotlib.pyplot.angle_spectrum(x, Fs=None, Fc=None, window=None, pad_to=None,
                                sides=None, *, data=None, **kwargs)
```

Plot the angle spectrum.

Compute the angle spectrum (wrapped phase spectrum) of `x`. Data is padded to a length of `pad_to` and the windowing function `window` is applied to the signal.

### Parameters

- x** [1-D array or sequence] Array or sequence containing the data.
- Fs** [scalar] The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, *freqs*, in cycles per time unit. The default value is 2.
- window** [callable or ndarray] A function or a vector of length *NFFT*. To create window vectors see `window_hanning`, `window_none`, `numpy.blackman`, `numpy.hamming`, `numpy.bartlett`, `scipy.signal`, `scipy.signal.get_window`, etc. The default is `window_hanning`. If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.
- sides** [{'default', 'onesided', 'twosided'}] Specifies which sides of the spectrum to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. 'onesided' forces the return of a one-sided spectrum, while 'twosided' forces two-sided.
- pad\_to** [int] The number of points to which the data segment is padded when performing the FFT. While not increasing the actual resolution of the spectrum (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the *n* parameter in the call to `fft()`. The default is `None`, which sets *pad\_to* equal to the length of the input signal (i.e. no padding).
- Fc** [int] The center frequency of *x* (defaults to 0), which offsets the *x* extents of the plot to reflect the frequency range used when a signal is acquired and then filtered and downsampled to baseband.

### Returns

- spectrum** [1-D array] The values for the angle spectrum in radians (real valued).
- freqs** [1-D array] The frequencies corresponding to the elements in *spectrum*.
- line** [a *Line2D* instance] The line created by this function.

### Other Parameters

**\*\*kwargs** Keyword arguments control the *Line2D* properties:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m,
<i>alpha</i>		float
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i>		bool
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   <code>None</code> ]
<i>color</i> or <i>c</i>		color
<i>contains</i>		callable
<i>dash_capstyle</i>		{'butt', 'round', 'projecting'}
<i>dash_joinstyle</i>		{'miter', 'round', 'bevel'}
<i>dashes</i>		sequence of floats (on/off ink in points) or ( <code>None</code> , <code>None</code> )

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Property	Description
<code>drawstyle</code> or <code>ds</code>	{'default', 'steps', 'steps-pre', 'steps-mid', 'steps-post'}, default: 'default'
<code>figure</code>	<i>Figure</i>
<code>fillstyle</code>	{'full', 'left', 'right', 'bottom', 'top', 'none'}
<code>gid</code>	str
<code>in_layout</code>	bool
<code>label</code>	object
<code>linestyle</code> or <code>ls</code>	{'-', '-.', '-.', ':', "", (offset, on-off-seq), ...}
<code>linewidth</code> or <code>lw</code>	float
<code>marker</code>	marker style
<code>markeredgewidth</code> or <code>mew</code>	float
<code>markerfacecolor</code> or <code>mfc</code>	color
<code>markerfacecoloralt</code> or <code>mfcalt</code>	color
<code>markersize</code> or <code>ms</code>	float
<code>markevery</code>	None or int or (int, int) or slice or List[int] or float or (float, float)
<code>path_effects</code>	<i>AbstractPathEffect</i>
<code>picker</code>	float or callable[[Artist, Event], Tuple[bool, dict]]
<code>pickradius</code>	float
<code>rasterized</code>	bool or None
<code>sketch_params</code>	(scale: float, length: float, randomness: float)
<code>snap</code>	bool or None
<code>solid_capstyle</code>	{'butt', 'round', 'projecting'}
<code>solid_joinstyle</code>	{'miter', 'round', 'bevel'}
<code>transform</code>	<i>matplotlib.transforms.Transform</i>
<code>url</code>	str
<code>visible</code>	bool
<code>xdata</code>	1D array
<code>ydata</code>	1D array
<code>zorder</code>	float

**See also:**

`magnitude_spectrum()` `angle_spectrum()` plots the magnitudes of the corresponding frequencies.

`phase_spectrum()` `phase_spectrum()` plots the unwrapped version of this function.

`specgram()` `specgram()` can plot the angle spectrum of segments within the signal in a colormap.

**Notes**

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

`matplotlib.pyplot.annotate`

`matplotlib.pyplot.annotate(s, xy, *args, **kwargs)`

Annotate the point  $xy$  with text  $text$ .

In the simplest form, the text is placed at  $xy$ .

Optionally, the text can be displayed in another position  $xytext$ . An arrow pointing from the text to the annotated point  $xy$  can then be added by defining  $arrowprops$ .

**Parameters**

**text** [str] The text of the annotation.  $s$  is a deprecated synonym for this parameter.

**xy** [(float, float)] The point  $(x,y)$  to annotate.

**xytext** [(float, float), optional] The position  $(x,y)$  to place the text at. If *None*, defaults to  $xy$ .

**xycoords** [str, *Artist*, *Transform*, callable or tuple, optional] The coordinate system that  $xy$  is given in. The following types of values are supported:

- One of the following strings:

Value	Description
'figure points'	Points from the lower left of the figure
'figure pixels'	Pixels from the lower left of the figure
'figure fraction'	Fraction of figure from lower left
'axes points'	Points from lower left corner of axes
'axes pixels'	Pixels from lower left corner of axes
'axes fraction'	Fraction of axes from lower left
'data'	Use the coordinate system of the object being annotated (default)
'polar'	$(\theta, r)$ if not native 'data' coordinates

- An *Artist*:  $xy$  is interpreted as a fraction of the artists *Bbox*. E.g.  $(0, 0)$  would be the lower left corner of the bounding box and  $(0.5, 1)$  would be the center top of the bounding box.
- A *Transform* to transform  $xy$  to screen coordinates.
- A function with one of the following signatures:

```
def transform(renderer) -> Bbox
def transform(renderer) -> Transform
```

where *renderer* is a *RendererBase* subclass.

The result of the function is interpreted like the *Artist* and *Transform* cases above.

- A tuple (*xcoords*, *ycoords*) specifying separate coordinate systems for *x* and *y*. *xcoords* and *ycoords* must each be of one of the above described types.

See *Advanced Annotation* for more details.

Defaults to 'data'.

**textcoords** [*str*, *Artist*, *Transform*, callable or tuple, optional] The coordinate system that *xytext* is given in.

All *xycoords* values are valid as well as the following strings:

Value	Description
'offset points'	Offset (in points) from the <i>xy</i> value
'offset pixels'	Offset (in pixels) from the <i>xy</i> value

Defaults to the value of *xycoords*, i.e. use the same coordinate system for annotation point and text position.

**arrowprops** [*dict*, optional] The properties used to draw a *FancyArrowPatch* arrow between the positions *xy* and *xytext*.

If *arrowprops* does not contain the key 'arrowstyle' the allowed keys are:

Key	Description
width	The width of the arrow in points
headwidth	The width of the base of the arrow head in points
headlength	The length of the arrow head in points
shrink	Fraction of total length to shrink from both ends
?	Any key to <i>matplotlib.patches.FancyArrowPatch</i>

If *arrowprops* contains the key 'arrowstyle' the above keys are forbidden. The allowed values of 'arrowstyle' are:

Name	Attrs
'-'	None
'->'	head_length=0.4,head_width=0.2
'-['	widthB=1.0,lengthB=0.2,angleB=None
' - '	widthA=1.0,widthB=1.0
'- >'	head_length=0.4,head_width=0.2
'<-'	head_length=0.4,head_width=0.2
'<->'	head_length=0.4,head_width=0.2
'< -'	head_length=0.4,head_width=0.2
'< - >'	head_length=0.4,head_width=0.2
'fancy'	head_length=0.4,head_width=0.4,tail_width=0.4
'simple'	head_length=0.5,head_width=0.5,tail_width=0.2
'wedge'	tail_width=0.3,shrink_factor=0.5

Valid keys for *FancyArrowPatch* are:

Key	Description
<code>arrowstyle</code>	the arrow style
<code>connectionstyle</code>	the connection style
<code>relpos</code>	default is (0.5, 0.5)
<code>patchA</code>	default is bounding box of the text
<code>patchB</code>	default is None
<code>shrinkA</code>	default is 2 points
<code>shrinkB</code>	default is 2 points
<code>mutation_scale</code>	default is text size (in points)
<code>mutation_aspect</code>	default is 1.
<code>?</code>	any key for <code>matplotlib.patches.PathPatch</code>

Defaults to None, i.e. no arrow is drawn.

**annotation\_clip** [bool or None, optional] Whether to draw the annotation when the annotation point `xy` is outside the axes area.

- If *True*, the annotation will only be drawn when `xy` is within the axes.
- If *False*, the annotation will always be drawn.
- If *None*, the annotation will only be drawn when `xy` is within the axes and `xycoords` is 'data'.

Defaults to *None*.

**\*\*kwargs** Additional kwargs are passed to *Text*.

### Returns

**annotation** [*Annotation*]

**See also:**

### *Advanced Annotation*

#### Examples using `matplotlib.pyplot.annotate`

- `sphx_glr_gallery_lines_bars_and_markers_barchart.py`
- `sphx_glr_gallery_statistics_barchart_demo.py`
- `sphx_glr_gallery_text_labels_and_annotations_mathtext_examples.py`
- `sphx_glr_gallery_text_labels_and_annotations_usetex_demo.py`
- `sphx_glr_gallery_pyplots_annotate_transform.py`
- `sphx_glr_gallery_pyplots_annotation_basic.py`
- `sphx_glr_gallery_pyplots_annotation_polar.py`
- *Pyplot tutorial*

`matplotlib.pyplot.arrow`

`matplotlib.pyplot.arrow(x, y, dx, dy, **kwargs)`

Add an arrow to the axes.

This draws an arrow from  $(x, y)$  to  $(x+dx, y+dy)$ .

**Parameters**

**x, y** [float] The x and y coordinates of the arrow base.

**dx, dy** [float] The length of the arrow along x and y direction.

**Returns**

**arrow** [*FancyArrow*] The created *FancyArrow* object.

**Other Parameters**

**\*\*kwargs** Optional kwargs (inherited from *FancyArrow* patch) control the arrow construction and properties:

**Constructor arguments**

**width: float (default: 0.001)** width of full arrow tail

**length\_includes\_head: bool (default: False)** True if head is to be counted in calculating the length.

**head\_width: float or None (default: 3\*width)** total width of the full arrow head

**head\_length: float or None (default: 1.5 \* head\_width)** length of arrow head

**shape: ['full', 'left', 'right'] (default: 'full')** draw the left-half, right-half, or full arrow

**overhang: float (default: 0)** fraction that the arrow is swept back (0 overhang means triangular shape). Can be negative or greater than one.

**head\_starts\_at\_zero: bool (default: False)** if True, the head starts being drawn at coordinate 0 instead of ending at coordinate 0.

**Other valid kwargs (inherited from :class:'Patch') are:**

	Property	Description
<code>agg_filter</code>		a filter function, which takes a $(m, n, 3)$ float array and a dpi value, and returns a $(m, n, 3)$ float array
<code>alpha</code>		float or None
<code>animated</code>		bool
<code>antialiased</code> or <code>aa</code>		unknown
<code>capstyle</code>		{'butt', 'round', 'projecting'}
<code>clip_box</code>		<i>Bbox</i>
<code>clip_on</code>		bool
<code>clip_path</code>		$[(Path, Transform)   Patch   None]$
<code>color</code>		color
<code>contains</code>		callable
<code>edgecolor</code> or <code>ec</code>		color or None or 'auto'
<code>facecolor</code> or <code>fc</code>		color or None

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	Property	Description
<i>figure</i>		<i>Figure</i>
<i>fill</i>		bool
<i>gid</i>		str
<i>hatch</i>		{ '/', '\', ' ', '-', '+', 'x', 'o', 'O', '.', '*' }
<i>in_layout</i>		bool
<i>joinstyle</i>		{ 'miter', 'round', 'bevel' }
<i>label</i>		object
<i>linestyle</i> or <i>ls</i>		{ '-', '-.', '-.-', ':', ' ', (offset, on-off-seq), ... }
<i>linewidth</i> or <i>lw</i>		float or None
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		None or bool or float or callable
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>transform</i>		<i>Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>zorder</i>		float

### Notes

The resulting arrow is affected by the axes aspect ratio and limits. This may produce an arrow whose head is not square with its stem. To create an arrow whose head is square with its stem, use `annotate()` for example:

```
>>> ax.annotate("", xy=(0.5, 0.5), xytext=(0, 0),
...             arrowprops=dict(arrowstyle="->"))
```

### Examples using `matplotlib.pyplot.arrow`

- `sphinx_glr_gallery_text_labels_and_annotations_arrow_demo.py`

### `matplotlib.pyplot.autoscale`

`matplotlib.pyplot.autoscale(enable=True, axis='both', tight=None)`

Autoscale the axis view to the data (toggle).

Convenience method for simple axis view autoscaling. It turns autoscaling on or off, and then, if autoscaling for either axis is on, it performs the autoscaling on the specified axis or axes.

#### Parameters

**enable** [bool or None, optional] True (default) turns autoscaling on, False turns it off. None leaves the autoscaling state unchanged.

**axis** [{ 'both', 'x', 'y' }, optional] which axis to operate on; default is 'both'

**tight** [bool or None, optional] If True, set view limits to data limits; if False, let the locator and margins expand the view limits; if None, use

tight scaling if the only artist is an image, otherwise treat *tight* as False. The *tight* setting is retained for future autoscaling until it is explicitly changed.

### matplotlib.pyplot.autumn

matplotlib.pyplot.autumn()  
Set the colormap to "autumn".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

### matplotlib.pyplot.axes

matplotlib.pyplot.axes(*arg=None*, *\*\*kwargs*)  
Add an axes to the current figure and make it the current axes.

Call signatures:

```
plt.axes()
plt.axes(rect, projection=None, polar=False, **kwargs)
plt.axes(ax)
```

#### Parameters

**arg** [{ None, 4-tuple, Axes }] The exact behavior of this function depends on the type:

- *None*: A new full window axes is added using `subplot(111, **kwargs)`
- 4-tuple of floats *rect* = [left, bottom, width, height]. A new axes is added with dimensions *rect* in normalized (0, 1) units using `add_axes` on the current figure.
- *Axes*: This is equivalent to `pyplot.sca`. It sets the current axes to *arg*. Note: This implicitly changes the current figure to the parent of *arg*.

---

**Note:** The use of an `axes.Axes` as an argument is deprecated and will be removed in v3.0. Please use `pyplot.sca` instead.

---

**projection** [{None, 'aitoff', 'hammer', 'lambert', 'mollweide', 'polar', 'rectilinear', str}, optional] The projection type of the *Axes*. *str* is the name of a custom projection, see *projections*. The default None results in a 'rectilinear' projection.

**polar** [boolean, optional] If True, equivalent to `projection='polar'`.

**sharex, sharey** [*Axes*, optional] Share the x or y *axis* with `sharex` and/or `sharey`. The axis will have the same limits, ticks, and scale as the axis of the shared axes.

**label** [str] A label for the returned axes.

### Returns

**axes** [*Axes* (or a subclass of *Axes*)] The returned axes class depends on the projection used. It is *Axes* if rectilinear projection are used and *projections.polar.PolarAxes* if polar projection are used.

### Other Parameters

**\*\*kwargs** This method also takes the keyword arguments for the returned axes class. The keyword arguments for the rectilinear axes class *Axes* can be found in the following table but there might also be other keyword arguments if another projection is used, see the actual axes class.

	Property	Description
<i>adjustable</i>		{'box', 'datalim'}
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3)
<i>alpha</i>		float
<i>anchor</i>		2-tuple of floats or {'C', 'SW', 'S', 'SE', ...}
<i>animated</i>		bool
<i>aspect</i>		{'auto', 'equal'} or num
<i>autoscale_on</i>		bool
<i>autoscalex_on</i>		bool
<i>autoscaley_on</i>		bool
<i>axes_locator</i>		Callable[[ <i>Axes</i> , <i>Renderer</i> ], <i>Bbox</i> ]
<i>axisbelow</i>		bool or 'line'
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>contains</i>		callable
<i>facecolor</i>		color
<i>fc</i>		color
<i>figure</i>		<i>Figure</i>
<i>frame_on</i>		bool
<i>gid</i>		str
<i>in_layout</i>		bool
<i>label</i>		object
<i>navigate</i>		bool
<i>navigate_mode</i>		unknown
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		None or bool or float or callable
<i>position</i>		[left, bottom, width, height] or <i>Bbox</i>
<i>rasterization_zorder</i>		float or None
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>title</i>		str
<i>transform</i>		<i>Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>xbound</i>		unknown
<i>xlabel</i>		str
<i>xlim</i>		(left: float, right: float)
<i>xmargin</i>		float greater than -0.5

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	Property	Description
<i>xscale</i>		{"linear", "log", "symlog", "logit", ...}
<i>xticklabels</i>		List[str]
<i>xticks</i>		list
<i>ybound</i>		unknown
<i>ylabel</i>		str
<i>ylim</i>		(bottom: float, top: float)
<i>ymargin</i>		float greater than -0.5
<i>yscale</i>		{"linear", "log", "symlog", "logit", ...}
<i>yticklabels</i>		List[str]
<i>yticks</i>		list
<i>zorder</i>		float

**See also:***Figure.add\_axes**pyplot.subplot**Figure.add\_subplot**Figure.subplots**pyplot.subplots***Notes**

If the figure already has a axes with key (*args*, *kwargs*) then it will simply make that axes current and return it. This behavior is deprecated. Meanwhile, if you do not want this behavior (i.e., you want to force the creation of a new axes), you must use a unique set of args and kwargs. The axes *label* attribute has been exposed for this purpose: if you want two axes that are otherwise identical to be added to the figure, make sure you give them unique labels.

**Examples**

```
# Creating a new full window axes
plt.axes()

# Creating a new axes with specified dimensions and some kwargs
plt.axes((left, bottom, width, height), facecolor='w')
```

**Examples using matplotlib.pyplot.axes**

- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_scatter\_hist.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_axes\_demo.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_subplots\_adjust.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_arrow\_simple\_demo.py

- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_mathtext\_examples.py
- sphx\_glr\_gallery\_axes\_grid1\_demo\_axes\_hbox\_divider.py
- sphx\_glr\_gallery\_axes\_grid1\_make\_room\_for\_ylabel\_using\_axesgrid.py
- sphx\_glr\_gallery\_event\_handling\_lasso\_demo.py
- sphx\_glr\_gallery\_widgets\_buttons.py
- sphx\_glr\_gallery\_widgets\_check\_buttons.py
- sphx\_glr\_gallery\_widgets\_radio\_buttons.py
- sphx\_glr\_gallery\_widgets\_slider\_demo.py
- sphx\_glr\_gallery\_widgets\_textbox.py

### matplotlib.pyplot.axhline

matplotlib.pyplot.axhline(y=0, xmin=0, xmax=1, \*\*kwargs)

Add a horizontal line across the axis.

#### Parameters

**y** [scalar, optional, default: 0] y position in data coordinates of the horizontal line.

**xmin** [scalar, optional, default: 0] Should be between 0 and 1, 0 being the far left of the plot, 1 the far right of the plot.

**xmax** [scalar, optional, default: 1] Should be between 0 and 1, 0 being the far left of the plot, 1 the far right of the plot.

#### Returns

**line** [*Line2D*]

#### Other Parameters

**\*\*kwargs** Valid kwargs are *Line2D* properties, with the exception of 'transform':

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<i>alpha</i>	float	
<i>animated</i>	bool	
<i>antialiased</i> or <i>aa</i>	bool	
<i>clip_box</i>	<i>Bbox</i>	
<i>clip_on</i>	bool	
<i>clip_path</i>	$[(Path, Transform)   Patch   None]$	
<i>color</i> or <i>c</i>	color	
<i>contains</i>	callable	
<i>dash_capstyle</i>	{'butt', 'round', 'projecting'}	
<i>dash_joinstyle</i>	{'miter', 'round', 'bevel'}	
<i>dashes</i>	sequence of floats (on/off ink in points) or (None, None)	
<i>drawstyle</i> or <i>ds</i>	{'default', 'steps', 'steps-pre', 'steps-mid', 'steps-post'}, default: 'default'	
<i>figure</i>	<i>Figure</i>	
<i>fillstyle</i>	{'full', 'left', 'right', 'bottom', 'top', 'none'}	

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	Property	Description
<i>gid</i>	str	
<i>in_layout</i>	bool	
<i>label</i>	object	
<i>linestyle</i> or <i>ls</i>	{ '-', '-.', '-:', ':', '', (offset, on-off-seq), ... }	
<i>linewidth</i> or <i>lw</i>	float	
<i>marker</i>		marker style
<i>markeredgewidth</i> or <i>mec</i>	color	
<i>markeredgewidth</i> or <i>mew</i>	float	
<i>markerfacecolor</i> or <i>mfc</i>	color	
<i>markerfacecoloralt</i> or <i>mfcalt</i>	color	
<i>markersize</i> or <i>ms</i>	float	
<i>markevery</i>	None or int or (int, int) or slice or List[int] or float or (float, float)	
<i>path_effects</i>	<i>AbstractPathEffect</i>	
<i>picker</i>	float or callable[[Artist, Event], Tuple[bool, dict]]	
<i>pickradius</i>	float	
<i>rasterized</i>	bool or None	
<i>sketch_params</i>	(scale: float, length: float, randomness: float)	
<i>snap</i>	bool or None	
<i>solid_capstyle</i>	{ 'butt', 'round', 'projecting' }	
<i>solid_joinstyle</i>	{ 'miter', 'round', 'bevel' }	
<i>transform</i>	<i>matplotlib.transforms.Transform</i>	
<i>url</i>	str	
<i>visible</i>	bool	
<i>xdata</i>	1D array	
<i>ydata</i>	1D array	
<i>zorder</i>	float	

**See also:**

*hlines* Add horizontal lines in data coordinates.

*axhspan* Add a horizontal span (rectangle) across the axis.

**Examples**

- draw a thick red hline at 'y' = 0 that spans the xrange:

```
>>> axhline(linewidth=4, color='r')
```

- draw a default hline at 'y' = 1 that spans the xrange:

```
>>> axhline(y=1)
```

- draw a default hline at 'y' = .5 that spans the middle half of the xrange:

```
>>> axhline(y=.5, xmin=0.25, xmax=0.75)
```

**Examples using matplotlib.pyplot.axhline**

- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_axhspan\_demo.py

- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_multiline.py
- sphx\_glr\_gallery\_color\_color\_cycle\_default.py
- sphx\_glr\_gallery\_misc\_zorder\_demo.py

**matplotlib.pyplot.axhspan**

matplotlib.pyplot.axhspan(*ymin*, *ymax*, *xmin*=0, *xmax*=1, **\*\*kwargs**)

Add a horizontal span (rectangle) across the axis.

Draw a horizontal span (rectangle) from *ymin* to *ymax*. With the default values of *xmin* = 0 and *xmax* = 1, this always spans the xrange, regardless of the xlim settings, even if you change them, e.g., with the `set_xlim()` command. That is, the horizontal extent is in axes coords: 0=left, 0.5=middle, 1.0=right but the y location is in data coordinates.

**Parameters**

- ymin** [float] Lower limit of the horizontal span in data units.
- ymax** [float] Upper limit of the horizontal span in data units.
- xmin** [float, optional, default: 0] Lower limit of the vertical span in axes (relative 0-1) units.
- xmax** [float, optional, default: 1] Upper limit of the vertical span in axes (relative 0-1) units.

**Returns**

**Polygon** [*Polygon*]

**Other Parameters**

**\*\*kwargs** [*Polygon* properties.]

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<i>alpha</i>		float or None
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i>		unknown
<i>capstyle</i>		{'butt', 'round', 'projecting'}
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>color</i>		color
<i>contains</i>		callable
<i>edgecolor</i> or <i>ec</i>		color or None or 'auto'
<i>facecolor</i> or <i>fc</i>		color or None
<i>figure</i>		<i>Figure</i>
<i>fill</i>		bool
<i>gid</i>		str
<i>hatch</i>		{'/', '\', ' ', '-.', '+', 'x', 'o', 'O', '.', '*'}
<i>in_layout</i>		bool
<i>joinstyle</i>		{'miter', 'round', 'bevel'}
<i>label</i>		object
<i>linestyle</i> or <i>ls</i>		{'-.', '-.', '-.', ':', '-', (offset, on-off-seq), ...}

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Property	Description
<i>linewidth</i> or <i>lw</i>	float or None
<i>path_effects</i>	<i>AbstractPathEffect</i>
<i>picker</i>	None or bool or float or callable
<i>rasterized</i>	bool or None
<i>sketch_params</i>	(scale: float, length: float, randomness: float)
<i>snap</i>	bool or None
<i>transform</i>	<i>Transform</i>
<i>url</i>	str
<i>visible</i>	bool
<i>zorder</i>	float

**See also:**

`axvspan` Add a vertical span across the axes.

**Examples using `matplotlib.pyplot.axhspan`**

- `sphx_glr_gallery_subplots_axes_and_figures_axhspan_demo.py`

**`matplotlib.pyplot.axis`**

`matplotlib.pyplot.axis(*args, **kwargs)`

Convenience method to get or set some axis properties.

Call signatures:

```
xmin, xmax, ymin, ymax = axis()
xmin, xmax, ymin, ymax = axis([xmin, xmax, ymin, ymax])
xmin, xmax, ymin, ymax = axis(option)
xmin, xmax, ymin, ymax = axis(**kwargs)
```

**Parameters**

**xmin, xmax, ymin, ymax** [float, optional] The axis limits to be set. Either none or all of the limits must be given. This can also be achieved using

```
ax.set(xlim=(xmin, xmax), ylim=(ymin, ymax))
```

**option** [bool or str] If a bool, turns axis lines and labels on or off. If a string, possible values are:

Value	Description
'on'	Turn on axis lines and labels. Same as <code>True</code> .
'off'	Turn off axis lines and labels. Same as <code>False</code> .
'equal'	Set equal scaling (i.e., make circles circular) by changing axis limits.
'scaled'	Set equal scaling (i.e., make circles circular) by changing dimensions of the plot box.
'tight'	Set limits just large enough to show all data.
'auto'	Automatic scaling (fill plot box with data).
'normal'	Same as 'auto'; deprecated.
'image'	'scaled' with axis limits equal to data limits.
'square'	Square plot; similar to 'scaled', but initially forcing $x_{\max}-x_{\min} = y_{\max}-y_{\min}$ .

**emit** [bool, optional, default *True*] Whether observers are notified of the axis limit change. This option is passed on to `set_xlim` and `set_ylim`.

### Returns

**xmin, xmax, ymin, ymax** [float] The axis limits.

### See also:

`matplotlib.axes.Axes.set_xlim`

`matplotlib.axes.Axes.set_ylim`

### Examples using `matplotlib.pyplot.axis`

- `sphx_glr_gallery_lines_bars_and_markers_fill.py`
- `sphx_glr_gallery_text_labels_and_annotations_autowrap.py`
- `sphx_glr_gallery_text_labels_and_annotations_text_alignment.py`
- `sphx_glr_gallery_shapes_and_collections_artist_reference.py`
- *Pyplot tutorial*

### `matplotlib.pyplot.axvline`

`matplotlib.pyplot.axvline(x=0, ymin=0, ymax=1, **kwargs)`

Add a vertical line across the axes.

### Parameters

**x** [scalar, optional, default: 0] x position in data coordinates of the vertical line.

**ymin** [scalar, optional, default: 0] Should be between 0 and 1, 0 being the bottom of the plot, 1 the top of the plot.

**ymax** [scalar, optional, default: 1] Should be between 0 and 1, 0 being the bottom of the plot, 1 the top of the plot.

**Returns****line** [*Line2D*]**Other Parameters**

**\*\*kwargs** Valid kwargs are *Line2D* properties, with the exception of 'transform':

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<i>alpha</i>		float
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i>		bool
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>color</i> or <i>c</i>		color
<i>contains</i>		callable
<i>dash_capstyle</i>		{'butt', 'round', 'projecting'}
<i>dash_joinstyle</i>		{'miter', 'round', 'bevel'}
<i>dashes</i>		sequence of floats (on/off ink in points) or (None, None)
<i>drawstyle</i> or <i>ds</i>		{'default', 'steps', 'steps-pre', 'steps-mid', 'steps-post'}, default: 'default'
<i>figure</i>		<i>Figure</i>
<i>fillstyle</i>		{'full', 'left', 'right', 'bottom', 'top', 'none'}
<i>gid</i>		str
<i>in_layout</i>		bool
<i>label</i>		object
<i>linestyle</i> or <i>ls</i>		{'-', '--', '-.', ':', '', (offset, on-off-seq), ...}
<i>linewidth</i> or <i>lw</i>		float
<i>marker</i>		marker style
<i>markeredgewidth</i> or <i>mec</i>		float
<i>markerfacecolor</i> or <i>mfc</i>		color
<i>markerfacecoloralt</i> or <i>mfcalt</i>		color
<i>markersize</i> or <i>ms</i>		float
<i>markevery</i>		None or int or (int, int) or slice or List[int] or float or (float, float)
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		float or callable[[ <i>Artist</i> , <i>Event</i> ], Tuple[bool, dict]]
<i>pickradius</i>		float
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>solid_capstyle</i>		{'butt', 'round', 'projecting'}
<i>solid_joinstyle</i>		{'miter', 'round', 'bevel'}
<i>transform</i>		<i>matplotlib.transforms.Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>xdata</i>		1D array
<i>ydata</i>		1D array
<i>zorder</i>		float

**See also:**

*vlines* Add vertical lines in data coordinates.

*axvspan* Add a vertical span (rectangle) across the axis.

### Examples

- draw a thick red vline at  $x = 0$  that spans the yrange:

```
>>> axvline(linewidth=4, color='r')
```

- draw a default vline at  $x = 1$  that spans the yrange:

```
>>> axvline(x=1)
```

- draw a default vline at  $x = .5$  that spans the middle half of the yrange:

```
>>> axvline(x=.5, ymin=0.25, ymax=0.75)
```

### Examples using `matplotlib.pyplot.axvline`

- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_axhspan\_demo.py
- sphx\_glr\_gallery\_color\_color\_cycle\_default.py

### `matplotlib.pyplot.axvspan`

`matplotlib.pyplot.axvspan(xmin, xmax, ymin=0, ymax=1, **kwargs)`

Add a vertical span (rectangle) across the axes.

Draw a vertical span (rectangle) from `xmin` to `xmax`. With the default values of `ymin = 0` and `ymax = 1`. This always spans the yrange, regardless of the `ylim` settings, even if you change them, e.g., with the `set_ylim()` command. That is, the vertical extent is in axes coords: 0=bottom, 0.5=middle, 1.0=top but the x location is in data coordinates.

#### Parameters

**xmin** [scalar] Number indicating the first X-axis coordinate of the vertical span rectangle in data units.

**xmax** [scalar] Number indicating the second X-axis coordinate of the vertical span rectangle in data units.

**ymin** [scalar, optional] Number indicating the first Y-axis coordinate of the vertical span rectangle in relative Y-axis units (0-1). Default to 0.

**ymax** [scalar, optional] Number indicating the second Y-axis coordinate of the vertical span rectangle in relative Y-axis units (0-1). Default to 1.

#### Returns

**rectangle** [`matplotlib.patches.Polygon`] Vertical span (rectangle) from (`xmin`, `ymin`) to (`xmax`, `ymax`).

#### Other Parameters

**\*\*kwargs** Optional parameters are properties of the class `matplotlib.patches.Polygon`.

### See also:

`axhspan` Add a horizontal span across the axes.

### Examples

Draw a vertical, green, translucent rectangle from  $x = 1.25$  to  $x = 1.55$  that spans the range of the axes.

```
>>> axvspan(1.25, 1.55, facecolor='g', alpha=0.5)
```

### Examples using `matplotlib.pyplot.axvspan`

- `sphinx_glr_gallery_subplots_axes_and_figures_axhspan_demo.py`

### `matplotlib.pyplot.bar`

```
matplotlib.pyplot.bar(x, height, width=0.8, bottom=None, *, align='center',
                     data=None, **kwargs)
```

Make a bar plot.

The bars are positioned at  $x$  with the given *alignment*. Their dimensions are given by *width* and *height*. The vertical baseline is *bottom* (default 0).

Each of  $x$ , *height*, *width*, and *bottom* may either be a scalar applying to all bars, or it may be a sequence of length  $N$  providing a separate value for each bar.

#### Parameters

**x** [sequence of scalars] The  $x$  coordinates of the bars. See also *align* for the alignment of the bars to the coordinates.

**height** [scalar or sequence of scalars] The height(s) of the bars.

**width** [scalar or array-like, optional] The width(s) of the bars (default: 0.8).

**bottom** [scalar or array-like, optional] The  $y$  coordinate(s) of the bars bases (default: 0).

**align** [{'center', 'edge'}, optional, default: 'center'] Alignment of the bars to the  $x$  coordinates:

- 'center': Center the base on the  $x$  positions.
- 'edge': Align the left edges of the bars with the  $x$  positions.

To align the bars on the right edge pass a negative *width* and `align='edge'`.

#### Returns

**container** [`BarContainer`] Container with all the bars and optionally error-bars.

### Other Parameters

**color** [scalar or array-like, optional] The colors of the bar faces.

**edgecolor** [scalar or array-like, optional] The colors of the bar edges.

**linewidth** [scalar or array-like, optional] Width of the bar edge(s). If 0, don't draw edges.

**tick\_label** [string or array-like, optional] The tick labels of the bars. Default: None (Use default numeric labels.)

**xerr, yerr** [scalar or array-like of shape(N,) or shape(2,N), optional] If not *None*, add horizontal / vertical errorbars to the bar tips. The values are +/- sizes relative to the data:

- scalar: symmetric +/- values for all bars
- shape(N,): symmetric +/- values for each bar
- **shape(2,N): Separate - and + values for each bar. First row** contains the lower errors, the second row contains the upper errors.
- *None*: No errorbar. (Default)

See [/gallery/statistics/errorbar\\_features](/gallery/statistics/errorbar_features) for an example on the usage of `xerr` and `yerr`.

**ecolor** [scalar or array-like, optional, default: 'black'] The line color of the errorbars.

**capsize** [scalar, optional] The length of the error bar caps in points. Default: None, which will take the value from `rcParams["errorbar.capsize"]`.

**error\_kw** [dict, optional] Dictionary of kwargs to be passed to the `errorbar` method. Values of `ecolor` or `capsize` defined here take precedence over the independent kwargs.

**log** [bool, optional, default: False] If *True*, set the y-axis to be log scale.

**orientation** [{'vertical', 'horizontal'}, optional] *This is for internal use only.* Please use `barh` for horizontal bar plots. Default: 'vertical'.

### See also:

`barh` Plot a horizontal bar plot.

### Notes

The optional arguments `color`, `edgecolor`, `linewidth`, `xerr`, and `yerr` can be either scalars or sequences of length equal to the number of bars. This enables you to use bar as the basis for stacked bar charts, or candlestick plots. Detail: `xerr` and `yerr` are passed directly to `errorbar()`, so they can also have shape 2xN for independent specification of lower and upper errors.

Other optional kwargs:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<i>alpha</i>		float or None
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i>		unknown
<i>capstyle</i>		{'butt', 'round', 'projecting'}
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>color</i>		color
<i>contains</i>		callable
<i>edgecolor</i> or <i>ec</i>		color or None or 'auto'
<i>facecolor</i> or <i>fc</i>		color or None
<i>figure</i>		<i>Figure</i>
<i>fill</i>		bool
<i>gid</i>		str
<i>hatch</i>		{'/', '\\', ' ', '-.', '+', 'x', 'o', 'O', ':', '*'}
<i>in_layout</i>		bool
<i>joinstyle</i>		{'miter', 'round', 'bevel'}
<i>label</i>		object
<i>linestyle</i> or <i>ls</i>		{'-', '-', '-.', ':', "", (offset, on-off-seq), ...}
<i>linewidth</i> or <i>lw</i>		float or None
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		None or bool or float or callable
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>transform</i>		<i>Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>zorder</i>		float

---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

#### Examples using `matplotlib.pyplot.bar`

- `sphx_glr_gallery_lines_bars_and_markers_bar_stacked.py`
- `sphx_glr_gallery_lines_bars_and_markers_barchart.py`
- `sphx_glr_gallery_statistics_barchart_demo.py`
- `sphx_glr_gallery_pie_and_polar_charts_nested_pie.py`

- sphx\_glr\_gallery\_pie\_and\_polar\_charts\_polar\_bar.py
- sphx\_glr\_gallery\_shapes\_and\_collections\_hatch\_demo.py
- sphx\_glr\_gallery\_misc\_table\_demo.py
- sphx\_glr\_gallery\_ticks\_and\_spines\_custom\_ticker1.py
- *Pyplot tutorial*

### matplotlib.pyplot.barbs

`matplotlib.pyplot.barbs(*args, data=None, **kw)`

Plot a 2D field of barbs.

Call signature:

```
barbs([X, Y], U, V, [C], **kw)
```

Where  $X$ ,  $Y$  define the barb locations,  $U$ ,  $V$  define the barb directions, and  $C$  optionally sets the color.

All arguments may be 1D or 2D.  $U$ ,  $V$ ,  $C$  may be masked arrays, but masked  $X$ ,  $Y$  are not supported at present.

Barbs are traditionally used in meteorology as a way to plot the speed and direction of wind observations, but can technically be used to plot any two dimensional vector quantity. As opposed to arrows, which give vector magnitude by the length of the arrow, the barbs give more quantitative information about the vector magnitude by putting slanted lines or a triangle for various increments in magnitude, as show schematically below:



The largest increment is given by a triangle (or "flag"). After those come full lines (barbs). The smallest increment is a half line. There is only, of course, ever at most 1 half line. If the magnitude is small and only needs a single half-line and no full lines or triangles, the half-line is offset from the end of the barb so that it can be easily distinguished from barbs with a single full line. The magnitude for the barb shown above would nominally be 65, using the standard increments of 50, 10, and 5.

See also [https://en.wikipedia.org/wiki/Wind\\_barb](https://en.wikipedia.org/wiki/Wind_barb).

#### Parameters

**X, Y** [1D or 2D array-like, optional] The x and y coordinates of the barb locations. See *pivot* for how the barbs are drawn to the x, y positions.

If not given, they will be generated as a uniform integer meshgrid based on the dimensions of  $U$  and  $V$ .

If  $X$  and  $Y$  are 1D but  $U$ ,  $V$  are 2D,  $X$ ,  $Y$  are expanded to 2D using  $x$ ,  $Y = \text{np.meshgrid}(X, Y)$ . In this case  $\text{len}(X)$  and  $\text{len}(Y)$  must match the column and row dimensions of  $U$  and  $V$ .

**U, V** [1D or 2D array-like] The x and y components of the barb shaft.

**C** [1D or 2D array-like, optional] Numeric data that defines the barb colors by colormapping via *norm* and *cmap*.

This does not support explicit colors. If you want to set colors directly, use *barbcolor* instead.

**length** [float, default: 7] Length of the barb in points; the other parts of the barb are scaled against this.

**pivot** [{'tip', 'middle'} or float, default: 'tip'] The part of the arrow that is anchored to the X, Y grid. The barb rotates about this point. This can also be a number, which shifts the start of the barb that many points away from grid point.

**barbcolor** [color or color sequence] Specifies the color of all parts of the barb except for the flags. This parameter is analogous to the *edgecolor* parameter for polygons, which can be used instead. However this parameter will override *facecolor*.

**flagcolor** [color or color sequence] Specifies the color of any flags on the barb. This parameter is analogous to the *facecolor* parameter for polygons, which can be used instead. However, this parameter will override *facecolor*. If this is not set (and *C* has not either) then *flagcolor* will be set to match *barbcolor* so that the barb has a uniform color. If *C* has been set, *flagcolor* has no effect.

**sizes** [dict, optional] A dictionary of coefficients specifying the ratio of a given feature to the length of the barb. Only those values one wishes to override need to be included. These features include:

- 'spacing' - space between features (flags, full/half barbs)
- 'height' - height (distance from shaft to top) of a flag or full barb
- 'width' - width of a flag, twice the width of a full barb
- 'emptybarb' - radius of the circle used for low magnitudes

**fill\_empty** [bool, default: False] Whether the empty barbs (circles) that are drawn should be filled with the flag color. If they are not filled, the center is transparent.

**rounding** [bool, default: True] Whether the vector magnitude should be rounded when allocating barb components. If True, the magnitude is rounded to the nearest multiple of the half-barb increment. If False, the magnitude is simply truncated to the next lowest multiple.

**barb\_increments** [dict, optional] A dictionary of increments specifying values to associate with different parts of the barb. Only those values one wishes to override need to be included.

- 'half' - half barbs (Default is 5)
- 'full' - full barbs (Default is 10)
- 'flag' - flags (default is 50)

**flip\_barb** [bool or array-like of bool, default: False] Whether the lines and flags should point opposite to normal. Normal behavior is for the barbs and lines to point right (comes from wind barbs having these features point towards low pressure in the Northern Hemisphere).

A single value is applied to all barbs. Individual barbs can be flipped by passing a bool array of the same size as  $U$  and  $V$ .

**Returns**

**barbs** [Barbs]

**Other Parameters**

**\*\*kwargs** The barbs can further be customized using *PolyCollection* keyword arguments:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and
<i>alpha</i>		float or None
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i> or <i>antialiaseds</i>		bool or sequence of bools
<i>array</i>		ndarray
<i>capstyle</i>		{'butt', 'round', 'projecting'}
<i>clim</i>		a length 2 sequence of floats; may be overridden in methods that have
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>cmap</i>		colormap or registered colormap name
<i>color</i>		color or sequence of rgba tuples
<i>contains</i>		callable
<i>edgecolor</i> or <i>ec</i> or <i>edgecolors</i>		color or sequence of colors or 'face'
<i>facecolor</i> or <i>facecolors</i> or <i>fc</i>		color or sequence of colors
<i>figure</i>		<i>Figure</i>
<i>gid</i>		str
<i>hatch</i>		{'/', '\', ' ', '-.', '+', 'x', 'o', 'O', '.', '*'}
<i>in_layout</i>		bool
<i>joinstyle</i>		{'miter', 'round', 'bevel'}
<i>label</i>		object
<i>linestyle</i> or <i>dashes</i> or <i>linestyles</i> or <i>ls</i>		{'-', '--', '-.', ':', "", (offset, on-off-seq), ...}
<i>linewidth</i> or <i>linewidths</i> or <i>lw</i>		float or sequence of floats
<i>norm</i>		<i>Normalize</i>
<i>offset_position</i>		{'screen', 'data'}
<i>offsets</i>		float or sequence of floats
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		None or bool or float or callable
<i>pickradius</i>		unknown
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>transform</i>		<i>Transform</i>
<i>url</i>		str
<i>urls</i>		List[str] or None
<i>visible</i>		bool
<i>zorder</i>		float

**Notes**

---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

#### Examples using `matplotlib.pyplot.barbs`

- `sphx_glr_gallery_images_contours_and_fields_barb_demo.py`

#### `matplotlib.pyplot.barh`

`matplotlib.pyplot.barh(y, width, height=0.8, left=None, *, align='center', **kwargs)`

Make a horizontal bar plot.

The bars are positioned at `y` with the given *alignment*. Their dimensions are given by *width* and *height*. The horizontal baseline is *left* (default 0).

Each of `y`, *width*, *height*, and *left* may either be a scalar applying to all bars, or it may be a sequence of length N providing a separate value for each bar.

#### Parameters

**y** [scalar or array-like] The y coordinates of the bars. See also *align* for the alignment of the bars to the coordinates.

**width** [scalar or array-like] The width(s) of the bars.

**height** [sequence of scalars, optional, default: 0.8] The heights of the bars.

**left** [sequence of scalars] The x coordinates of the left sides of the bars (default: 0).

**align** [{'center', 'edge'}, optional, default: 'center'] Alignment of the base to the y coordinates\*:

- 'center': Center the bars on the y positions.
- 'edge': Align the bottom edges of the bars with the y positions.

To align the bars on the top edge pass a negative *height* and `align='edge'`.

#### Returns

**container** [`BarContainer`] Container with all the bars and optionally error-bars.

#### Other Parameters

**color** [scalar or array-like, optional] The colors of the bar faces.

**edgecolor** [scalar or array-like, optional] The colors of the bar edges.

**linewidth** [scalar or array-like, optional] Width of the bar edge(s). If 0, don't draw edges.

**tick\_label** [string or array-like, optional] The tick labels of the bars. Default: None (Use default numeric labels.)

**xerr, yerr** [scalar or array-like of shape(N,) or shape(2,N), optional] If not None, add horizontal / vertical errorbars to the bar tips. The values are +/- sizes relative to the data:

- scalar: symmetric +/- values for all bars
- shape(N,): symmetric +/- values for each bar
- **shape(2,N): Separate - and + values for each bar. First row** contains the lower errors, the second row contains the upper errors.
- None: No errorbar. (default)

See /gallery/statistics/errorbar\_features for an example on the usage of xerr and yerr.

**ecolor** [scalar or array-like, optional, default: 'black'] The line color of the errorbars.

**capsize** [scalar, optional] The length of the error bar caps in points. Default: None, which will take the value from `rcParams["errorbar.capsize"]`.

**error\_kw** [dict, optional] Dictionary of kwargs to be passed to the `errorbar` method. Values of `ecolor` or `capsize` defined here take precedence over the independent kwargs.

**log** [bool, optional, default: False] If True, set the x-axis to be log scale.

**See also:**

`bar` Plot a vertical bar plot.

**Notes**

The optional arguments `color`, `edgcolor`, `linewidth`, `xerr`, and `yerr` can be either scalars or sequences of length equal to the number of bars. This enables you to use bar as the basis for stacked bar charts, or candlestick plots. Detail: `xerr` and `yerr` are passed directly to `errorbar()`, so they can also have shape 2xN for independent specification of lower and upper errors.

Other optional kwargs:

	Property	Description
<code>agg_filter</code>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<code>alpha</code>		float or None
<code>animated</code>		bool
<code>antialiased</code> or <code>aa</code>		unknown
<code>capstyle</code>		{'butt', 'round', 'projecting'}
<code>clip_box</code>		Bbox
<code>clip_on</code>		bool

Continued on next page

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	Property	Description
<i>clip_path</i>	<code>[(Path, Transform)   Patch   None]</code>	
<i>color</i>	color	
<i>contains</i>	callable	
<i>edgecolor</i> or <i>ec</i>	color or None or 'auto'	
<i>facecolor</i> or <i>fc</i>	color or None	
<i>figure</i>	<i>Figure</i>	
<i>fill</i>	bool	
<i>gid</i>	str	
<i>hatch</i>	{'/', '\', ' ', '-.', '+', 'x', 'o', 'O', '.', '*'}	
<i>in_layout</i>	bool	
<i>joinstyle</i>	{'miter', 'round', 'bevel'}	
<i>label</i>	object	
<i>linestyle</i> or <i>ls</i>	{'-', '--', '-.', ':', "", (offset, on-off-seq), ...}	
<i>linewidth</i> or <i>lw</i>	float or None	
<i>path_effects</i>	<i>AbstractPathEffect</i>	
<i>picker</i>	None or bool or float or callable	
<i>rasterized</i>	bool or None	
<i>sketch_params</i>	(scale: float, length: float, randomness: float)	
<i>snap</i>	bool or None	
<i>transform</i>	<i>Transform</i>	
<i>url</i>	str	
<i>visible</i>	bool	
<i>zorder</i>	float	

#### Examples using `matplotlib.pyplot.barh`

- `sphx_glr_gallery_lines_bars_and_markers_horizontal_barchart_distribution.py`

#### `matplotlib.pyplot.bone`

`matplotlib.pyplot.bone()`

Set the colormap to "bone".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

#### `matplotlib.pyplot.box`

`matplotlib.pyplot.box(on=None)`

Turn the axes box on or off on the current axes.

##### Parameters

**on** [bool or None] The new *Axes* box state. If None, toggle the state.

**See also:**

```
matplotlib.axes.Axes.set_frame_on()
```

```
matplotlib.axes.Axes.get_frame_on()
```

### matplotlib.pyplot.boxplot

```
matplotlib.pyplot.boxplot(x, notch=None, sym=None, vert=None, whis=None, positions=None, widths=None, patch_artist=None, bootstrap=None, usermedians=None, conf_intervals=None, meanline=None, showmeans=None, showcaps=None, showbox=None, showfliers=None, boxprops=None, labels=None, flierprops=None, medianprops=None, meanprops=None, capprops=None, whiskerprops=None, manage_ticks=True, autorange=False, zorder=None, *, data=None)
```

Make a box and whisker plot.

Make a box and whisker plot for each column of `x` or each vector in sequence `x`. The box extends from the lower to upper quartile values of the data, with a line at the median. The whiskers extend from the box to show the range of the data. Flier points are those past the end of the whiskers.

#### Parameters

**x** [Array or a sequence of vectors.] The input data.

**notch** [bool, optional (False)] If `True`, will produce a notched box plot. Otherwise, a rectangular boxplot is produced. The notches represent the confidence interval (CI) around the median. See the entry for the `bootstrap` parameter for information regarding how the locations of the notches are computed.

---

**Note:** In cases where the values of the CI are less than the lower quartile or greater than the upper quartile, the notches will extend beyond the box, giving it a distinctive “flipped” appearance. This is expected behavior and consistent with other statistical visualization packages.

---

**sym** [str, optional] The default symbol for flier points. Enter an empty string (“”) if you don’t want to show fliers. If `None`, then the fliers default to ‘b+’ if you want more control use the `flierprops` kwarg.

**vert** [bool, optional (True)] If `True` (default), makes the boxes vertical. If `False`, everything is drawn horizontally.

**whis** [float, sequence, or string (default = 1.5)] As a float, determines the reach of the whiskers to the beyond the first and third quartiles. In other words, where `IQR` is the interquartile range ( $Q3 - Q1$ ), the upper whisker will extend to last datum less than  $Q3 + whis * IQR$ . Similarly, the lower whisker will extend to the first datum greater than  $Q1 - whis * IQR$ . Beyond the whiskers, data are considered outliers and are plotted as individual points. Set this to an unreasonably high value to force the whiskers to show the min and max values. Alternatively, set this to an ascending sequence of percentile (e.g., [5, 95]) to set the

whiskers at specific percentiles of the data. Finally, `whis` can be the string `'range'` to force the whiskers to the min and max of the data.

**bootstrap** [int, optional] Specifies whether to bootstrap the confidence intervals around the median for notched boxplots. If `bootstrap` is `None`, no bootstrapping is performed, and notches are calculated using a Gaussian-based asymptotic approximation (see McGill, R., Tukey, J.W., and Larsen, W.A., 1978, and Kendall and Stuart, 1967). Otherwise, `bootstrap` specifies the number of times to bootstrap the median to determine its 95% confidence intervals. Values between 1000 and 10000 are recommended.

**usermedians** [array-like, optional] An array or sequence whose first dimension (or length) is compatible with `x`. This overrides the medians computed by matplotlib for each element of `usermedians` that is not `None`. When an element of `usermedians` is `None`, the median will be computed by matplotlib as normal.

**conf\_intervals** [array-like, optional] Array or sequence whose first dimension (or length) is compatible with `x` and whose second dimension is 2. When the an element of `conf_intervals` is not `None`, the notch locations computed by matplotlib are overridden (provided `notch` is `True`). When an element of `conf_intervals` is `None`, the notches are computed by the method specified by the other kwargs (e.g., `bootstrap`).

**positions** [array-like, optional] Sets the positions of the boxes. The ticks and limits are automatically set to match the positions. Defaults to `range(1, N+1)` where `N` is the number of boxes to be drawn.

**widths** [scalar or array-like] Sets the width of each box either with a scalar or a sequence. The default is 0.5, or  $0.15 * (\text{distance between extreme positions})$ , if that is smaller.

**patch\_artist** [bool, optional (False)] If `False` produces boxes with the `Line2D` artist. Otherwise, boxes and drawn with Patch artists.

**labels** [sequence, optional] Labels for each dataset. Length must be compatible with dimensions of `x`.

**manage\_ticks** [bool, optional (True)] If `True`, the tick locations and labels will be adjusted to match the boxplot positions.

**autorange** [bool, optional (False)] When `True` and the data are distributed such that the 25th and 75th percentiles are equal, `whis` is set to `'range'` such that the whisker ends are at the minimum and maximum of the data.

**meanline** [bool, optional (False)] If `True` (and `showmeans` is `True`), will try to render the mean as a line spanning the full width of the box according to `meanprops` (see below). Not recommended if `shownotches` is also `True`. Otherwise, means will be shown as points.

**zorder** [scalar, optional (None)] Sets the zorder of the boxplot.

## Returns

**result** [dict] A dictionary mapping each component of the boxplot to a list of the `matplotlib.lines.Line2D` instances created. That dictionary has the following keys (assuming vertical boxplots):

- **boxes**: the main body of the boxplot showing the quartiles and the median's confidence intervals if enabled.
- **medians**: horizontal lines at the median of each box.
- **whiskers**: the vertical lines extending to the most extreme, non-outlier data points.
- **caps**: the horizontal lines at the ends of the whiskers.
- **fliers**: points representing data that extend beyond the whiskers (fliers).
- **means**: points or lines representing the means.

### Other Parameters

**showcaps** [bool, optional (True)] Show the caps on the ends of whiskers.

**showbox** [bool, optional (True)] Show the central box.

**showfliers** [bool, optional (True)] Show the outliers beyond the caps.

**showmeans** [bool, optional (False)] Show the arithmetic means.

**capprops** [dict, optional (None)] Specifies the style of the caps.

**boxprops** [dict, optional (None)] Specifies the style of the box.

**whiskerprops** [dict, optional (None)] Specifies the style of the whiskers.

**flierprops** [dict, optional (None)] Specifies the style of the fliers.

**medianprops** [dict, optional (None)] Specifies the style of the median.

**meanprops** [dict, optional (None)] Specifies the style of the mean.

### Notes

---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

### Examples using `matplotlib.pyplot.boxplot`

- `sphx_glr_gallery_pyplots_boxplot_demo_pyplot.py`

### `matplotlib.pyplot.broken_barh`

`matplotlib.pyplot.broken_barh(xranges, yrange, *, data=None, **kwargs)`  
Plot a horizontal sequence of rectangles.

A rectangle is drawn for each element of *xranges*. All rectangles have the same vertical position and size defined by *yrange*.

This is a convenience function for instantiating a *BrokenBarHCollection*, adding it to the axes and autoscaling the view.

### Parameters

**xranges** [sequence of tuples (*xmin*, *xwidth*)] The x-positions and extends of the rectangles. For each tuple (*xmin*, *xwidth*) a rectangle is drawn from *xmin* to *xmin* + *xwidth*.

**yranges** [(*ymin*, *ymax*)] The y-position and extend for all the rectangles.

### Returns

**collection** [A *BrokenBarHCollection*]

### Other Parameters

**\*\*kwargs** [*BrokenBarHCollection* properties] Each *kwarg* can be either a single argument applying to all rectangles, e.g.:

```
facecolors='black'
```

or a sequence of arguments over which is cycled, e.g.:

```
facecolors=('black', 'blue')
```

would create interleaving black and blue rectangles.

Supported keywords:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and
<i>alpha</i>		float or None
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i> or <i>antialiaseds</i>		bool or sequence of bools
<i>array</i>		ndarray
<i>capstyle</i>		{'butt', 'round', 'projecting'}
<i>clim</i>		a length 2 sequence of floats; may be overridden in methods that have
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>cmap</i>		colormap or registered colormap name
<i>color</i>		color or sequence of rgba tuples
<i>contains</i>		callable
<i>edgecolor</i> or <i>ec</i> or <i>edgecolors</i>		color or sequence of colors or 'face'
<i>facecolor</i> or <i>facecolors</i> or <i>fc</i>		color or sequence of colors
<i>figure</i>		<i>Figure</i>
<i>gid</i>		str
<i>hatch</i>		{'/' , '\', ' ', '-', '+', 'x', 'o', 'O', '.', '*'}
<i>in_layout</i>		bool
<i>joinstyle</i>		{'miter', 'round', 'bevel'}
<i>label</i>		object
<i>linestyle</i> or <i>dashes</i> or <i>linestyles</i> or <i>ls</i>		{'-', '--', '-.', ':', '', (offset, on-off-seq), ...}
<i>linewidth</i> or <i>linewidths</i> or <i>lw</i>		float or sequence of floats

Continued on next page

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Property	Description
<i>norm</i>	<i>Normalize</i>
<i>offset_position</i>	{'screen', 'data'}
<i>offsets</i>	float or sequence of floats
<i>path_effects</i>	<i>AbstractPathEffect</i>
<i>picker</i>	None or bool or float or callable
<i>pickradius</i>	unknown
<i>rasterized</i>	bool or None
<i>sketch_params</i>	(scale: float, length: float, randomness: float)
<i>snap</i>	bool or None
<i>transform</i>	<i>Transform</i>
<i>url</i>	str
<i>urls</i>	List[str] or None
<i>visible</i>	bool
<i>zorder</i>	float

## Notes

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

## matplotlib.pyplot.cla

```
matplotlib.pyplot.cla()
    Clear the current axes.
```

## matplotlib.pyplot.clabel

```
matplotlib.pyplot.clabel(CS, *args, **kwargs)
    Label a contour plot.
```

Call signature:

```
clabel(cs, [levels,] **kwargs)
```

Adds labels to line contours in *cs*, where *cs* is a *ContourSet* object returned by `contour()`.

### Parameters

**cs** [*ContourSet*] The *ContourSet* to label.

**levels** [array-like, optional] A list of level values, that should be labeled. The list must be a subset of `cs.levels`. If not given, all levels are labeled.

**fontsize** [string or float, optional] Size in points or relative size e.g., 'smaller', 'x-large'. See `Text.set_size` for accepted string values.

**colors** [color-spec, optional] The label colors:

- If *None*, the color of each label matches the color of the corresponding contour.
- If one string color, e.g., `colors = 'r'` or `colors = 'red'`, all labels will be plotted in this color.
- If a tuple of matplotlib color args (string, float, rgb, etc), different labels will be plotted in different colors in the order specified.

**inline** [bool, optional] If `True` the underlying contour is removed where the label is placed. Default is `True`.

**inline\_spacing** [float, optional] Space in pixels to leave on each side of label when placing inline. Defaults to 5.

This spacing will be exact for labels at locations where the contour is straight, less so for labels on curved contours.

**fmt** [string or dict, optional] A format string for the label. Default is `'%1.3f'`

Alternatively, this can be a dictionary matching contour levels with arbitrary strings to use for each contour level (i.e., `fmt[level]=string`), or it can be any callable, such as a *Formatter* instance, that returns a string when called with a numeric contour level.

**manual** [bool or iterable, optional] If `True`, contour labels will be placed manually using mouse clicks. Click the first button near a contour to add a label, click the second button (or potentially both mouse buttons at once) to finish adding labels. The third button can be used to remove the last label added, but only if labels are not inline. Alternatively, the keyboard can be used to select label locations (enter to end label placement, delete or backspace act like the third mouse button, and any other key will select a label location).

*manual* can also be an iterable object of x,y tuples. Contour labels will be created as if mouse is clicked at each x,y positions.

**rightside\_up** [bool, optional] If `True`, label rotations will always be plus or minus 90 degrees from level. Default is `True`.

**use\_clabeltext** [bool, optional] If `True`, *ClabelText* class (instead of *Text*) is used to create labels. *ClabelText* recalculates rotation angles of texts during the drawing time, therefore this can be used if aspect of the axes changes. Default is `False`.

## Returns

**labels** A list of *Text* instances for the labels.

## Examples using `matplotlib.pyplot.clabel`

- `sphx_glr_gallery_images_contours_and_fields_contour_demo.py`
- `sphx_glr_gallery_images_contours_and_fields_contour_label_demo.py`

- sphx\_glr\_gallery\_images\_contours\_and\_fields\_contourf\_demo.py
- sphx\_glr\_gallery\_event\_handling\_ginput\_manual\_clabel\_sgskip.py

### matplotlib.pyplot.clf

`matplotlib.pyplot.clf()`  
Clear the current figure.

### Examples using matplotlib.pyplot.clf

- sphx\_glr\_gallery\_shapes\_and\_collections\_fancybox\_demo.py
- sphx\_glr\_gallery\_event\_handling\_ginput\_manual\_clabel\_sgskip.py

### matplotlib.pyplot.clim

`matplotlib.pyplot.clim(vmin=None, vmax=None)`  
Set the color limits of the current image.

If either *vmin* or *vmax* is *None*, the image min/max respectively will be used for color scaling.

If you want to set the clim of multiple images, use *set\_clim* on every image, for example:

```
for im in gca().get_images():
    im.set_clim(0, 0.5)
```

### matplotlib.pyplot.close

`matplotlib.pyplot.close(fig=None)`  
Close a figure window.

#### Parameters

**fig** [None or int or str or *Figure*] The figure to close. There are a number of ways to specify this:

- *None*: the current figure
- *Figure*: the given *Figure* instance
- *int*: a figure number
- *str*: a figure name
- 'all': all figures

### Examples using matplotlib.pyplot.close

- sphx\_glr\_gallery\_event\_handling\_pipong.py
- sphx\_glr\_gallery\_misc\_multipage\_pdf.py

- sphx\_glr\_gallery\_misc\_multiprocess\_sgskip.py
- *Tight Layout guide*

### matplotlib.pyplot.cohere

```
matplotlib.pyplot.cohere(x, y, NFFT=256, Fs=2, Fc=0, detrend=<function de-
trend_none at 0x7f69881a1378>, window=<function
window_hanning at 0x7f6988216bf8>, noverlap=0,
pad_to=None, sides='default', scale_by_freq=None, *,
data=None, **kwargs)
```

Plot the coherence between x and y.

Plot the coherence between x and y. Coherence is the normalized cross spectral density:

$$C_{xy} = \frac{|P_{xy}|^2}{P_{xx}P_{yy}}$$

### Parameters

**Fs** [scalar] The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, freqs, in cycles per time unit. The default value is 2.

**window** [callable or ndarray] A function or a vector of length *NFFT*. To create window vectors see `window_hanning`, `window_none`, `numpy.blackman`, `numpy.hamming`, `numpy.bartlett`, `scipy.signal`, `scipy.signal.get_window`, etc. The default is `window_hanning`. If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.

**sides** [{'default', 'onesided', 'twosided'}] Specifies which sides of the spectrum to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. 'onesided' forces the return of a one-sided spectrum, while 'twosided' forces two-sided.

**pad\_to** [int] The number of points to which the data segment is padded when performing the FFT. This can be different from *NFFT*, which specifies the number of data points used. While not increasing the actual resolution of the spectrum (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the *n* parameter in the call to `fft()`. The default is `None`, which sets `pad_to` equal to *NFFT*

**NFFT** [int] The number of data points used in each block for the FFT. A power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use `pad_to` for this instead.

**detrend** [{'none', 'mean', 'linear'} or callable, default 'none'] The function applied to each segment before `fft`-ing, designed to remove the mean or linear trend. Unlike in MATLAB, where the *detrend* parameter is a vector, in Matplotlib it is a function. The *mlab* module defines `detrend_none`, `detrend_mean`, and `detrend_linear`, but you can use a custom function as well. You can also use a string to choose one of the functions: 'none' calls `detrend_none`. 'mean' calls `detrend_mean`. 'linear' calls `detrend_linear`.

**scale\_by\_freq** [bool, optional] Specifies whether the resulting density values should be scaled by the scaling frequency, which gives density in units of  $\text{Hz}^{-1}$ . This allows for integration over the returned frequency values. The default is True for MATLAB compatibility.

**noverlap** [int] The number of points of overlap between blocks. The default value is 0 (no overlap).

**Fc** [int] The center frequency of  $x$  (defaults to 0), which offsets the  $x$  extents of the plot to reflect the frequency range used when a signal is acquired and then filtered and downsampled to baseband.

**Returns**

**Cxy** [1-D array] The coherence vector.

**freqs** [1-D array] The frequencies for the elements in  $Cxy$ .

**Other Parameters**

**\*\*kwargs** Keyword arguments control the *Line2D* properties:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<i>alpha</i>	float	
<i>animated</i>	bool	
<i>antialiased</i> or <i>aa</i>	bool	
<i>clip_box</i>	<i>Bbox</i>	
<i>clip_on</i>	bool	
<i>clip_path</i>	$[(Path, Transform)   Patch   None]$	
<i>color</i> or <i>c</i>	color	
<i>contains</i>	callable	
<i>dash_capstyle</i>	{'butt', 'round', 'projecting'}	
<i>dash_joinstyle</i>	{'miter', 'round', 'bevel'}	
<i>dashes</i>	sequence of floats (on/off ink in points) or (None, None)	
<i>drawstyle</i> or <i>ds</i>	{'default', 'steps', 'steps-pre', 'steps-mid', 'steps-post'}, default: 'default'	
<i>figure</i>	<i>Figure</i>	
<i>fillstyle</i>	{'full', 'left', 'right', 'bottom', 'top', 'none'}	
<i>gid</i>	str	
<i>in_layout</i>	bool	
<i>label</i>	object	
<i>linestyle</i> or <i>ls</i>	{'-' , '-' , '-.' , ':' , '' , (offset, on-off-seq), ...}	
<i>linewidth</i> or <i>lw</i>	float	
<i>marker</i>		marker style
<i>markeredgewidth</i> or <i>mec</i>	color	
<i>markeredgecolor</i> or <i>mew</i>	float	
<i>markerfacecolor</i> or <i>mfc</i>	color	
<i>markerfacecoloralt</i> or <i>mfcalt</i>	color	
<i>markersize</i> or <i>ms</i>	float	
<i>markevery</i>	None or int or (int, int) or slice or List[int] or float or (float, float)	
<i>path_effects</i>	<i>AbstractPathEffect</i>	
<i>picker</i>	float or callable[[Artist, Event], Tuple[bool, dict]]	
<i>pickradius</i>	float	
<i>rasterized</i>	bool or None	
<i>sketch_params</i>	(scale: float, length: float, randomness: float)	

Continued on next page

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	Property	Description
<i>snap</i>		bool or None
<i>solid_capstyle</i>		{'butt', 'round', 'projecting'}
<i>solid_joinstyle</i>		{'miter', 'round', 'bevel'}
<i>transform</i>		<i>matplotlib.transforms.Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>xdata</i>		1D array
<i>ydata</i>		1D array
<i>zorder</i>		float

## Notes

**Note:** In addition to the above described arguments, this function can take a **data** key-word argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x', 'y'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

## References

Bendat & Piersol – Random Data: Analysis and Measurement Procedures, John Wiley & Sons (1986)

## matplotlib.pyplot.colorbar

`matplotlib.pyplot.colorbar(mappable=None, cax=None, ax=None, **kw)`

Add a colorbar to a plot.

Function signatures for the *pyplot* interface; all but the first are also method signatures for the *colorbar()* method:

```
colorbar(**kwargs)
colorbar(mappable, **kwargs)
colorbar(mappable, cax=cax, **kwargs)
colorbar(mappable, ax=ax, **kwargs)
```

## Parameters

**mappable** The *matplotlib.cm.ScalarMappable* (i.e., *Image*, *ContourSet*, etc.) described by this colorbar. This argument is mandatory for the *Figure.colorbar* method but optional for the *pyplot.colorbar* function, which sets the default to the current image.

Note that one can create a *ScalarMappable* "on-the-fly" to generate colorbars not attached to a previously drawn artist, e.g.

```
fig.colorbar(cm.ScalarMappable(norm=norm, cmap=cmap), ax=ax)
```

**cax** [*Axes* object, optional] Axes into which the colorbar will be drawn.

**ax** [*Axes*, list of *Axes*, optional] Parent axes from which space for a new colorbar axes will be stolen. If a list of axes is given they will all be resized to make room for the colorbar axes.

**use\_gridspec** [bool, optional] If *cax* is *None*, a new *cax* is created as an instance of *Axes*. If *ax* is an instance of *Subplot* and *use\_gridspec* is *True*, *cax* is created as an instance of *Subplot* using the *gridspec* module.

### Returns

**colorbar** [*Colorbar*] See also its base class, *ColorbarBase*. Use *set\_label* to label the colorbar.

### Notes

Additional keyword arguments are of two kinds:

axes properties:

Property	Description
<i>orientation</i>	vertical or horizontal
<i>fraction</i>	0.15; fraction of original axes to use for colorbar
<i>pad</i>	0.05 if vertical, 0.15 if horizontal; fraction of original axes between colorbar and new image axes
<i>shrink</i>	1.0; fraction by which to multiply the size of the colorbar
<i>aspect</i>	20; ratio of long to short dimensions
<i>anchor</i>	(0.0, 0.5) if vertical; (0.5, 1.0) if horizontal; the anchor point of the colorbar axes
<i>panchor</i>	(1.0, 0.5) if vertical; (0.5, 0.0) if horizontal; the anchor point of the colorbar parent axes. If <i>False</i> , the parent axes' anchor will be unchanged

colorbar properties:

Property	Description
<i>extend</i>	[ 'neither'   'both'   'min'   'max' ] If not 'neither', make pointed end(s) for out-of-range values. These are set for a given colormap using the colormap <code>set_under</code> and <code>set_over</code> methods.
<i>extendfrac</i>	[ <i>None</i>   'auto'   length   lengths ] If set to <i>None</i> , both the minimum and maximum triangular colorbar extensions will have a length of 5% of the interior colorbar length (this is the default setting). If set to 'auto', makes the triangular colorbar extensions the same lengths as the interior boxes (when <i>spacing</i> is set to 'uniform') or the same lengths as the respective adjacent interior boxes (when <i>spacing</i> is set to 'proportional'). If a scalar, indicates the length of both the minimum and maximum triangular colorbar extensions as a fraction of the interior colorbar length. A two-element sequence of fractions may also be given, indicating the lengths of the minimum and maximum colorbar extensions respectively as a fraction of the interior colorbar length.
<i>extendedrect</i>	bool If <i>False</i> the minimum and maximum colorbar extensions will be triangular (the default). If <i>True</i> the extensions will be rectangular.
<i>spacing</i>	[ 'uniform'   'proportional' ] Uniform spacing gives each discrete color the same space; proportional makes the space proportional to the data interval.
<i>ticks</i>	[ <i>None</i>   list of ticks   Locator object ] If <i>None</i> , ticks are determined automatically from the input.
<i>format</i>	[ <i>None</i>   format string   Formatter object ] If <i>None</i> , the <i>ScalarFormatter</i> is used. If a format string is given, e.g., '%.3f', that is used. An alternative <i>Formatter</i> object may be given instead.
<i>drawedges</i>	bool Whether to draw lines at color boundaries.

The following will probably be useful only in the context of indexed colors (that is, when the mappable has `norm=NoNorm()`), or other unusual circumstances.

Property	Description
<i>boundaries</i>	<i>None</i> or a sequence
<i>values</i>	<i>None</i> or a sequence which must be of length 1 less than the sequence of <i>boundaries</i> . For each region delimited by adjacent entries in <i>boundaries</i> , the color mapped to the corresponding value in <i>values</i> will be used.

If *mappable* is a `ContourSet`, its *extend* kwarg is included automatically.

The *shrink* kwarg provides a simple way to scale the colorbar with respect to the axes. Note that if *cax* is specified, it determines the size of the colorbar and *shrink* and *aspect* kwargs are ignored.

For more precise control, you can manually specify the positions of the axes objects in

which the mappable and the colorbar are drawn. In this case, do not use any of the axes properties kwargs.

It is known that some vector graphics viewers (svg and pdf) renders white gaps between segments of the colorbar. This is due to bugs in the viewers, not Matplotlib. As a workaround, the colorbar can be rendered with overlapping segments:

```
cbar = colorbar()
cbar.solids.set_edgecolor("face")
draw()
```

However this has negative consequences in other circumstances, e.g. with semi-transparent images ( $\alpha < 1$ ) and colorbar extensions; therefore, this workaround is not used by default (see issue #1188).

#### Examples using `matplotlib.pyplot.colorbar`

- `sphx_glr_gallery_images_contours_and_fields_contour_demo.py`
- `sphx_glr_gallery_images_contours_and_fields_contour_image.py`
- `sphx_glr_gallery_images_contours_and_fields_contourf_demo.py`
- `sphx_glr_gallery_images_contours_and_fields_contourf_hatching.py`
- `sphx_glr_gallery_images_contours_and_fields_contourf_log.py`
- `sphx_glr_gallery_images_contours_and_fields_image_annotated_heatmap.py`
- `sphx_glr_gallery_images_contours_and_fields_image_masked.py`
- `sphx_glr_gallery_images_contours_and_fields_multi_image.py`
- `sphx_glr_gallery_images_contours_and_fields_pcolor_demo.py`
- `sphx_glr_gallery_images_contours_and_fields_pcolormesh_levels.py`
- `sphx_glr_gallery_subplots_axes_and_figures_subplots_adjust.py`
- `sphx_glr_gallery_color_colorbar_basics.py`
- `sphx_glr_gallery_color_custom_cmap.py`
- `sphx_glr_gallery_shapes_and_collections_ellipse_collection.py`
- `sphx_glr_gallery_shapes_and_collections_line_collection.py`
- `sphx_glr_gallery_axes_grid1_demo_axes_divider.py`
- `sphx_glr_gallery_axes_grid1_simple_colorbar.py`
- *Image tutorial*
- *Tight Layout guide*

#### `matplotlib.pyplot.connect`

`matplotlib.pyplot.connect(s, func)`

Connect event with string *s* to *func*. The signature of *func* is:

```
def func(event)
```

where event is a `matplotlib.backend_bases.Event`. The following events are recognized

- 'button\_press\_event'
- 'button\_release\_event'
- 'draw\_event'
- 'key\_press\_event'
- 'key\_release\_event'
- 'motion\_notify\_event'
- 'pick\_event'
- 'resize\_event'
- 'scroll\_event'
- 'figure\_enter\_event',
- 'figure\_leave\_event',
- 'axes\_enter\_event',
- 'axes\_leave\_event'
- 'close\_event'

For the location events (button and key press/release), if the mouse is over the axes, the variable `event.inaxes` will be set to the *Axes* the event occurs is over, and additionally, the variables `event.xdata` and `event.ydata` will be defined. This is the mouse location in data coords. See *KeyEvent* and *MouseEvent* for more info.

Return value is a connection id that can be used with `mpl_disconnect()`.

### Examples

Usage:

```
def on_press(event):
    print('you pressed', event.button, event.xdata, event.ydata)

cid = canvas.mpl_connect('button_press_event', on_press)
```

### Examples using `matplotlib.pyplot.connect`

- `sphinx_glr_gallery_event_handling_coords_demo.py`
- `sphinx_glr_gallery_widgets_rectangle_selector.py`

**matplotlib.pyplot.contour**

matplotlib.pyplot.contour(\*args, data=None, \*\*kwargs)  
Plot contours.

Call signature:

```
contour([X, Y,] Z, [levels], **kwargs)
```

*contour* and *contourf* draw contour lines and filled contours, respectively. Except as noted, function signatures and return values are the same for both versions.

**Parameters**

**X, Y** [array-like, optional] The coordinates of the values in Z.

X and Y must both be 2-D with the same shape as Z (e.g. created via `numpy.meshgrid`), or they must both be 1-D such that `len(X) == M` is the number of columns in Z and `len(Y) == N` is the number of rows in Z.

If not given, they are assumed to be integer indices, i.e. `X = range(M)`, `Y = range(N)`.

**Z** [array-like(N, M)] The height values over which the contour is drawn.

**levels** [int or array-like, optional] Determines the number and positions of the contour lines / regions.

If an int *n*, use *n* data intervals; i.e. draw *n+1* contour lines. The level heights are automatically chosen.

If array-like, draw contour lines at the specified levels. The values must be in increasing order.

**Returns**

**c** [*QuadContourSet*]

**Other Parameters**

**corner\_mask** [bool, optional] Enable/disable corner masking, which only has an effect if Z is a masked array. If `False`, any quad touching a masked point is masked out. If `True`, only the triangular corners of quads nearest those points are always masked out, other triangular corners comprising three unmasked points are contoured as usual.

Defaults to `rcParams["contour.corner_mask"]`, which defaults to `True`.

**colors** [color string or sequence of colors, optional] The colors of the levels, i.e. the lines for *contour* and the areas for *contourf*.

The sequence is cycled for the levels in ascending order. If the sequence is shorter than the number of levels, it's repeated.

As a shortcut, single color strings may be used in place of one-element lists, i.e. `'red'` instead of `['red']` to color all levels with the same color. This shortcut does only work for color strings, not for other ways of specifying colors.

By default (value *None*), the colormap specified by *cmap* will be used.

**alpha** [float, optional] The alpha blending value, between 0 (transparent) and 1 (opaque).

**cmap** [str or *Colormap*, optional] A *Colormap* instance or registered colormap name. The colormap maps the level values to colors. Defaults to `rcParams["image.cmap"]`.

If given, *colors* take precedence over *cmap*.

**norm** [*Normalize*, optional] If a colormap is used, the *Normalize* instance scales the level values to the canonical colormap range [0, 1] for mapping to colors. If not given, the default linear scaling is used.

**vmin, vmax** [float, optional] If not *None*, either or both of these values will be supplied to the *Normalize* instance, overriding the default color scaling based on *levels*.

**origin** [{*None*, 'upper', 'lower', 'image'}, optional] Determines the orientation and exact position of *Z* by specifying the position of *Z*[0, 0]. This is only relevant, if *X*, *Y* are not given.

- *None*: *Z*[0, 0] is at *X*=0, *Y*=0 in the lower left corner.
- 'lower': *Z*[0, 0] is at *X*=0.5, *Y*=0.5 in the lower left corner.
- 'upper': *Z*[0, 0] is at *X*=*N*+0.5, *Y*=0.5 in the upper left corner.
- 'image': Use the value from `rcParams["image.origin"]`.

**extent** [(*x0*, *x1*, *y0*, *y1*), optional] If *origin* is not *None*, then *extent* is interpreted as in *imshow*: it gives the outer pixel boundaries. In this case, the position of *Z*[0,0] is the center of the pixel, not a corner. If *origin* is *None*, then (*x0*, *y0*) is the position of *Z*[0,0], and (*x1*, *y1*) is the position of *Z*[-1,-1].

This argument is ignored if *X* and *Y* are specified in the call to *contour*.

**locator** [ticker.Locator subclass, optional] The locator is used to determine the contour levels if they are not given explicitly via *levels*. Defaults to *MaxNLocator*.

**extend** [{'neither', 'both', 'min', 'max'}, optional, default: 'neither'] Determines the *contourf*-coloring of values that are outside the *levels* range.

If 'neither', values outside the *levels* range are not colored. If 'min', 'max' or 'both', color the values below, above or below and above the *levels* range.

Values below `min(levels)` and above `max(levels)` are mapped to the under/over values of the *Colormap*. Note, that most colormaps do not have dedicated colors for these by default, so that the over and under values are the edge values of the colormap. You may want to set these values explicitly using *Colormap.set\_under* and *Colormap.set\_over*.

---

**Note:** An existing *QuadContourSet* does not get notified if properties of its colormap are changed. Therefore, an explicit call *QuadContourSet.changed()* is needed after modifying the colormap. The explicit call can be left out, if a colorbar is assigned to the *QuadContourSet* because it internally calls *QuadContourSet.changed()*.

---

Example:

```

x = np.arange(1, 10)
y = x.reshape(-1, 1)
h = x * y

cs = plt.contourf(h, levels=[10, 30, 50],
                  colors=['#808080', '#A0A0A0', '#C0C0C0'], extend='both')
cs.cmap.set_over('red')
cs.cmap.set_under('blue')
cs.changed()

```

**xunits, yunits** [registered units, optional] Override axis units by specifying an instance of a `matplotlib.units.ConversionInterface`.

**antialiased** [bool, optional] Enable antialiasing, overriding the defaults. For filled contours, the default is `True`. For line contours, it is taken from `rcParams["lines.antialiased"]`.

**Nchunk** [int >= 0, optional] If 0, no subdivision of the domain. Specify a positive integer to divide the domain into subdomains of *nchunk* by *nchunk* quads. Chunking reduces the maximum length of polygons generated by the contouring algorithm which reduces the rendering workload passed on to the backend and also requires slightly less RAM. It can however introduce rendering artifacts at chunk boundaries depending on the backend, the *antialiased* flag and value of *alpha*.

**linewidths** [float or sequence of float, optional] *Only applies to contour.*

The line width of the contour lines.

If a number, all levels will be plotted with this linewidth.

If a sequence, the levels in ascending order will be plotted with the linewidths in the order specified.

Defaults to `rcParams["lines.linewidth"]`.

**linestyles** [{`None`, 'solid', 'dashed', 'dashdot', 'dotted'}, optional] *Only applies to contour.*

If *linestyles* is `None`, the default is 'solid' unless the lines are monochrome. In that case, negative contours will take their linestyle from `rcParams["contour.negative_linestyle"]` setting.

*linestyles* can also be an iterable of the above strings specifying a set of linestyles to be used. If this iterable is shorter than the number of contour levels it will be repeated as necessary.

**hatches** [List[str], optional] *Only applies to contourf.*

A list of cross hatch patterns to use on the filled areas. If `None`, no hatching will be added to the contour. Hatching is supported in the PostScript, PDF, SVG and Agg backends only.

## Notes

1. `contourf` differs from the MATLAB version in that it does not draw the polygon edges. To draw edges, add line contours with calls to `contour`.

2. `contourf` fills intervals that are closed at the top; that is, for boundaries  $z1$  and  $z2$ , the filled region is:

```
z1 < Z <= z2
```

except for the lowest interval, which is closed on both sides (i.e. it includes the lowest value).

#### Examples using `matplotlib.pyplot.contour`

- `sphx_glr_gallery_images_contours_and_fields_contour_corner_mask.py`
- `sphx_glr_gallery_images_contours_and_fields_contour_demo.py`
- `sphx_glr_gallery_images_contours_and_fields_contour_image.py`
- `sphx_glr_gallery_images_contours_and_fields_contour_label_demo.py`
- `sphx_glr_gallery_images_contours_and_fields_contourf_demo.py`
- `sphx_glr_gallery_images_contours_and_fields_contourf_hatching.py`
- `sphx_glr_gallery_images_contours_and_fields_image_transparency_blend.py`
- `sphx_glr_gallery_images_contours_and_fields_irregulardatagrid.py`
- `sphx_glr_gallery_event_handling_ginput_manual_clabel_sgskip.py`

#### `matplotlib.pyplot.contourf`

`matplotlib.pyplot.contourf(*args, data=None, **kwargs)`

Plot contours.

Call signature:

```
contour([X, Y,] Z, [levels], **kwargs)
```

`contour` and `contourf` draw contour lines and filled contours, respectively. Except as noted, function signatures and return values are the same for both versions.

#### Parameters

**X, Y** [array-like, optional] The coordinates of the values in  $Z$ .

$X$  and  $Y$  must both be 2-D with the same shape as  $Z$  (e.g. created via `numpy.meshgrid`), or they must both be 1-D such that `len(X) == M` is the number of columns in  $Z$  and `len(Y) == N` is the number of rows in  $Z$ .

If not given, they are assumed to be integer indices, i.e.  $X = \text{range}(M)$ ,  $Y = \text{range}(N)$ .

**Z** [array-like( $N, M$ )] The height values over which the contour is drawn.

**levels** [int or array-like, optional] Determines the number and positions of the contour lines / regions.

If an int  $n$ , use  $n$  data intervals; i.e. draw  $n+1$  contour lines. The level heights are automatically chosen.

If array-like, draw contour lines at the specified levels. The values must be in increasing order.

**Returns**

**c** [*QuadContourSet*]

**Other Parameters**

**corner\_mask** [bool, optional] Enable/disable corner masking, which only has an effect if *Z* is a masked array. If `False`, any quad touching a masked point is masked out. If `True`, only the triangular corners of quads nearest those points are always masked out, other triangular corners comprising three unmasked points are contoured as usual.

Defaults to `rcParams["contour.corner_mask"]`, which defaults to `True`.

**colors** [color string or sequence of colors, optional] The colors of the levels, i.e. the lines for *contour* and the areas for *contourf*.

The sequence is cycled for the levels in ascending order. If the sequence is shorter than the number of levels, it's repeated.

As a shortcut, single color strings may be used in place of one-element lists, i.e. `'red'` instead of `['red']` to color all levels with the same color. This shortcut does only work for color strings, not for other ways of specifying colors.

By default (value *None*), the colormap specified by *cmap* will be used.

**alpha** [float, optional] The alpha blending value, between 0 (transparent) and 1 (opaque).

**cmap** [str or *Colormap*, optional] A *Colormap* instance or registered colormap name. The colormap maps the level values to colors. Defaults to `rcParams["image.cmap"]`.

If given, *colors* take precedence over *cmap*.

**norm** [*Normalize*, optional] If a colormap is used, the *Normalize* instance scales the level values to the canonical colormap range [0, 1] for mapping to colors. If not given, the default linear scaling is used.

**vmin, vmax** [float, optional] If not *None*, either or both of these values will be supplied to the *Normalize* instance, overriding the default color scaling based on *levels*.

**origin** [*None*, 'upper', 'lower', 'image'], optional] Determines the orientation and exact position of *Z* by specifying the position of *Z*[0, 0]. This is only relevant, if *X*, *Y* are not given.

- *None*: *Z*[0, 0] is at *X*=0, *Y*=0 in the lower left corner.
- 'lower': *Z*[0, 0] is at *X*=0.5, *Y*=0.5 in the lower left corner.
- 'upper': *Z*[0, 0] is at *X*=*N*+0.5, *Y*=0.5 in the upper left corner.
- 'image': Use the value from `rcParams["image.origin"]`.

**extent** [(*x0*, *x1*, *y0*, *y1*), optional] If *origin* is not *None*, then *extent* is interpreted as in *imshow*: it gives the outer pixel boundaries. In this case, the position of *Z*[0,0] is the center of the pixel, not a corner. If *origin* is *None*, then (*x0*, *y0*) is the position of *Z*[0,0], and (*x1*, *y1*) is the position of *Z*[-1,-1].

This argument is ignored if *X* and *Y* are specified in the call to *contour*.

**locator** [ticker.Locator subclass, optional] The locator is used to determine the contour levels if they are not given explicitly via *levels*. Defaults to *MaxNLocator*.

**extend** [{'neither', 'both', 'min', 'max'}, optional, default: 'neither'] Determines the *contourf*-coloring of values that are outside the *levels* range.

If 'neither', values outside the *levels* range are not colored. If 'min', 'max' or 'both', color the values below, above or below and above the *levels* range.

Values below `min(levels)` and above `max(levels)` are mapped to the under/over values of the *Colormap*. Note, that most colormaps do not have dedicated colors for these by default, so that the over and under values are the edge values of the colormap. You may want to set these values explicitly using *Colormap.set\_under* and *Colormap.set\_over*.

---

**Note:** An existing *QuadContourSet* does not get notified if properties of its colormap are changed. Therefore, an explicit call `QuadContourSet.changed()` is needed after modifying the colormap. The explicit call can be left out, if a colorbar is assigned to the *QuadContourSet* because it internally calls `QuadContourSet.changed()`.

---

Example:

```
x = np.arange(1, 10)
y = x.reshape(-1, 1)
h = x * y

cs = plt.contourf(h, levels=[10, 30, 50],
                  colors=['#808080', '#A0A0A0', '#C0C0C0'], extend='both')
cs.cmap.set_over('red')
cs.cmap.set_under('blue')
cs.changed()
```

**xunits, yunits** [registered units, optional] Override axis units by specifying an instance of a *matplotlib.units.ConversionInterface*.

**antialiased** [bool, optional] Enable antialiasing, overriding the defaults. For filled contours, the default is *True*. For line contours, it is taken from `rcParams["lines.antialiased"]`.

**Nchunk** [int >= 0, optional] If 0, no subdivision of the domain. Specify a positive integer to divide the domain into subdomains of *nchunk* by *nchunk* quads. Chunking reduces the maximum length of polygons generated by the contouring algorithm which reduces the rendering workload passed on to the backend and also requires slightly less RAM. It can however introduce rendering artifacts at chunk boundaries depending on the backend, the *antialiased* flag and value of *alpha*.

**linewidths** [float or sequence of float, optional] *Only applies to contour.*

The line width of the contour lines.

If a number, all levels will be plotted with this linewidth.

If a sequence, the levels in ascending order will be plotted with the linewidths in the order specified.

Defaults to `rcParams["lines.linewidth"]`.

**linestyles** [{*None*, 'solid', 'dashed', 'dashdot', 'dotted'}, optional] *Only applies to contour.*

If *linestyles* is *None*, the default is 'solid' unless the lines are monochrome. In that case, negative contours will take their linestyle from `rcParams["contour.negative_linestyle"]` setting.

*linestyles* can also be an iterable of the above strings specifying a set of linestyles to be used. If this iterable is shorter than the number of contour levels it will be repeated as necessary.

**hatches** [List[str], optional] *Only applies to contourf.*

A list of cross hatch patterns to use on the filled areas. If *None*, no hatching will be added to the contour. Hatching is supported in the PostScript, PDF, SVG and Agg backends only.

## Notes

1. *contourf* differs from the MATLAB version in that it does not draw the polygon edges. To draw edges, add line contours with calls to *contour*.
2. *contourf* fills intervals that are closed at the top; that is, for boundaries *z1* and *z2*, the filled region is:

$$z1 < Z \leq z2$$

except for the lowest interval, which is closed on both sides (i.e. it includes the lowest value).

## Examples using `matplotlib.pyplot.contourf`

- `sphx_glr_gallery_images_contours_and_fields_contour_corner_mask.py`
- `sphx_glr_gallery_images_contours_and_fields_contourf_demo.py`
- `sphx_glr_gallery_images_contours_and_fields_contourf_hatching.py`
- `sphx_glr_gallery_images_contours_and_fields_contourf_log.py`
- `sphx_glr_gallery_images_contours_and_fields_irregulardatagrid.py`
- `sphx_glr_gallery_images_contours_and_fields_pcolormesh_levels.py`
- `sphx_glr_gallery_images_contours_and_fields_triinterp_demo.py`

## `matplotlib.pyplot.cool`

`matplotlib.pyplot.cool()`  
Set the colormap to "cool".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

**matplotlib.pyplot.copper**

```
matplotlib.pyplot.copper()
    Set the colormap to "copper".
```

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

**matplotlib.pyplot.csd**

```
matplotlib.pyplot.csd(x, y, NFFT=None, Fs=None, Fc=None, detrend=None, window=None,
                      noverlap=None, pad_to=None, sides=None,
                      scale_by_freq=None, return_line=None, *, data=None,
                      **kwargs)
```

Plot the cross-spectral density.

The cross spectral density  $P_{xy}$  by Welch's average periodogram method. The vectors  $x$  and  $y$  are divided into  $NFFT$  length segments. Each segment is detrended by function *detrend* and windowed by function *window*. *noverlap* gives the length of the overlap between segments. The product of the direct FFTs of  $x$  and  $y$  are averaged over each segment to compute  $P_{xy}$ , with a scaling to correct for power loss due to windowing.

If  $\text{len}(x) < NFFT$  or  $\text{len}(y) < NFFT$ , they will be zero padded to  $NFFT$ .

**Parameters**

- x, y** [1-D arrays or sequences] Arrays or sequences containing the data.
- Fs** [scalar] The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, *freqs*, in cycles per time unit. The default value is 2.
- window** [callable or ndarray] A function or a vector of length  $NFFT$ . To create window vectors see `window_hanning`, `window_none`, `numpy.blackman`, `numpy.hamming`, `numpy.bartlett`, `scipy.signal`, `scipy.signal.get_window`, etc. The default is `window_hanning`. If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.
- sides** [{'default', 'onesided', 'twosided'}] Specifies which sides of the spectrum to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. 'onesided' forces the return of a one-sided spectrum, while 'twosided' forces two-sided.
- pad\_to** [int] The number of points to which the data segment is padded when performing the FFT. This can be different from  $NFFT$ , which specifies the number of data points used. While not increasing the actual resolution of the spectrum (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the  $n$  parameter in the call to `fft()`. The default is `None`, which sets *pad\_to* equal to  $NFFT$ .
- NFFT** [int] The number of data points used in each block for the FFT. A power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use *pad\_to* for this instead.

**detrend** [{'none', 'mean', 'linear'} or callable, default 'none'] The function applied to each segment before fft-ing, designed to remove the mean or linear trend. Unlike in MATLAB, where the *detrend* parameter is a vector, in Matplotlib it is a function. The *mlab* module defines *detrend\_none*, *detrend\_mean*, and *detrend\_linear*, but you can use a custom function as well. You can also use a string to choose one of the functions: 'none' calls *detrend\_none*. 'mean' calls *detrend\_mean*. 'linear' calls *detrend\_linear*.

**scale\_by\_freq** [bool, optional] Specifies whether the resulting density values should be scaled by the scaling frequency, which gives density in units of Hz<sup>-1</sup>. This allows for integration over the returned frequency values. The default is True for MATLAB compatibility.

**noverlap** [int] The number of points of overlap between segments. The default value is 0 (no overlap).

**Fc** [int] The center frequency of x (defaults to 0), which offsets the x extents of the plot to reflect the frequency range used when a signal is acquired and then filtered and downsampled to baseband.

**return\_line** [bool] Whether to include the line object plotted in the returned values. Default is False.

**Returns**

**Pxy** [1-D array] The values for the cross spectrum P<sub>{xy}</sub> before scaling (complex valued).

**freqs** [1-D array] The frequencies corresponding to the elements in Pxy.

**line** [a *Line2D* instance] The line created by this function. Only returned if *return\_line* is True.

**Other Parameters**

**\*\*kwargs** Keyword arguments control the *Line2D* properties:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m,
<i>alpha</i>		float
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i>		bool
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>color</i> or <i>c</i>		color
<i>contains</i>		callable
<i>dash_capstyle</i>		{'butt', 'round', 'projecting'}
<i>dash_joinstyle</i>		{'miter', 'round', 'bevel'}
<i>dashes</i>		sequence of floats (on/off ink in points) or (None, None)
<i>drawstyle</i> or <i>ds</i>		{'default', 'steps', 'steps-pre', 'steps-mid', 'steps-post'}, default: 'default'
<i>figure</i>		<i>Figure</i>
<i>fillstyle</i>		{'full', 'left', 'right', 'bottom', 'top', 'none'}
<i>gid</i>		str
<i>in_layout</i>		bool
<i>label</i>		object

Continued on next page

Table 177 – continued from previous page

	Property	Description
<i>linestyle</i> or <i>ls</i>		{'-', '--', '-.', ':', ' ', (offset, on-off-seq), ...}
<i>linewidth</i> or <i>lw</i>		float
<i>marker</i>		marker style
<i>markeredgecolor</i> or <i>mec</i>		color
<i>markeredgewidth</i> or <i>mew</i>		float
<i>markerfacecolor</i> or <i>mfc</i>		color
<i>markerfacecoloralt</i> or <i>mfcalt</i>		color
<i>markersize</i> or <i>ms</i>		float
<i>markevery</i>		None or int or (int, int) or slice or List[int] or float or (float, float)
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		float or callable[[Artist, Event], Tuple[bool, dict]]
<i>pickradius</i>		float
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>solid_capstyle</i>		{'butt', 'round', 'projecting'}
<i>solid_joinstyle</i>		{'miter', 'round', 'bevel'}
<i>transform</i>		<i>matplotlib.transforms.Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>xdata</i>		1D array
<i>ydata</i>		1D array
<i>zorder</i>		float

**See also:**

*psd()* *psd()* is the equivalent to setting  $y=x$ .

**Notes**

For plotting, the power is plotted as  $10 \log_{10}(P_{xy})$  for decibels, though  $P_{xy}$  itself is returned.

**References**

Bendat & Piersol – Random Data: Analysis and Measurement Procedures, John Wiley & Sons (1986)

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x', 'y'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

### matplotlib.pyplot.delaxes

`matplotlib.pyplot.delaxes(ax=None)`

Remove the Axes *ax* (defaulting to the current axes) from its figure.

A `KeyError` is raised if the axes doesn't exist.

### matplotlib.pyplot.disconnect

`matplotlib.pyplot.disconnect(cid)`

Disconnect callback id *cid*

#### Examples

Usage:

```
cid = canvas.mpl_connect('button_press_event', on_press)
#...later
canvas.mpl_disconnect(cid)
```

#### Examples using matplotlib.pyplot.disconnect

- `sphinx_glr_gallery_event_handling_coords_demo.py`

### matplotlib.pyplot.draw

`matplotlib.pyplot.draw()`

Redraw the current figure.

This is used to update a figure that has been altered, but not automatically re-drawn. If interactive mode is on (`ion()`), this should be only rarely needed, but there may be ways to modify the state of a figure without marking it as `stale`. Please report these cases as bugs.

A more object-oriented alternative, given any *Figure* instance, *fig*, that was created using a *pyplot* function, is:

```
fig.canvas.draw_idle()
```

#### Examples using matplotlib.pyplot.draw

- `sphinx_glr_gallery_event_handling_ginput_manual_clabel_sgskip.py`
- `sphinx_glr_gallery_mplot3d_rotate_axes3d_sgskip.py`
- `sphinx_glr_gallery_widgets_buttons.py`
- `sphinx_glr_gallery_widgets_check_buttons.py`
- `sphinx_glr_gallery_widgets_radio_buttons.py`

- sphx\_glr\_gallery\_widgets\_textbox.py

### matplotlib.pyplot.errorbar

```
matplotlib.pyplot.errorbar(x, y, yerr=None, xerr=None, fmt="", ecolor=None,
                           linewidth=None, capsize=None, barsabove=False,
                           lolims=False, uplims=False, xlolims=False, xuplims=False,
                           errorevery=1, capthick=None, *, data=None, **kwargs)
```

Plot y versus x as lines and/or markers with attached errorbars.

x, y define the data locations, xerr, yerr define the errorbar sizes. By default, this draws the data markers/lines as well the errorbars. Use `fmt='none'` to draw errorbars without any data markers.

#### Parameters

**x, y** [scalar or array-like] The data positions.

**xerr, yerr** [scalar or array-like, shape(N,) or shape(2,N), optional] The errorbar sizes:

- scalar: Symmetric +/- values for all data points.
- shape(N,): Symmetric +/-values for each data point.
- **shape(2,N): Separate - and + values for each bar. First row** contains the lower errors, the second row contains the upper errors.
- *None*: No errorbar.

Note that all error arrays should have *positive* values.

See [/gallery/statistics/errorbar\\_features](/gallery/statistics/errorbar_features) for an example on the usage of xerr and yerr.

**fmt** [plot format string, optional, default: ""] The format for the data points / data lines. See *plot* for details.

Use 'none' (case insensitive) to plot errorbars without any data markers.

**ecolor** [mpl color, optional, default: None] A matplotlib color arg which gives the color the errorbar lines. If None, use the color of the line connecting the markers.

**linewidth** [scalar, optional, default: None] The linewidth of the errorbar lines. If None, the linewidth of the current style is used.

**capsize** [scalar, optional, default: None] The length of the error bar caps in points. If None, it will take the value from `rcParams["errorbar.capsize"]`.

**capthick** [scalar, optional, default: None] An alias to the keyword argument *markeredgewidth* (a.k.a. *mew*). This setting is a more sensible name for the property that controls the thickness of the error bar cap in points. For backwards compatibility, if *mew* or *markeredgewidth* are given, then they will over-ride *capthick*. This may change in future releases.

**barsabove** [bool, optional, default: False] If True, will plot the errorbars above the plot symbols. Default is below.

**lolims, uplims, xlolims, xuplims** [bool, optional, default: False] These arguments can be used to indicate that a value gives only upper/lower limits. In that case a caret symbol is used to indicate this. *lims*-arguments may be of the same type as *xerr* and *yerr*. To use limits with inverted axes, *set\_xlim()* or *set\_ylim()* must be called before *errorbar()*.

**errorevery** [positive integer, optional, default: 1] Subsamples the errorbars. e.g., if *errorevery*=5, errorbars for every 5-th datapoint will be plotted. The data plot itself still shows all data points.

**Returns**

**container** [*ErrorbarContainer*] The container contains:

- *plotline*: *Line2D* instance of x, y plot markers and/or line.
- *caplines*: A tuple of *Line2D* instances of the error bar caps.
- *barlinecols*: A tuple of *LineCollection* with the horizontal and vertical error ranges.

**Other Parameters**

**\*\*kwargs** All other keyword arguments are passed on to the plot command for the markers. For example, this code makes big red squares with thick green edges:

```
x,y,yerr = rand(3,10)
errorbar(x, y, yerr, marker='s', mfc='red',
         mec='green', ms=20, mew=4)
```

where *mfc*, *mec*, *ms* and *mew* are aliases for the longer property names, *markerfacecolor*, *markeredgcolor*, *markersize* and *markeredgewidth*.

Valid kwargs for the marker properties are Lines2D properties:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m,
<i>alpha</i>		float
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i>		bool
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>color</i> or <i>c</i>		color
<i>contains</i>		callable
<i>dash_capstyle</i>		{'butt', 'round', 'projecting'}
<i>dash_joinstyle</i>		{'miter', 'round', 'bevel'}
<i>dashes</i>		sequence of floats (on/off ink in points) or (None, None)
<i>drawstyle</i> or <i>ds</i>		{'default', 'steps', 'steps-pre', 'steps-mid', 'steps-post'}, default: 'default'
<i>figure</i>		<i>Figure</i>
<i>fillstyle</i>		{'full', 'left', 'right', 'bottom', 'top', 'none'}

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	Property	Description
<i>gid</i>		str
<i>in_layout</i>		bool
<i>label</i>		object
<i>linestyle</i> or <i>ls</i>		{ '-', ' - ', '- . ', ': ', "", (offset, on-off-seq), ... }
<i>linewidth</i> or <i>lw</i>		float
<i>marker</i>		marker style
<i>markeredgewidth</i> or <i>mew</i>		float
<i>markerfacecolor</i> or <i>mfc</i>		color
<i>markerfacecoloralt</i> or <i>mfcalt</i>		color
<i>markersize</i> or <i>ms</i>		float
<i>markevery</i>		None or int or (int, int) or slice or List[int] or float or (float, float)
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		float or callable[[Artist, Event], Tuple[bool, dict]]
<i>pickradius</i>		float
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>solid_capstyle</i>		{ 'butt', 'round', 'projecting' }
<i>solid_joinstyle</i>		{ 'miter', 'round', 'bevel' }
<i>transform</i>		<i>matplotlib.transforms.Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>xdata</i>		1D array
<i>ydata</i>		1D array
<i>zorder</i>		float

## Notes

**Note:** In addition to the above described arguments, this function can take a **data** key-word argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x', 'xerr', 'y', 'yerr'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

## Examples using `matplotlib.pyplot.errorbar`

- `sphx_glr_gallery_lines_bars_and_markers_errorbar_limits_simple.py`

`matplotlib.pyplot.eventplot`

```
matplotlib.pyplot.eventplot(positions, orientation='horizontal', lineoffsets=1,
                           linelengths=1, linewidths=None, colors=None,
                           linestyle='solid', *, data=None, **kwargs)
```

Plot identical parallel lines at the given positions.

*positions* should be a 1D or 2D array-like object, with each row corresponding to a row or column of lines.

This type of plot is commonly used in neuroscience for representing neural events, where it is usually called a spike raster, dot raster, or raster plot.

However, it is useful in any situation where you wish to show the timing or position of multiple sets of discrete events, such as the arrival times of people to a business on each day of the month or the date of hurricanes each year of the last century.

**Parameters**

**positions** [1D or 2D array-like object] Each value is an event. If *positions* is a 2D array-like, each row corresponds to a row or a column of lines (depending on the *orientation* parameter).

**orientation** [{'horizontal', 'vertical'}, optional] Controls the direction of the event collections:

- 'horizontal' : the lines are arranged horizontally in rows, and are vertical.
- 'vertical' : the lines are arranged vertically in columns, and are horizontal.

**lineoffsets** [scalar or sequence of scalars, optional, default: 1] The offset of the center of the lines from the origin, in the direction orthogonal to *orientation*.

**linelengths** [scalar or sequence of scalars, optional, default: 1] The total height of the lines (i.e. the lines stretches from `lineoffset - linelength/2` to `lineoffset + linelength/2`).

**linewidths** [scalar, scalar sequence or None, optional, default: None] The line width(s) of the event lines, in points. If it is None, defaults to its rcParams setting.

**colors** [color, sequence of colors or None, optional, default: None] The color(s) of the event lines. If it is None, defaults to its rcParams setting.

**linestyles** [str or tuple or a sequence of such values, optional] Default is 'solid'. Valid strings are ['solid', 'dashed', 'dashdot', 'dotted', '-', '-.', '-.', ':']. Dash tuples should be of the form:

```
(offset, onoffseq),
```

where *onoffseq* is an even length tuple of on and off ink in points.

**\*\*kwargs** [optional] Other keyword arguments are line collection properties. See *LineCollection* for a list of the valid properties.

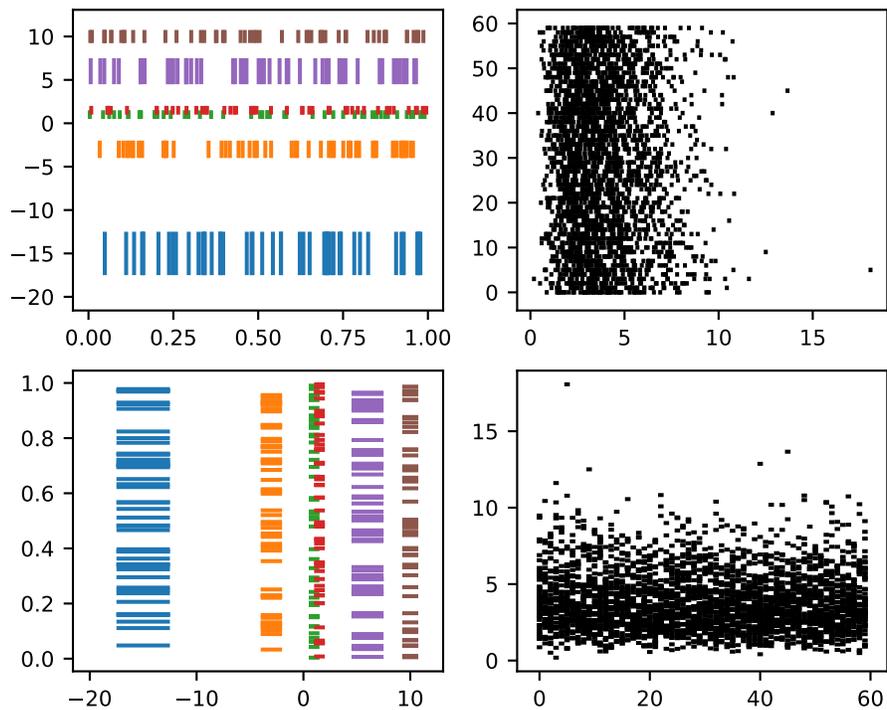
**Returns**

**list** [A list of *EventCollection* objects.] Contains the *EventCollection* that were added.

## Notes

For *linelengths*, *linewidths*, *colors*, and *linestyles*, if only a single value is given, that value is applied to all lines. If an array-like is given, it must have the same length as *positions*, and each value will be applied to the corresponding row of the array.

## Examples



**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'colors', 'linelengths', 'lineoffsets', 'linestyles', 'linewidths', 'positions'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

## matplotlib.pyplot.figimage

`matplotlib.pyplot.figimage(*args, **kwargs)`  
Add a non-resampled image to the figure.

The image is attached to the lower or upper left corner depending on *origin*.

### Parameters

**X** The image data. This is an array of one of the following shapes:

- MxN: luminance (grayscale) values
- MxNx3: RGB values
- MxNx4: RGBA values

**xo, yo** [int] The x/y image offset in pixels.

**alpha** [None or float] The alpha blending value.

**norm** [*matplotlib.colors.Normalize*] A *Normalize* instance to map the luminance to the interval [0, 1].

**cmap** [str or *matplotlib.colors.Colormap*] The colormap to use. Default: `rcParams["image.cmap"]`.

**vmin, vmax** [scalar] If *norm* is not given, these values set the data limits for the colormap.

**origin** [{'upper', 'lower'}] Indicates where the [0, 0] index of the array is in the upper left or lower left corner of the axes. Defaults to `rcParams["image.origin"]`.

**resize** [bool] If *True*, resize the figure to match the given image size.

### Returns

*matplotlib.image.FigureImage*

### Other Parameters

**\*\*kwargs** Additional kwargs are *Artist* kwargs passed on to *FigureImage*.

### Notes

`figimage` complements the axes image (`imshow()`) which will be resampled to fit the current axes. If you want a resampled image to fill the entire figure, you can define an *Axes* with extent [0,0,1,1].

Examples:

```
f = plt.figure()
nx = int(f.get_figwidth() * f.dpi)
ny = int(f.get_figheight() * f.dpi)
data = np.random.random((ny, nx))
f.figimage(data)
plt.show()
```

### Examples using `matplotlib.pyplot.figimage`

- `sphx_glr_gallery_images_contours_and_fields_figimage_demo.py`

**matplotlib.pyplot.figlegend**

`matplotlib.pyplot.figlegend(*args, **kwargs)`

Place a legend on the figure.

To make a legend from existing artists on every axes:

```
figlegend()
```

To make a legend for a list of lines and labels:

```
figlegend(
    (line1, line2, line3),
    ('label1', 'label2', 'label3'),
    loc='upper right')
```

These can also be specified by keyword:

```
figlegend(
    handles=(line1, line2, line3),
    labels=('label1', 'label2', 'label3'),
    loc='upper right')
```

**Parameters**

**handles** [sequence of *Artist*, optional] A list of Artists (lines, patches) to be added to the legend. Use this together with *labels*, if you need full control on what is shown in the legend and the automatic mechanism described above is not sufficient.

The length of handles and labels should be the same in this case. If they are not, they are truncated to the smaller length.

**labels** [sequence of strings, optional] A list of labels to show next to the artists. Use this together with *handles*, if you need full control on what is shown in the legend and the automatic mechanism described above is not sufficient.

**Returns**

`matplotlib.legend.Legend` instance

**Other Parameters**

**loc** [str or pair of floats, default: `rcParams["legend.loc"]` ('best' for axes, 'upper right' for figures)] The location of the legend.

The strings 'upper left', 'upper right', 'lower left', 'lower right' place the legend at the corresponding corner of the axes/figure.

The strings 'upper center', 'lower center', 'center left', 'center right' place the legend at the center of the corresponding edge of the axes/figure.

The string 'center' places the legend at the center of the axes/figure.

The string 'best' places the legend at the location, among the nine locations defined so far, with the minimum overlap with other drawn artists. This option can be quite slow for plots with large amounts of

data; your plotting speed may benefit from providing a specific location.

The location can also be a 2-tuple giving the coordinates of the lower-left corner of the legend in axes coordinates (in which case `bbox_to_anchor` will be ignored).

For back-compatibility, 'center right' (but no other location) can also be spelled 'right', and each "string" locations can also be given as a numeric value:

Location String	Location Code
'best'	0
'upper right'	1
'upper left'	2
'lower left'	3
'lower right'	4
'right'	5
'center left'	6
'center right'	7
'lower center'	8
'upper center'	9
'center'	10

**bbox\_to\_anchor** [*BboxBase*, 2-tuple, or 4-tuple of floats] Box that is used to position the legend in conjunction with `loc`. Defaults to `axes.bbox` (if called as a method to `Axes.legend`) or `figure.bbox` (if `Figure.legend`). This argument allows arbitrary placement of the legend.

Bbox coordinates are interpreted in the coordinate system given by `bbox_transform`, with the default transform Axes or Figure coordinates, depending on which legend is called.

If a 4-tuple or *BboxBase* is given, then it specifies the bbox (`x`, `y`, `width`, `height`) that the legend is placed in. To put the legend in the best location in the bottom right quadrant of the axes (or figure):

```
loc='best', bbox_to_anchor=(0.5, 0., 0.5, 0.5)
```

A 2-tuple (`x`, `y`) places the corner of the legend specified by `loc` at `x`, `y`. For example, to put the legend's upper right-hand corner in the center of the axes (or figure) the following keywords can be used:

```
loc='upper right', bbox_to_anchor=(0.5, 0.5)
```

**ncol** [integer] The number of columns that the legend has. Default is 1.

**prop** [None or `matplotlib.font_manager.FontProperties` or dict] The font properties of the legend. If None (default), the current `matplotlib.rcParams` will be used.

**fontsize** [int or float or {'xx-small', 'x-small', 'small', 'medium', 'large', 'x-large', 'xx-large'}] Controls the font size of the legend. If the value is numeric the size will be the absolute font size in points. String values are relative to the current default font size. This argument is only used if `prop` is not specified.

- numpoints** [None or int] The number of marker points in the legend when creating a legend entry for a *Line2D* (line). Default is `None`, which will take the value from `rcParams["legend.numpoints"]`.
- scatterpoints** [None or int] The number of marker points in the legend when creating a legend entry for a *PathCollection* (scatter plot). Default is `None`, which will take the value from `rcParams["legend.scatterpoints"]`.
- scatteryoffsets** [iterable of floats] The vertical offset (relative to the font size) for the markers created for a scatter plot legend entry. 0.0 is at the base the legend text, and 1.0 is at the top. To draw all markers at the same height, set to `[0.5]`. Default is `[0.375, 0.5, 0.3125]`.
- markerscale** [None or int or float] The relative size of legend markers compared with the originally drawn ones. Default is `None`, which will take the value from `rcParams["legend.markerscale"]`.
- markerfirst** [bool] If `True`, legend marker is placed to the left of the legend label. If `False`, legend marker is placed to the right of the legend label. Default is `True`.
- frameon** [None or bool] Control whether the legend should be drawn on a patch (frame). Default is `None`, which will take the value from `rcParams["legend.frameon"]`.
- fancybox** [None or bool] Control whether round edges should be enabled around the *FancyBboxPatch* which makes up the legend's background. Default is `None`, which will take the value from `rcParams["legend.fancybox"]`.
- shadow** [None or bool] Control whether to draw a shadow behind the legend. Default is `None`, which will take the value from `rcParams["legend.shadow"]`.
- framealpha** [None or float] Control the alpha transparency of the legend's background. Default is `None`, which will take the value from `rcParams["legend.framealpha"]`. If shadow is activated and *framealpha* is `None`, the default value is ignored.
- facecolor** [None or "inherit" or a color spec] Control the legend's background color. Default is `None`, which will take the value from `rcParams["legend.facecolor"]`. If "inherit", it will take `rcParams["axes.facecolor"]`.
- edgecolor** [None or "inherit" or a color spec] Control the legend's background patch edge color. Default is `None`, which will take the value from `rcParams["legend.edgecolor"]` If "inherit", it will take `rcParams["axes.edgecolor"]`.
- mode** [{"expand", None}] If mode is set to "expand" the legend will be horizontally expanded to fill the axes area (or `bbox_to_anchor` if defines the legend's size).
- bbox\_transform** [None or *matplotlib.transforms.Transform*] The transform for the bounding box (`bbox_to_anchor`). For a value of `None` (default) the Axes' `transAxes` transform will be used.
- title** [str or None] The legend's title. Default is no title (`None`).

**title\_fontsize: str or None** The fontsize of the legend's title. Default is the default fontsize.

**borderpad** [float or None] The fractional whitespace inside the legend border. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.borderpad"]`.

**labelspacing** [float or None] The vertical space between the legend entries. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.labelspacing"]`.

**handlelength** [float or None] The length of the legend handles. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.handlelength"]`.

**handletextpad** [float or None] The pad between the legend handle and text. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.handletextpad"]`.

**borderaxespad** [float or None] The pad between the axes and legend border. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.borderaxespad"]`.

**columnspacing** [float or None] The spacing between columns. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.columnspacing"]`.

**handler\_map** [dict or None] The custom dictionary mapping instances or types to a legend handler. This `handler_map` updates the default handler map found at `matplotlib.legend.Legend.get_legend_handler_map()`.

## Notes

Not all kinds of artist are supported by the legend command. See *Legend guide* for details.

## `matplotlib.pyplot.fignum_exists`

`matplotlib.pyplot.fignum_exists(num)`

Return whether the figure with the given id exists.

## `matplotlib.pyplot.figtext`

`matplotlib.pyplot.figtext(x, y, s, *args, **kwargs)`

Add text to figure.

### Parameters

**x, y** [float] The position to place the text. By default, this is in figure coordinates, floats in [0, 1]. The coordinate system can be changed using the *transform* keyword.

**s** [str] The text string.

**fontdict** [dictionary, optional, default: None] A dictionary to override the default text properties. If fontdict is None, the defaults are determined by your rc parameters. A property in *kwargs* override the same property in fontdict.

**withdash** [boolean, optional, default: False] Creates a *TextWithDash* instance instead of a *Text* instance.

### Returns

**text** [*Text*]

### Other Parameters

**\*\*kwargs** [*Text* properties] Other miscellaneous text parameters.

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and
<i>alpha</i>	float	
<i>animated</i>	bool	
<i>backgroundcolor</i>	color	
<i>bbox</i>	dict with properties for <i>patches.FancyBboxPatch</i>	
<i>clip_box</i>	<i>Bbox</i>	
<i>clip_on</i>	bool	
<i>clip_path</i>	[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]	
<i>color</i> or <i>c</i>	color	
<i>contains</i>	callable	
<i>figure</i>	<i>Figure</i>	
<i>fontfamily</i> or <i>family</i>	{'FONTNAME', 'serif', 'sans-serif', 'cursive', 'fantasy', 'monospace'}	
<i>fontproperties</i> or <i>font_properties</i>	<i>font_manager.FontProperties</i>	
<i>fontsize</i> or <i>size</i>	{size in points, 'xx-small', 'x-small', 'small', 'medium', 'large', 'x-large'}	
<i>fontstretch</i> or <i>stretch</i>	{a numeric value in range 0-1000, 'ultra-condensed', 'extra-condensed'}	
<i>fontstyle</i> or <i>style</i>	{'normal', 'italic', 'oblique'}	
<i>fontvariant</i> or <i>variant</i>	{'normal', 'small-caps'}	
<i>fontweight</i> or <i>weight</i>	{a numeric value in range 0-1000, 'ultralight', 'light', 'normal', 'regular'}	
<i>gid</i>	str	
<i>horizontalalignment</i> or <i>ha</i>	{'center', 'right', 'left'}	
<i>in_layout</i>	bool	
<i>label</i>	object	
<i>linespacing</i>	float (multiple of font size)	
<i>multialignment</i> or <i>ma</i>	{'left', 'right', 'center'}	
<i>path_effects</i>	<i>AbstractPathEffect</i>	
<i>picker</i>	None or bool or float or callable	
<i>position</i>	(float, float)	
<i>rasterized</i>	bool or None	
<i>rotation</i>	{angle in degrees, 'vertical', 'horizontal'}	
<i>rotation_mode</i>	{None, 'default', 'anchor'}	
<i>sketch_params</i>	(scale: float, length: float, randomness: float)	
<i>snap</i>	bool or None	
<i>text</i>	object	
<i>transform</i>	<i>Transform</i>	
<i>url</i>	str	
<i>usetex</i>	bool or None	
<i>verticalalignment</i> or <i>va</i>	{'center', 'top', 'bottom', 'baseline', 'center_baseline'}	

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	Property	Description
<i>visible</i>	bool	
<i>wrap</i>	bool	
<i>x</i>	float	
<i>y</i>	float	
<i>zorder</i>	float	

**See also:**`Axes.text``pyplot.text`**Examples using `matplotlib.pyplot.figtext`**

- `sphinx_gallery_text_labels_and_annotations_fonts_demo.py`
- `sphinx_gallery_text_labels_and_annotations_fonts_demo_kw.py`

**`matplotlib.pyplot.figure`**

```
matplotlib.pyplot.figure(num=None, figsize=None, dpi=None, facecolor=None,
                        edgecolor=None, frameon=True, FigureClass=<class 'matplotlib.figure.Figure'>, clear=False, **kwargs)
```

Create a new figure.

**Parameters**

**num** [integer or string, optional, default: None] If not provided, a new figure will be created, and the figure number will be incremented. The figure objects holds this number in a `number` attribute. If num is provided, and a figure with this id already exists, make it active, and returns a reference to it. If this figure does not exists, create it and returns it. If num is a string, the window title will be set to this figure's num.

**figsize** [(float, float), optional, default: None] width, height in inches. If not provided, defaults to `rcParams["figure.figsize"] = [6.4, 4.8]`.

**dpi** [integer, optional, default: None] resolution of the figure. If not provided, defaults to `rcParams["figure.dpi"] = 100`.

**facecolor** [color spec] the background color. If not provided, defaults to `rcParams["figure.facecolor"] = 'w'`.

**edgecolor** [color spec] the border color. If not provided, defaults to `rcParams["figure.edgecolor"] = 'w'`.

**frameon** [bool, optional, default: True] If False, suppress drawing the figure frame.

**FigureClass** [subclass of `Figure`] Optionally use a custom `Figure` instance.

**clear** [bool, optional, default: False] If True and the figure already exists, then it is cleared.

## Returns

**figure** [*Figure*] The *Figure* instance returned will also be passed to new *figure\_manager* in the backends, which allows to hook custom *Figure* classes into the pyplot interface. Additional kwargs will be passed to the *Figure* init function.

## Notes

If you are creating many figures, make sure you explicitly call `pyplot.close()` on the figures you are not using, because this will enable pyplot to properly clean up the memory.

`rcParams` defines the default values, which can be modified in the `matplotlibrc` file.

## Examples using `matplotlib.pyplot.figure`

- `sphinx_gallery_gallery_lines_bars_and_markers_errorbar_limits_simple.py`
- `sphinx_gallery_gallery_lines_bars_and_markers_eventcollection_demo.py`
- `sphinx_gallery_gallery_lines_bars_and_markers_fill.py`
- `sphinx_gallery_gallery_lines_bars_and_markers_markevery_prop_cycle.py`
- `sphinx_gallery_gallery_lines_bars_and_markers_psd_demo.py`
- `sphinx_gallery_gallery_lines_bars_and_markers_scatter_hist.py`
- `sphinx_gallery_gallery_images_contours_and_fields_barcode_demo.py`
- `sphinx_gallery_gallery_images_contours_and_fields_figimage_demo.py`
- `sphinx_gallery_gallery_images_contours_and_fields_layer_images.py`
- `sphinx_gallery_gallery_images_contours_and_fields_plot_streamplot.py`
- `sphinx_gallery_gallery_subplots_axes_and_figures_align_labels_demo.py`
- `sphinx_gallery_gallery_subplots_axes_and_figures_axes_zoom_effect.py`
- `sphinx_gallery_gallery_subplots_axes_and_figures_custom_figure_class.py`
- `sphinx_gallery_gallery_subplots_axes_and_figures_demo_constrained_layout.py`
- `sphinx_gallery_gallery_subplots_axes_and_figures_demo_tight_layout.py`
- `sphinx_gallery_gallery_subplots_axes_and_figures_geo_demo.py`
- `sphinx_gallery_gallery_subplots_axes_and_figures_gridspec_multicolumn.py`
- `sphinx_gallery_gallery_subplots_axes_and_figures_gridspec_nested.py`
- `sphinx_gallery_gallery_subplots_axes_and_figures_multiple_figs_demo.py`
- `sphinx_gallery_gallery_pie_and_polar_charts_bar_of_pie.py`
- `sphinx_gallery_gallery_pie_and_polar_charts_polar_legend.py`
- `sphinx_gallery_gallery_pie_and_polar_charts_polar_scatter.py`
- `sphinx_gallery_gallery_text_labels_and_annotations_arrow_demo.py`
- `sphinx_gallery_gallery_text_labels_and_annotations_autowrap.py`
- `sphinx_gallery_gallery_text_labels_and_annotations_demo_text_path.py`

- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_demo\_text\_rotation\_mode.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_dfrac\_demo.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_fancyarrow\_demo.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_mathtext\_asarray.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_mathtext\_examples.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_multiline.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_rainbow\_text.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_stix\_fonts\_demo.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_usetex\_baseline\_test.py
- sphx\_glr\_gallery\_pyplots\_annotation\_polar.py
- sphx\_glr\_gallery\_pyplots\_fig\_axes\_customize\_simple.py
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### matplotlib.pyplot.fill

matplotlib.pyplot.fill(\*args, data=None, \*\*kwargs)  
Plot filled polygons.

#### Parameters

**\*args** [sequence of x, y, [color]] Each polygon is defined by the lists of x and y positions of its nodes, optionally followed by a *color* specifier. See *matplotlib.colors* for supported color specifiers. The standard color cycle is used for polygons without a color specifier.

You can plot multiple polygons by providing multiple x, y, [color] groups.

For example, each of the following is legal:

```
ax.fill(x, y)                # a polygon with default color
ax.fill(x, y, "b")           # a blue polygon
ax.fill(x, y, x2, y2)        # two polygons
ax.fill(x, y, "b", x2, y2, "r") # a blue and a red polygon
```

**data** [indexable object, optional] An object with labelled data. If given, provide the label names to plot in x and y, e.g.:

```
ax.fill("time", "signal",
        data={"time": [0, 1, 2], "signal": [0, 1, 0]})
```

#### Returns

a list of *Polygon*

#### Other Parameters

**\*\*kwargs** [*Polygon* properties]

#### Notes

Use *fill\_between()* if you would like to fill the region between two curves.

#### Examples using matplotlib.pyplot.fill

- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_fill.py
- sphx\_glr\_gallery\_event\_handling\_ginput\_manual\_clabel\_sgskip.py
- sphx\_glr\_gallery\_misc\_fill\_spiral.py

`matplotlib.pyplot.fill_between`

```
matplotlib.pyplot.fill_between(x, y1, y2=0, where=None, interpolate=False,
                              step=None, *, data=None, **kwargs)
```

Fill the area between two horizontal curves.

The curves are defined by the points  $(x, y1)$  and  $(x, y2)$ . This creates one or multiple polygons describing the filled area.

You may exclude some horizontal sections from filling using *where*.

By default, the edges connect the given points directly. Use *step* if the filling should be a step function, i.e. constant in between  $x$ .

**Parameters**

**x** [array (length N)] The x coordinates of the nodes defining the curves.

**y1** [array (length N) or scalar] The y coordinates of the nodes defining the first curve.

**y2** [array (length N) or scalar, optional, default: 0] The y coordinates of the nodes defining the second curve.

**where** [array of bool (length N), optional, default: None] Define *where* to exclude some horizontal regions from being filled. The filled regions are defined by the coordinates  $x[where]$ . More precisely, fill between  $x[i]$  and  $x[i+1]$  if  $where[i]$  and  $where[i+1]$ . Note that this definition implies that an isolated *True* value between two *False* values in *where* will not result in filling. Both sides of the *True* position remain unfilled due to the adjacent *False* values.

**interpolate** [bool, optional] This option is only relevant if *where* is used and the two curves are crossing each other.

Semantically, *where* is often used for  $y1 > y2$  or similar. By default, the nodes of the polygon defining the filled region will only be placed at the positions in the  $x$  array. Such a polygon cannot describe the above semantics close to the intersection. The x-sections containing the intersection are simply clipped.

Setting *interpolate* to *True* will calculate the actual intersection point and extend the filled region up to this point.

**step** [{'pre', 'post', 'mid'}, optional] Define *step* if the filling should be a step function, i.e. constant in between  $x$ . The value determines where the step will occur:

- 'pre': The y value is continued constantly to the left from every  $x$  position, i.e. the interval  $(x[i-1], x[i])$  has the value  $y[i]$ .
- 'post': The y value is continued constantly to the right from every  $x$  position, i.e. the interval  $[x[i], x[i+1])$  has the value  $y[i]$ .
- 'mid': Steps occur half-way between the  $x$  positions.

**Returns**

*PolyCollection* A *PolyCollection* containing the plotted polygons.

**Other Parameters**

**\*\*kwargs** All other keyword arguments are passed on to *PolyCollection*. They control the *Polygon* properties:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and
<i>alpha</i>		float or None
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i> or <i>antialiaseds</i>		bool or sequence of bools
<i>array</i>		ndarray
<i>capstyle</i>		{'butt', 'round', 'projecting'}
<i>clip</i>		a length 2 sequence of floats; may be overridden in methods that have
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>cmap</i>		colormap or registered colormap name
<i>color</i>		color or sequence of rgba tuples
<i>contains</i>		callable
<i>edgecolor</i> or <i>ec</i> or <i>edgecolors</i>		color or sequence of colors or 'face'
<i>facecolor</i> or <i>facecolors</i> or <i>fc</i>		color or sequence of colors
<i>figure</i>		<i>Figure</i>
<i>gid</i>		str
<i>hatch</i>		{'/', '\', ' ', '-', '+', 'x', 'o', 'O', '.', '*'}
<i>in_layout</i>		bool
<i>joinstyle</i>		{'miter', 'round', 'bevel'}
<i>label</i>		object
<i>linestyle</i> or <i>dashes</i> or <i>linestyles</i> or <i>ls</i>		{'-', '--', '-.', ':', "", (offset, on-off-seq), ...}
<i>linewidth</i> or <i>linewidths</i> or <i>lw</i>		float or sequence of floats
<i>norm</i>		<i>Normalize</i>
<i>offset_position</i>		{'screen', 'data'}
<i>offsets</i>		float or sequence of floats
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		None or bool or float or callable
<i>pickradius</i>		unknown
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>transform</i>		<i>Transform</i>
<i>url</i>		str
<i>urls</i>		List[str] or None
<i>visible</i>		bool
<i>zorder</i>		float

**See also:**

*fill\_betweenx* Fill between two sets of x-values.

**Notes**

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced

by **data**[<arg>]:

- All arguments with the following names: 'where', 'x', 'y1', 'y2'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

#### Examples using `matplotlib.pyplot.fill_between`

- `sphinx_glr_gallery_text_labels_and_annotations_mathtext_examples.py`

#### `matplotlib.pyplot.fill_betweenx`

```
matplotlib.pyplot.fill_betweenx(y, x1, x2=0, where=None, step=None, interpolate=False, *, data=None, **kwargs)
```

Fill the area between two vertical curves.

The curves are defined by the points  $(x1, y)$  and  $(x2, y)$ . This creates one or multiple polygons describing the filled area.

You may exclude some vertical sections from filling using *where*.

By default, the edges connect the given points directly. Use *step* if the filling should be a step function, i.e. constant in between *y*.

#### Parameters

**y** [array (length N)] The y coordinates of the nodes defining the curves.

**x1** [array (length N) or scalar] The x coordinates of the nodes defining the first curve.

**x2** [array (length N) or scalar, optional, default: 0] The x coordinates of the nodes defining the second curve.

**where** [array of bool (length N), optional, default: None] Define *where* to exclude some vertical regions from being filled. The filled regions are defined by the coordinates `y[where]`. More precisely, fill between `y[i]` and `y[i+1]` if `where[i]` and `where[i+1]`. Note that this definition implies that an isolated *True* value between two *False* values in *where* will not result in filling. Both sides of the *True* position remain unfilled due to the adjacent *False* values.

**interpolate** [bool, optional] This option is only relevant if *where* is used and the two curves are crossing each other.

Semantically, *where* is often used for  $x1 > x2$  or similar. By default, the nodes of the polygon defining the filled region will only be placed at the positions in the *y* array. Such a polygon cannot describe the above semantics close to the intersection. The y-sections containing the intersection are simply clipped.

Setting *interpolate* to *True* will calculate the actual intersection point and extend the filled region up to this point.

**step** [{'pre', 'post', 'mid'}, optional] Define *step* if the filling should be a step function, i.e. constant in between *y*. The value determines where the step will occur:

- 'pre': The y value is continued constantly to the left from every x position, i.e. the interval (x[i-1], x[i]) has the value y[i].
- 'post': The y value is continued constantly to the right from every x position, i.e. the interval [x[i], x[i+1]) has the value y[i].
- 'mid': Steps occur half-way between the x positions.

**Returns**

*PolyCollection* A *PolyCollection* containing the plotted polygons.

**Other Parameters**

**\*\*kwargs** All other keyword arguments are passed on to *PolyCollection*. They control the *Polygon* properties:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and
<i>alpha</i>		float or None
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i> or <i>antialiaseds</i>		bool or sequence of bools
<i>array</i>		ndarray
<i>capstyle</i>		{'butt', 'round', 'projecting'}
<i>clim</i>		a length 2 sequence of floats; may be overridden in methods that have
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>cmap</i>		colormap or registered colormap name
<i>color</i>		color or sequence of rgba tuples
<i>contains</i>		callable
<i>edgecolor</i> or <i>ec</i> or <i>edgecolors</i>		color or sequence of colors or 'face'
<i>facecolor</i> or <i>facecolors</i> or <i>fc</i>		color or sequence of colors
<i>figure</i>		<i>Figure</i>
<i>gid</i>		str
<i>hatch</i>		{'/', '\', ' ', '-.', '+', 'x', 'o', 'O', '.', '*'}
<i>in_layout</i>		bool
<i>joinstyle</i>		{'miter', 'round', 'bevel'}
<i>label</i>		object
<i>linestyle</i> or <i>dashes</i> or <i>linestyles</i> or <i>ls</i>		{'-', '-.', '-.', ':', "", (offset, on-off-seq), ...}
<i>linewidth</i> or <i>linewidths</i> or <i>lw</i>		float or sequence of floats
<i>norm</i>		<i>Normalize</i>
<i>offset_position</i>		{'screen', 'data'}
<i>offsets</i>		float or sequence of floats
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		None or bool or float or callable
<i>pickradius</i>		unknown
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>transform</i>		<i>Transform</i>
<i>url</i>		str
<i>urls</i>		List[str] or None
<i>visible</i>		bool

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	Property	Description
<code>zorder</code>		float

**See also:**

`fill_between` Fill between two sets of y-values.

**Notes**

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'where', 'x1', 'x2', 'y'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

**matplotlib.pyplot.findobj**

`matplotlib.pyplot.findobj(o=None, match=None, include_self=True)`

Find artist objects.

Recursively find all *Artist* instances contained in the artist.

**Parameters**

**match** A filter criterion for the matches. This can be

- *None*: Return all objects contained in artist.
- A function with signature `def match(artist: Artist) -> bool`. The result will only contain artists for which the function returns *True*.
- A class instance: e.g., *Line2D*. The result will only contain artists of this class or its subclasses (*isinstance* check).

**include\_self** [bool] Include *self* in the list to be checked for a match.

**Returns**

**artists** [list of *Artist*]

**matplotlib.pyplot.flag**

`matplotlib.pyplot.flag()`

Set the colormap to "flag".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

**matplotlib.pyplot.gca**`matplotlib.pyplot.gca(**kwargs)`

Get the current *Axes* instance on the current figure matching the given keyword args, or create one.

**See also:**

`matplotlib.figure.Figure.gca` The figure's gca method.

**Examples**

To get the current polar axes on the current figure:

```
plt.gca(projection='polar')
```

If the current axes doesn't exist, or isn't a polar one, the appropriate axes will be created and then returned.

**Examples using matplotlib.pyplot.gca**

- sphx\_glr\_gallery\_images\_contours\_and\_fields\_image\_annotated\_heatmap.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_multiple\_figs\_demo.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_mathtext\_examples.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_rainbow\_text.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_text\_alignment.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_text\_rotation\_relative\_to\_line.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_usetex\_demo.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_usetex\_fonteffects.py
- sphx\_glr\_gallery\_pyplots\_pyplot\_scales.py
- sphx\_glr\_gallery\_axes\_grid1\_simple\_anchored\_artists.py
- sphx\_glr\_gallery\_event\_handling\_ginput\_manual\_clabel\_sgskip.py
- sphx\_glr\_gallery\_event\_handling\_trifinder\_event\_demo.py
- sphx\_glr\_gallery\_misc\_anchored\_artists.py
- sphx\_glr\_gallery\_misc\_set\_and\_get.py
- sphx\_glr\_gallery\_scales\_custom\_scale.py
- sphx\_glr\_gallery\_scales\_symlog\_demo.py
- sphx\_glr\_gallery\_specialty\_plots\_hinton\_demo.py
- *Pyplot tutorial*
- *Legend guide*
- *Tight Layout guide*

**matplotlib.pyplot.gcf**

```
matplotlib.pyplot.gcf()
```

Get the current figure.

If no current figure exists, a new one is created using *figure()*.

**Examples using matplotlib.pyplot.gcf**

- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_arrow\_demo.py
- sphx\_glr\_gallery\_event\_handling\_trifinder\_event\_demo.py
- *Tight Layout guide*

**matplotlib.pyplot.gci**

```
matplotlib.pyplot.gci()
```

Get the current colorable artist. Specifically, returns the current *ScalarMappable* instance (image or patch collection), or *None* if no images or patch collections have been defined. The commands *imshow()* and *figimage()* create *Image* instances, and the commands *pcolor()* and *scatter()* create *Collection* instances. The current image is an attribute of the current axes, or the nearest earlier axes in the current figure that contains an image.

**Notes**

Historically, the only colorable artists were images; hence the name *gci* (get current image).

**matplotlib.pyplot.get\_current\_fig\_manager**

```
matplotlib.pyplot.get_current_fig_manager()
```

Return the figure manager of the current figure.

The figure manager is a container for the actual backend-dependent window that displays the figure on screen.

If if no current figure exists, a new one is created an its figure manager is returned.

**Returns**

**manager** [*FigureManagerBase* or backend-dependent subclass thereof]

**Examples using matplotlib.pyplot.get\_current\_fig\_manager**

- sphx\_glr\_gallery\_misc\_agg\_buffer.py

### matplotlib.pyplot.get\_figlabels

`matplotlib.pyplot.get_figlabels()`  
Return a list of existing figure labels.

### matplotlib.pyplot.get\_fignums

`matplotlib.pyplot.get_fignums()`  
Return a list of existing figure numbers.

### matplotlib.pyplot.get\_plot\_commands

`matplotlib.pyplot.get_plot_commands()`  
Get a sorted list of all of the plotting commands.

### matplotlib.pyplot.ginput

`matplotlib.pyplot.ginput(*args, **kwargs)`  
Blocking call to interact with a figure.

Wait until the user clicks  $n$  times on the figure, and return the coordinates of each click in a list.

There are three possible interactions:

- Add a point.
- Remove the most recently added point.
- Stop the interaction and return the points added so far.

The actions are assigned to mouse buttons via the arguments *mouse\_add*, *mouse\_pop* and *mouse\_stop*. Mouse buttons are defined by the numbers:

- 1: left mouse button
- 2: middle mouse button
- 3: right mouse button
- None: no mouse button

#### Parameters

**n** [int, optional, default: 1] Number of mouse clicks to accumulate. If negative, accumulate clicks until the input is terminated manually.

**timeout** [scalar, optional, default: 30] Number of seconds to wait before timing out. If zero or negative will never timeout.

**show\_clicks** [bool, optional, default: True] If True, show a red cross at the location of each click.

**mouse\_add** [{1, 2, 3, None}, optional, default: 1 (left click)] Mouse button used to add points.

**mouse\_pop** [{1, 2, 3, None}, optional, default: 3 (right click)] Mouse button used to remove the most recently added point.

**mouse\_stop** [{1, 2, 3, None}, optional, default: 2 (middle click)] Mouse button used to stop input.

### Returns

**points** [list of tuples] A list of the clicked (x, y) coordinates.

### Notes

The keyboard can also be used to select points in case your mouse does not have one or more of the buttons. The delete and backspace keys act like right clicking (i.e., remove last point), the enter key terminates input and any other key (not already used by the window manager) selects a point.

### Examples using `matplotlib.pyplot.ginput`

- sphx\_glr\_gallery\_event\_handling\_ginput\_manual\_clabel\_sgskip.py

### `matplotlib.pyplot.gray`

`matplotlib.pyplot.gray()`  
Set the colormap to "gray".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

### `matplotlib.pyplot.grid`

`matplotlib.pyplot.grid(b=None, which='major', axis='both', **kwargs)`  
Configure the grid lines.

#### Parameters

**b** [bool or None, optional] Whether to show the grid lines. If any *kwargs* are supplied, it is assumed you want the grid on and *b* will be set to True.

If *b* is *None* and there are no *kwargs*, this toggles the visibility of the lines.

**which** [{'major', 'minor', 'both'}, optional] The grid lines to apply the changes on.

**axis** [{'both', 'x', 'y'}, optional] The axis to apply the changes on.

**\*\*kwargs** [*Line2D* properties] Define the line properties of the grid, e.g.:

```
grid(color='r', linestyle='-', linewidth=2)
```

Valid *kwargs* are

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<i>alpha</i>		float
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i>		bool
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>color</i> or <i>c</i>		color
<i>contains</i>		callable
<i>dash_capstyle</i>		{'butt', 'round', 'projecting'}
<i>dash_joinstyle</i>		{'miter', 'round', 'bevel'}
<i>dashes</i>		sequence of floats (on/off ink in points) or (None, None)
<i>drawstyle</i> or <i>ds</i>		{'default', 'steps', 'steps-pre', 'steps-mid', 'steps-post'}, default: 'default'
<i>figure</i>		<i>Figure</i>
<i>fillstyle</i>		{'full', 'left', 'right', 'bottom', 'top', 'none'}
<i>gid</i>		str
<i>in_layout</i>		bool
<i>label</i>		object
<i>linestyle</i> or <i>ls</i>		{'-', '--', '-.', ':', '', (offset, on-off-seq), ...}
<i>linewidth</i> or <i>lw</i>		float
<i>marker</i>		marker style
<i>markeredgewidth</i> or <i>mec</i>		color
<i>markeredgewidth</i> or <i>mew</i>		float
<i>markerfacecolor</i> or <i>mfc</i>		color
<i>markerfacecoloralt</i> or <i>mfcalt</i>		color
<i>markersize</i> or <i>ms</i>		float
<i>markevery</i>		None or int or (int, int) or slice or List[int] or float or (float, float)
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		float or callable[[ <i>Artist</i> , <i>Event</i> ], Tuple[bool, dict]]
<i>pickradius</i>		float
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>solid_capstyle</i>		{'butt', 'round', 'projecting'}
<i>solid_joinstyle</i>		{'miter', 'round', 'bevel'}
<i>transform</i>		<i>matplotlib.transforms.Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>xdata</i>		1D array
<i>ydata</i>		1D array
<i>zorder</i>		float

**Notes**

The axis is drawn as a unit, so the effective *zorder* for drawing the grid is determined by the *zorder* of each axis, not by the *zorder* of the *Line2D* objects comprising the grid. Therefore, to set grid *zorder*, use *set\_axisbelow* or, for more control, call the *set\_zorder* method of each axis.

**Examples using `matplotlib.pyplot.grid`**

- `sphx_glr_gallery_lines_bars_and_markers_nan_test.py`
- `sphx_glr_gallery_subplots_axes_and_figures_geo_demo.py`
- `sphx_glr_gallery_subplots_axes_and_figures_invert_axes.py`
- `sphx_glr_gallery_text_labels_and_annotations_multiline.py`
- `sphx_glr_gallery_pyplots_pyplot_scales.py`
- `sphx_glr_gallery_pyplots_pyplot_text.py`
- `sphx_glr_gallery_misc_custom_projection.py`
- `sphx_glr_gallery_misc_customize_rc.py`
- `sphx_glr_gallery_misc_findobj_demo.py`
- `sphx_glr_gallery_scales_custom_scale.py`
- `sphx_glr_gallery_scales_symlog_demo.py`
- `sphx_glr_gallery_specialty_plots_skewt.py`
- *Pyplot tutorial*

**`matplotlib.pyplot.hexbin`**

```
matplotlib.pyplot.hexbin(x, y, C=None, gridsize=100, bins=None, xscale='linear',
                        yscale='linear', extent=None, cmap=None, norm=None,
                        vmin=None, vmax=None, alpha=None, linewidths=None,
                        edgecolors='face', reduce_C_function=<function mean
                        at 0x7f6977bac268>, mincnt=None, marginals=False, *,
                        data=None, **kwargs)
```

Make a hexagonal binning plot.

Make a hexagonal binning plot of  $x$  versus  $y$ , where  $x$ ,  $y$  are 1-D sequences of the same length,  $N$ . If  $C$  is *None* (the default), this is a histogram of the number of occurrences of the observations at  $(x[i], y[i])$ .

If  $C$  is specified, it specifies values at the coordinate  $(x[i], y[i])$ . These values are accumulated for each hexagonal bin and then reduced according to *reduce\_C\_function*, which defaults to `numpy.mean`. (If  $C$  is specified, it must also be a 1-D sequence of the same length as  $x$  and  $y$ .)

**Parameters**

**$x$ ,  $y$**  [array or masked array]

**$C$**  [array or masked array, optional, default is *None*]

**`gridsize`** [int or (int, int), optional, default is 100] The number of hexagons in the  $x$ -direction, default is 100. The corresponding number of hexagons in the  $y$ -direction is chosen such that the hexagons are approximately regular. Alternatively, `gridsize` can be a tuple with two elements specifying the number of hexagons in the  $x$ -direction and the  $y$ -direction.

**bins** [`'log'` or int or sequence, optional, default is *None*] If *None*, no binning is applied; the color of each hexagon directly corresponds to its count value.

If `'log'`, use a logarithmic scale for the color map. Internally,  $\log_{10}(i+1)$  is used to determine the hexagon color.

If an integer, divide the counts in the specified number of bins, and color the hexagons accordingly.

If a sequence of values, the values of the lower bound of the bins to be used.

**xscale** [`'linear'`, `'log'`], optional, default is `'linear'`] Use a linear or log10 scale on the horizontal axis.

**yscale** [`'linear'`, `'log'`], optional, default is `'linear'`] Use a linear or log10 scale on the vertical axis.

**mincnt** [int > 0, optional, default is *None*] If not *None*, only display cells with more than *mincnt* number of points in the cell

**marginals** [bool, optional, default is *False*] if *marginals* is *True*, plot the marginal density as colormapped rectangles along the bottom of the x-axis and left of the y-axis

**extent** [scalar, optional, default is *None*] The limits of the bins. The default assigns the limits based on *gridsize*, *x*, *y*, *xscale* and *yscale*.

If *xscale* or *yscale* is set to `'log'`, the limits are expected to be the exponent for a power of 10. E.g. for x-limits of 1 and 50 in `'linear'` scale and y-limits of 10 and 1000 in `'log'` scale, enter (1, 50, 1, 3).

Order of scalars is (left, right, bottom, top).

## Returns

**polycollection** A *PolyCollection* instance; use *PolyCollection.get\_array* on this to get the counts in each hexagon.

If *marginals* is *True*, horizontal bar and vertical bar (both *PolyCollections*) will be attached to the return collection as attributes *hbar* and *vbar*.

## Other Parameters

**cmap** [object, optional, default is *None*] a *matplotlib.colors.Colormap* instance. If *None*, defaults to `rc.image.cmap`.

**norm** [object, optional, default is *None*] *matplotlib.colors.Normalize* instance is used to scale luminance data to 0,1.

**vmin, vmax** [scalar, optional, default is *None*] *vmin* and *vmax* are used in conjunction with *norm* to normalize luminance data. If *None*, the min and max of the color array *C* are used. Note if you pass a *norm* instance your settings for *vmin* and *vmax* will be ignored.

**alpha** [scalar between 0 and 1, optional, default is *None*] the alpha value for the patches

**linewidths** [scalar, optional, default is *None*] If *None*, defaults to 1.0.

**edgecolors** [`'face'`, `'none'`, *None*] or color, optional] If `'face'` (the default), draws the edges in the same color as the fill color.

If 'none', no edge is drawn; this can sometimes lead to unsightly unpainted pixels between the hexagons.

If *None*, draws outlines in the default color.

If a matplotlib color arg, draws outlines in the specified color.

## Notes

The standard descriptions of all the *Collection* parameters:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and
<i>alpha</i>		float or None
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i> or <i>antialiaseds</i>		bool or sequence of bools
<i>array</i>		ndarray
<i>capstyle</i>		{'butt', 'round', 'projecting'}
<i>clip</i>		a length 2 sequence of floats; may be overridden in methods that have
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>cmap</i>		colormap or registered colormap name
<i>color</i>		color or sequence of rgba tuples
<i>contains</i>		callable
<i>edgecolor</i> or <i>ec</i> or <i>edgecolors</i>		color or sequence of colors or 'face'
<i>facecolor</i> or <i>facecolors</i> or <i>fc</i>		color or sequence of colors
<i>figure</i>		<i>Figure</i>
<i>gid</i>		str
<i>hatch</i>		{'/', '\', ' ', '-', '+', 'x', 'o', 'O', '.', '*'}
<i>in_layout</i>		bool
<i>joinstyle</i>		{'miter', 'round', 'bevel'}
<i>label</i>		object
<i>linestyle</i> or <i>dashes</i> or <i>linestyles</i> or <i>ls</i>		{'-', '--', '-.', ':', '', (offset, on-off-seq), ...}
<i>linewidth</i> or <i>linewidths</i> or <i>lw</i>		float or sequence of floats
<i>norm</i>		<i>Normalize</i>
<i>offset_position</i>		{'screen', 'data'}
<i>offsets</i>		float or sequence of floats
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		None or bool or float or callable
<i>pickradius</i>		unknown
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>transform</i>		<i>Transform</i>
<i>url</i>		str
<i>urls</i>		List[str] or None
<i>visible</i>		bool
<i>zorder</i>		float

---

**Note:** In addition to the above described arguments, this function can take a **data** key-word argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x', 'y'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

## matplotlib.pyplot.hist

```
matplotlib.pyplot.hist(x, bins=None, range=None, density=None, weights=None,
                       cumulative=False, bottom=None, histtype='bar', align='mid',
                       orientation='vertical', rwidth=None, log=False, color=None,
                       label=None, stacked=False, normed=None, *, data=None,
                       **kwargs)
```

Plot a histogram.

Compute and draw the histogram of  $x$ . The return value is a tuple  $(n, bins, patches)$  or  $([n0, n1, \dots], bins, [patches0, patches1, \dots])$  if the input contains multiple data. See the documentation of the *weights* parameter to draw a histogram of already-binned data.

Multiple data can be provided via  $x$  as a list of datasets of potentially different length  $([x0, x1, \dots])$ , or as a 2-D ndarray in which each column is a dataset. Note that the ndarray form is transposed relative to the list form.

Masked arrays are not supported at present.

### Parameters

**x** [(n,) array or sequence of (n,) arrays] Input values, this takes either a single array or a sequence of arrays which are not required to be of the same length.

**bins** [int or sequence or str, optional] If an integer is given,  $bins + 1$  bin edges are calculated and returned, consistent with `numpy.histogram`.

If *bins* is a sequence, gives bin edges, including left edge of first bin and right edge of last bin. In this case, *bins* is returned unmodified.

All but the last (righthand-most) bin is half-open. In other words, if *bins* is:

```
[1, 2, 3, 4]
```

then the first bin is  $[1, 2)$  (including 1, but excluding 2) and the second  $[2, 3)$ . The last bin, however, is  $[3, 4]$ , which *includes* 4.

Unequally spaced bins are supported if *bins* is a sequence.

With Numpy 1.11 or newer, you can alternatively provide a string describing a binning strategy, such as 'auto', 'sturges', 'fd', 'doane', 'scott', 'rice' or 'sqrt', see `numpy.histogram`.

The default is taken from `rcParams["hist.bins"]`.

**range** [tuple or None, optional] The lower and upper range of the bins. Lower and upper outliers are ignored. If not provided, *range* is  $(x.\text{min}(), x.\text{max}())$ . Range has no effect if *bins* is a sequence.

If *bins* is a sequence or *range* is specified, autoscaling is based on the specified bin range instead of the range of *x*.

Default is `None`

**density** [bool, optional] If `True`, the first element of the return tuple will be the counts normalized to form a probability density, i.e., the area (or integral) under the histogram will sum to 1. This is achieved by dividing the count by the number of observations times the bin width and not dividing by the total number of observations. If *stacked* is also `True`, the sum of the histograms is normalized to 1.

Default is `None` for both *normed* and *density*. If either is set, then that value will be used. If neither are set, then the args will be treated as `False`.

If both *density* and *normed* are set an error is raised.

**weights** [(n, ) array\_like or None, optional] An array of weights, of the same shape as *x*. Each value in *x* only contributes its associated weight towards the bin count (instead of 1). If *normed* or *density* is `True`, the weights are normalized, so that the integral of the density over the range remains 1.

Default is `None`.

This parameter can be used to draw a histogram of data that has already been binned, e.g. using `np.histogram` (by treating each bin as a single point with a weight equal to its count)

```
counts, bins = np.histogram(data)
plt.hist(bins[:-1], bins, weights=counts)
```

(or you may alternatively use `bar()`).

**cumulative** [bool, optional] If `True`, then a histogram is computed where each bin gives the counts in that bin plus all bins for smaller values. The last bin gives the total number of datapoints. If *normed* or *density* is also `True` then the histogram is normalized such that the last bin equals 1. If *cumulative* evaluates to less than 0 (e.g., -1), the direction of accumulation is reversed. In this case, if *normed* and/or *density* is also `True`, then the histogram is normalized such that the first bin equals 1.

Default is `False`

**bottom** [array\_like, scalar, or None] Location of the bottom baseline of each bin. If a scalar, the base line for each bin is shifted by the same amount. If an array, each bin is shifted independently and the length of bottom must match the number of bins. If `None`, defaults to 0.

Default is `None`

**histtype** [{'bar', 'barstacked', 'step', 'stepfilled'}] The type of histogram to draw.

- 'bar' is a traditional bar-type histogram. If multiple data are given the bars are arranged side by side.
- 'barstacked' is a bar-type histogram where multiple data are stacked on top of each other.
- 'step' generates a lineplot that is by default unfilled.
- 'stepfilled' generates a lineplot that is by default filled.

Default is 'bar'

**align** [{'left', 'mid', 'right'}, optional] Controls how the histogram is plotted.

- 'left': bars are centered on the left bin edges.
- 'mid': bars are centered between the bin edges.
- 'right': bars are centered on the right bin edges.

Default is 'mid'

**orientation** [{'horizontal', 'vertical'}, optional] If 'horizontal', *barh* will be used for bar-type histograms and the *bottom* kwarg will be the left edges.

**rwidth** [scalar or None, optional] The relative width of the bars as a fraction of the bin width. If None, automatically compute the width.

Ignored if *histtype* is 'step' or 'stepfilled'.

Default is None

**log** [bool, optional] If True, the histogram axis will be set to a log scale. If *log* is True and *x* is a 1D array, empty bins will be filtered out and only the non-empty (*n*, *bins*, *patches*) will be returned.

Default is False

**color** [color or array\_like of colors or None, optional] Color spec or sequence of color specs, one per dataset. Default (None) uses the standard line color sequence.

Default is None

**label** [str or None, optional] String, or sequence of strings to match multiple datasets. Bar charts yield multiple patches per dataset, but only the first gets the label, so that the legend command will work as expected.

default is None

**stacked** [bool, optional] If True, multiple data are stacked on top of each other. If False multiple data are arranged side by side if *histtype* is 'bar' or on top of each other if *histtype* is 'step'

Default is False

**normed** [bool, optional] Deprecated; use the density keyword argument instead.

## Returns

**n** [array or list of arrays] The values of the histogram bins. See *density* and *weights* for a description of the possible semantics. If input *x* is an array, then this is an array of length *nbins*. If input is a sequence of arrays [*data1*, *data2*, ...], then this is a list of arrays with the values of the histograms for each of the arrays in the same order. The dtype of the array *n* (or of its element arrays) will always be float even if no weighting or normalization is used.

**bins** [array] The edges of the bins. Length *nbins* + 1 (*nbins* left edges and right edge of last bin). Always a single array even when multiple data sets are passed in.

**patches** [list or list of lists] Silent list of individual patches used to create the histogram or list of such list if multiple input datasets.

### Other Parameters

**\*\*kwargs** [*Patch* properties]

### See also:

*hist2d* 2D histograms

### Notes

---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'weights', 'x'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

### Examples using `matplotlib.pyplot.hist`

- `sphx_glr_gallery_subplots_axes_and_figures_axes_demo.py`
- `sphx_glr_gallery_pyplots_pyplot_text.py`
- `sphx_glr_gallery_user_interfaces_svg_histogram_sgskip.py`
- *Pyplot tutorial*
- *Image tutorial*

### `matplotlib.pyplot.hist2d`

```
matplotlib.pyplot.hist2d(x, y, bins=10, range=None, density=False, weights=None,
                        cmin=None, cmax=None, *, data=None, **kwargs)
```

Make a 2D histogram plot.

### Parameters

**x, y** [array\_like, shape (n, )] Input values

**bins** [None or int or [int, int] or array\_like or [array, array]] The bin specification:

- If int, the number of bins for the two dimensions (nx=ny=bins).
- If [int, int], the number of bins in each dimension (nx, ny = bins).
- If array\_like, the bin edges for the two dimensions (x\_edges=y\_edges=bins).
- If [array, array], the bin edges in each dimension (x\_edges, y\_edges = bins).

The default value is 10.

**range** [array\_like shape(2, 2), optional, default: None] The leftmost and rightmost edges of the bins along each dimension (if not specified explicitly in the bins parameters): [[xmin, xmax], [ymin, ymax]]. All values outside of this range will be considered outliers and not tallied in the histogram.

**density** [bool, optional, default: False] Normalize histogram. *normed* is a deprecated synonym for this parameter.

**weights** [array\_like, shape (n, ), optional, default: None] An array of values  $w_i$  weighing each sample ( $x_i, y_i$ ).

**cmin** [scalar, optional, default: None] All bins that has count less than cmin will not be displayed and these count values in the return value count histogram will also be set to nan upon return

**cmax** [scalar, optional, default: None] All bins that has count more than cmax will not be displayed (set to none before passing to imshow) and these count values in the return value count histogram will also be set to nan upon return

### Returns

**h** [2D array] The bi-dimensional histogram of samples x and y. Values in x are histogrammed along the first dimension and values in y are histogrammed along the second dimension.

**xedges** [1D array] The bin edges along the x axis.

**yedges** [1D array] The bin edges along the y axis.

**image** [*QuadMesh*]

### Other Parameters

**cmap** [Colormap or str, optional] A *colors.Colormap* instance. If not set, use rc settings.

**norm** [Normalize, optional] A *colors.Normalize* instance is used to scale luminance data to [0, 1]. If not set, defaults to *colors.Normalize()*.

**vmin/vmax** [None or scalar, optional] Arguments passed to the *Normalize* instance.

**alpha** [0 <= scalar <= 1 or None, optional] The alpha blending value.

### See also:

*hist* 1D histogram plotting

## Notes

- Currently `hist2d` calculates it's own axis limits, and any limits previously set are ignored.
- Rendering the histogram with a logarithmic color scale is accomplished by passing a `colors.LogNorm` instance to the `norm` keyword argument. Likewise, power-law normalization (similar in effect to gamma correction) can be accomplished with `colors.PowerNorm`.

---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'weights', 'x', 'y'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

## Examples using `matplotlib.pyplot.hist2d`

- `sphx_glr_gallery_scales_power_norm.py`

## `matplotlib.pyplot.hlines`

```
matplotlib.pyplot.hlines(y, xmin, xmax, colors='k', linestyle='solid', label="", *,
                        data=None, **kwargs)
```

Plot horizontal lines at each `y` from `xmin` to `xmax`.

### Parameters

**y** [scalar or sequence of scalar] y-indexes where to plot the lines.

**xmin, xmax** [scalar or 1D array\_like] Respective beginning and end of each line. If scalars are provided, all lines will have same length.

**colors** [array\_like of colors, optional, default: 'k']

**linestyles** [{ 'solid', 'dashed', 'dashdot', 'dotted' }, optional]

**label** [string, optional, default: ""]

### Returns

**lines** [*LineCollection*]

### Other Parameters

**\*\*kwargs** [*LineCollection* properties.]

### See also:

`vlines` vertical lines

`axhline` horizontal line across the axes

## Notes

---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'colors', 'xmax', 'xmin', 'y'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

### matplotlib.pyplot.hot

```
matplotlib.pyplot.hot()
    Set the colormap to "hot".
```

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

### matplotlib.pyplot.hsv

```
matplotlib.pyplot.hsv()
    Set the colormap to "hsv".
```

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

### matplotlib.pyplot.imread

```
matplotlib.pyplot.imread(fname, format=None)
    Read an image from a file into an array.
```

#### Parameters

**fname** [str or file-like] The image file to read. This can be a filename, a URL or a Python file-like object opened in read-binary mode.

**format** [str, optional] The image file format assumed for reading the data. If not given, the format is deduced from the filename. If nothing can be deduced, PNG is tried.

#### Returns

**imagedata** [numpy.array] The image data. The returned array has shape

- (M, N) for grayscale images.
- (M, N, 3) for RGB images.
- (M, N, 4) for RGBA images.

## Notes

Matplotlib can only read PNGs natively. Further image formats are supported via the optional dependency on Pillow. Note, URL strings are not compatible with Pillow. Check the [Pillow documentation](#) for more information.

### Examples using `matplotlib.pyplot.imread`

- `sphinx_glr_gallery_images_contours_and_fields_image_clip_path.py`
- `sphinx_glr_gallery_images_contours_and_fields_image_demo.py`
- `sphinx_glr_gallery_images_contours_and_fields_watermark_image.py`
- `sphinx_glr_gallery_text_labels_and_annotations_demo_annotation_box.py`
- `sphinx_glr_gallery_text_labels_and_annotations_demo_text_path.py`
- `sphinx_glr_gallery_misc_demo_ribbon_box.py`

### `matplotlib.pyplot.imsave`

`matplotlib.pyplot.imsave(fname, arr, **kwargs)`

Save an array as an image file.

#### Parameters

- fname** [str or PathLike file-like] A path or a Python file-like object to store the image in. If *format* is not set, then the output format is inferred from the extension of *fname*, if any, and from `rcParams["savefig.format"]` otherwise. If *format* is set, it determines the output format.
- arr** [array-like] The image data. The shape can be one of MxN (luminance), MxNx3 (RGB) or MxNx4 (RGBA).
- vmin, vmax** [scalar, optional] *vmin* and *vmax* set the color scaling for the image by fixing the values that map to the colormap color limits. If either *vmin* or *vmax* is None, that limit is determined from the *arr* min/max value.
- cmap** [str or *Colormap*, optional] A Colormap instance or registered colormap name. The colormap maps scalar data to colors. It is ignored for RGB(A) data. Defaults to `rcParams["image.cmap"]` ('viridis').
- format** [str, optional] The file format, e.g. 'png', 'pdf', 'svg', ... The behavior when this is unset is documented under *fname*.
- origin** [{ 'upper', 'lower' }, optional] Indicates whether the (0, 0) index of the array is in the upper left or lower left corner of the axes. Defaults to `rcParams["image.origin"]` ('upper').
- dpi** [int] The DPI to store in the metadata of the file. This does not affect the resolution of the output image.

**matplotlib.pyplot.imshow**

```
matplotlib.pyplot.imshow(X, cmap=None, norm=None, aspect=None, interpolation=None, alpha=None, vmin=None, vmax=None, origin=None, extent=None, shape=<deprecated parameter>, filternorm=1, filterrad=4.0, imlim=<deprecated parameter>, resample=None, url=None, *, data=None, **kwargs)
```

Display an image, i.e. data on a 2D regular raster.

**Parameters**

**X** [array-like or PIL image] The image data. Supported array shapes are:

- (M, N): an image with scalar data. The data is visualized using a colormap.
- (M, N, 3): an image with RGB values (0-1 float or 0-255 int).
- (M, N, 4): an image with RGBA values (0-1 float or 0-255 int), i.e. including transparency.

The first two dimensions (M, N) define the rows and columns of the image.

Out-of-range RGB(A) values are clipped.

**cmap** [str or *Colormap*, optional] The Colormap instance or registered colormap name used to map scalar data to colors. This parameter is ignored for RGB(A) data. Defaults to `rcParams["image.cmap"]`.

**norm** [*Normalize*, optional] The Normalize instance used to scale scalar data to the [0, 1] range before mapping to colors using *cmap*. By default, a linear scaling mapping the lowest value to 0 and the highest to 1 is used. This parameter is ignored for RGB(A) data.

**aspect** [{'equal', 'auto'} or float, optional] Controls the aspect ratio of the axes. The aspect is of particular relevance for images since it may distort the image, i.e. pixel will not be square.

This parameter is a shortcut for explicitly calling *Axes.set\_aspect*. See there for further details.

- 'equal': Ensures an aspect ratio of 1. Pixels will be square (unless pixel sizes are explicitly made non-square in data coordinates using *extent*).
- 'auto': The axes is kept fixed and the aspect is adjusted so that the data fit in the axes. In general, this will result in non-square pixels.

If not given, use `rcParams["image.aspect"]` (default: 'equal').

**interpolation** [str, optional] The interpolation method used. If *None* `rcParams["image.interpolation"]` is used, which defaults to 'nearest'.

Supported values are 'none', 'nearest', 'bilinear', 'bicubic', 'spline16', 'spline36', 'hanning', 'hamming', 'hermite', 'kaiser', 'quadric', 'catrom', 'gaussian', 'bessel', 'mitchell', 'sinc', 'lanczos'.

If *interpolation* is 'none', then no interpolation is performed on the Agg, ps, pdf and svg backends. Other backends will fall back to 'nearest'. Note that most SVG renders perform interpolation at rendering and that the default interpolation method they implement may differ.

See `/gallery/images_contours_and_fields/interpolation_methods` for an overview of the supported interpolation methods.

Some interpolation methods require an additional radius parameter, which can be set by *filterrad*. Additionally, the antigrain image resize filter is controlled by the parameter *filternorm*.

**alpha** [scalar, optional] The alpha blending value, between 0 (transparent) and 1 (opaque). This parameter is ignored for RGBA input data.

**vmin, vmax** [scalar, optional] When using scalar data and no explicit *norm*, *vmin* and *vmax* define the data range that the colormap covers. By default, the colormap covers the complete value range of the supplied data. *vmin*, *vmax* are ignored if the *norm* parameter is used.

**origin** [{'upper', 'lower'}, optional] Place the [0,0] index of the array in the upper left or lower left corner of the axes. The convention 'upper' is typically used for matrices and images. If not given, `rcParams["image.origin"]` is used, defaulting to 'upper'.

Note that the vertical axis points upward for 'lower' but downward for 'upper'.

See the *origin and extent in imshow* tutorial for examples and a more detailed description.

**extent** [scalars (left, right, bottom, top), optional] The bounding box in data coordinates that the image will fill. The image is stretched individually along x and y to fill the box.

The default extent is determined by the following conditions. Pixels have unit size in data coordinates. Their centers are on integer coordinates, and their center coordinates range from 0 to columns-1 horizontally and from 0 to rows-1 vertically.

Note that the direction of the vertical axis and thus the default values for top and bottom depend on *origin*:

- For `origin == 'upper'` the default is `(-0.5, numcols-0.5, numrows-0.5, -0.5)`.
- For `origin == 'lower'` the default is `(-0.5, numcols-0.5, -0.5, numrows-0.5)`.

See the *origin and extent in imshow* tutorial for examples and a more detailed description.

**filternorm** [bool, optional, default: True] A parameter for the antigrain image resize filter (see the antigrain documentation). If *filternorm* is set, the filter normalizes integer values and corrects the rounding errors. It doesn't do anything with the source floating point values, it corrects only integers according to the rule of 1.0 which means that any sum of pixel weights must be equal to 1.0. So, the filter function must produce a graph of the proper shape.

**filterrad** [float > 0, optional, default: 4.0] The filter radius for filters that have a radius parameter, i.e. when interpolation is one of: 'sinc', 'lanczos' or 'blackman'.

**resample** [bool, optional] When *True*, use a full resampling method. When *False*, only resample when the output image is larger than the

input image.

**url** [str, optional] Set the url of the created *AxesImage*. See *Artist.set\_url*.

### Returns

**image** [*AxesImage*]

### Other Parameters

**\*\*kwargs** [*Artist* properties] These parameters are passed on to the constructor of the *AxesImage* artist.

### See also:

*imshow* Plot a matrix or an array as an image.

### Notes

Unless *extent* is used, pixel centers will be located at integer coordinates. In other words: the origin will coincide with the center of pixel (0, 0).

There are two common representations for RGB images with an alpha channel:

- Straight (unassociated) alpha: R, G, and B channels represent the color of the pixel, disregarding its opacity.
- Premultiplied (associated) alpha: R, G, and B channels represent the color of the pixel, adjusted for its opacity by multiplication.

*imshow* expects RGB images adopting the straight (unassociated) alpha representation.

---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

### Examples using `matplotlib.pyplot.imshow`

- `sphx_glr_gallery_images_contours_and_fields_affine_image.py`
- `sphx_glr_gallery_images_contours_and_fields_barcode_demo.py`
- `sphx_glr_gallery_images_contours_and_fields_contour_image.py`
- `sphx_glr_gallery_images_contours_and_fields_image_annotated_heatmap.py`
- `sphx_glr_gallery_images_contours_and_fields_image_clip_path.py`
- `sphx_glr_gallery_images_contours_and_fields_image_demo.py`
- `sphx_glr_gallery_images_contours_and_fields_image_masked.py`
- `sphx_glr_gallery_images_contours_and_fields_image_transparency_blend.py`
- `sphx_glr_gallery_images_contours_and_fields_interpolation_methods.py`

- sphx\_glr\_gallery\_images\_contours\_and\_fields\_layer\_images.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_multi\_image.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_pcolor\_demo.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_shading\_example.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_subplots\_adjust.py
- sphx\_glr\_gallery\_color\_colorbar\_basics.py
- sphx\_glr\_gallery\_color\_custom\_cmap.py
- sphx\_glr\_gallery\_shapes\_and\_collections\_dolphin.py
- *Animated image using a precomputed list of images*
- sphx\_glr\_gallery\_misc\_hyperlinks\_sgskip.py
- *Image tutorial*
- *Tight Layout guide*

### **matplotlib.pyplot.inferno**

`matplotlib.pyplot.inferno()`  
Set the colormap to "inferno".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

### **matplotlib.pyplot.install\_repl\_displayhook**

`matplotlib.pyplot.install_repl_displayhook()`  
Install a repl display hook so that any stale figure are automatically redrawn when control is returned to the repl.

This works both with IPython and with vanilla python shells.

### **matplotlib.pyplot.ioff**

`matplotlib.pyplot.ioff()`  
Turn the interactive mode off.

#### **Examples using matplotlib.pyplot.ioff**

- *Usage Guide*

### **matplotlib.pyplot.ion**

`matplotlib.pyplot.ion()`  
Turn the interactive mode on.

## Examples using `matplotlib.pyplot.ion`

- *Usage Guide*

### `matplotlib.pyplot.isinteractive`

`matplotlib.pyplot.isinteractive()`  
Return the status of interactive mode.

### `matplotlib.pyplot.jet`

`matplotlib.pyplot.jet()`  
Set the colormap to "jet".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

### `matplotlib.pyplot.legend`

`matplotlib.pyplot.legend(*args, **kwargs)`  
Place a legend on the axes.

Call signatures:

```
legend()
legend(labels)
legend(handles, labels)
```

The call signatures correspond to three different ways how to use this method.

#### **1. Automatic detection of elements to be shown in the legend**

The elements to be added to the legend are automatically determined, when you do not pass in any extra arguments.

In this case, the labels are taken from the artist. You can specify them either at artist creation or by calling the `set_label()` method on the artist:

```
line, = ax.plot([1, 2, 3], label='Inline label')
ax.legend()
```

or:

```
line, = ax.plot([1, 2, 3])
line.set_label('Label via method')
ax.legend()
```

Specific lines can be excluded from the automatic legend element selection by defining a label starting with an underscore. This is default for all artists, so calling `Axes.legend` without any arguments and without setting the labels manually will result in no legend being drawn.

#### **2. Labeling existing plot elements**

To make a legend for lines which already exist on the axes (via plot for instance), simply call this function with an iterable of strings, one for each legend item. For example:

```
ax.plot([1, 2, 3])
ax.legend(['A simple line'])
```

Note: This way of using is discouraged, because the relation between plot elements and labels is only implicit by their order and can easily be mixed up.

### 3. Explicitly defining the elements in the legend

For full control of which artists have a legend entry, it is possible to pass an iterable of legend artists followed by an iterable of legend labels respectively:

```
legend((line1, line2, line3), ('label1', 'label2', 'label3'))
```

#### Parameters

**handles** [sequence of *Artist*, optional] A list of Artists (lines, patches) to be added to the legend. Use this together with *labels*, if you need full control on what is shown in the legend and the automatic mechanism described above is not sufficient.

The length of handles and labels should be the same in this case. If they are not, they are truncated to the smaller length.

**labels** [sequence of strings, optional] A list of labels to show next to the artists. Use this together with *handles*, if you need full control on what is shown in the legend and the automatic mechanism described above is not sufficient.

#### Returns

*matplotlib.legend.Legend* instance

#### Other Parameters

**loc** [str or pair of floats, default: `rcParams["legend.loc"]`] ('best' for axes, 'upper right' for figures) The location of the legend.

The strings 'upper left', 'upper right', 'lower left', 'lower right' place the legend at the corresponding corner of the axes/figure.

The strings 'upper center', 'lower center', 'center left', 'center right' place the legend at the center of the corresponding edge of the axes/figure.

The string 'center' places the legend at the center of the axes/figure.

The string 'best' places the legend at the location, among the nine locations defined so far, with the minimum overlap with other drawn artists. This option can be quite slow for plots with large amounts of data; your plotting speed may benefit from providing a specific location.

The location can also be a 2-tuple giving the coordinates of the lower-left corner of the legend in axes coordinates (in which case *bbox\_to\_anchor* will be ignored).

For back-compatibility, 'center right' (but no other location) can also be spelled 'right', and each "string" locations can also be given as a numeric value:

Location String	Location Code
'best'	0
'upper right'	1
'upper left'	2
'lower left'	3
'lower right'	4
'right'	5
'center left'	6
'center right'	7
'lower center'	8
'upper center'	9
'center'	10

**bbox\_to\_anchor** [*BboxBase*, 2-tuple, or 4-tuple of floats] Box that is used to position the legend in conjunction with *loc*. Defaults to `axes.bbox` (if called as a method to `Axes.legend`) or `figure.bbox` (if `Figure.legend`). This argument allows arbitrary placement of the legend.

Bbox coordinates are interpreted in the coordinate system given by `bbox_transform`, with the default transform Axes or Figure coordinates, depending on which legend is called.

If a 4-tuple or *BboxBase* is given, then it specifies the bbox (`x`, `y`, `width`, `height`) that the legend is placed in. To put the legend in the best location in the bottom right quadrant of the axes (or figure):

```
loc='best', bbox_to_anchor=(0.5, 0., 0.5, 0.5)
```

A 2-tuple (`x`, `y`) places the corner of the legend specified by *loc* at `x`, `y`. For example, to put the legend's upper right-hand corner in the center of the axes (or figure) the following keywords can be used:

```
loc='upper right', bbox_to_anchor=(0.5, 0.5)
```

**ncol** [integer] The number of columns that the legend has. Default is 1.

**prop** [None or `matplotlib.font_manager.FontProperties` or dict] The font properties of the legend. If None (default), the current `matplotlib.rcParams` will be used.

**fontsize** [int or float or {'xx-small', 'x-small', 'small', 'medium', 'large', 'x-large', 'xx-large'}] Controls the font size of the legend. If the value is numeric the size will be the absolute font size in points. String values are relative to the current default font size. This argument is only used if `prop` is not specified.

**numpoints** [None or int] The number of marker points in the legend when creating a legend entry for a *Line2D* (line). Default is None, which will take the value from `rcParams["legend.numpoints"]`.

**scatterpoints** [None or int] The number of marker points in the legend when creating a legend entry for a *PathCollection* (scatter plot).

Default is `None`, which will take the value from `rcParams["legend.scatterpoints"]`.

**scatteryoffsets** [iterable of floats] The vertical offset (relative to the font size) for the markers created for a scatter plot legend entry. 0.0 is at the base the legend text, and 1.0 is at the top. To draw all markers at the same height, set to [0.5]. Default is [0.375, 0.5, 0.3125].

**markerscale** [None or int or float] The relative size of legend markers compared with the originally drawn ones. Default is `None`, which will take the value from `rcParams["legend.markerscale"]`.

**markerfirst** [bool] If `True`, legend marker is placed to the left of the legend label. If `False`, legend marker is placed to the right of the legend label. Default is `True`.

**frameon** [None or bool] Control whether the legend should be drawn on a patch (frame). Default is `None`, which will take the value from `rcParams["legend.frameon"]`.

**fancybox** [None or bool] Control whether round edges should be enabled around the `FancyBboxPatch` which makes up the legend's background. Default is `None`, which will take the value from `rcParams["legend.fancybox"]`.

**shadow** [None or bool] Control whether to draw a shadow behind the legend. Default is `None`, which will take the value from `rcParams["legend.shadow"]`.

**framealpha** [None or float] Control the alpha transparency of the legend's background. Default is `None`, which will take the value from `rcParams["legend.framealpha"]`. If shadow is activated and `framealpha` is `None`, the default value is ignored.

**facecolor** [None or "inherit" or a color spec] Control the legend's background color. Default is `None`, which will take the value from `rcParams["legend.facecolor"]`. If "inherit", it will take `rcParams["axes.facecolor"]`.

**edgecolor** [None or "inherit" or a color spec] Control the legend's background patch edge color. Default is `None`, which will take the value from `rcParams["legend.edgecolor"]` If "inherit", it will take `rcParams["axes.edgecolor"]`.

**mode** [{"expand", None}] If mode is set to "expand" the legend will be horizontally expanded to fill the axes area (or `bbox_to_anchor` if defines the legend's size).

**bbox\_transform** [None or `matplotlib.transforms.Transform`] The transform for the bounding box (`bbox_to_anchor`). For a value of `None` (default) the Axes' `transAxes` transform will be used.

**title** [str or None] The legend's title. Default is no title (`None`).

**title\_fontsize: str or None** The fontsize of the legend's title. Default is the default fontsize.

**borderpad** [float or None] The fractional whitespace inside the legend border. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.borderpad"]`.

**labelspacing** [float or None] The vertical space between the legend entries. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.labelspacing"]`.

**handlelength** [float or None] The length of the legend handles. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.handlelength"]`.

**handletextpad** [float or None] The pad between the legend handle and text. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.handletextpad"]`.

**borderaxespad** [float or None] The pad between the axes and legend border. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.borderaxespad"]`.

**columnspacing** [float or None] The spacing between columns. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.columnspacing"]`.

**handler\_map** [dict or None] The custom dictionary mapping instances or types to a legend handler. This `handler_map` updates the default handler map found at `matplotlib.legend.Legend.get_legend_handler_map()`.

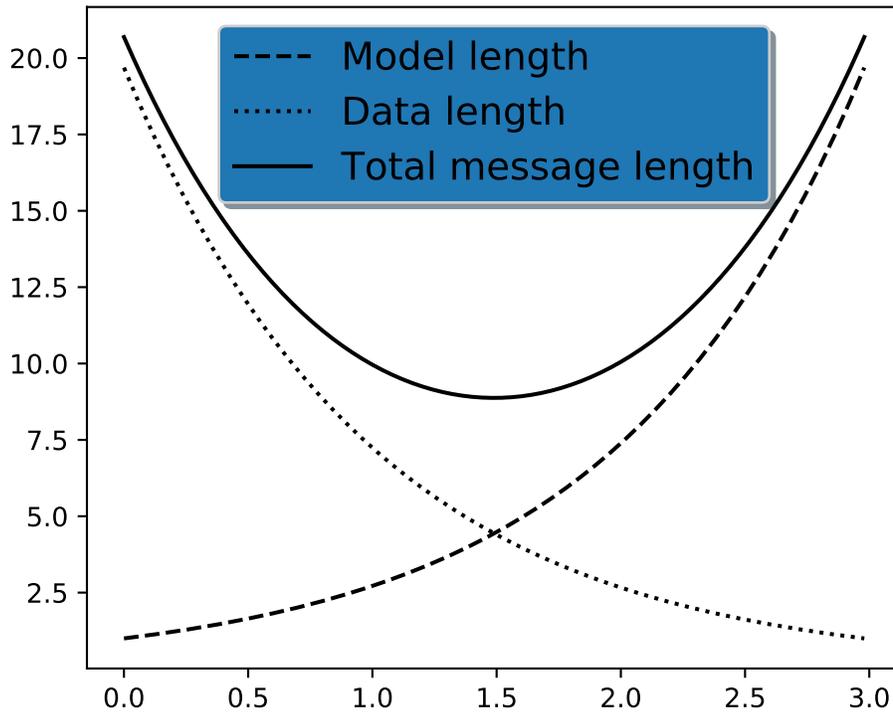
## Notes

Not all kinds of artist are supported by the legend command. See *Legend guide* for details.

## Examples

### Examples using `matplotlib.pyplot.legend`

- `sphx_glr_gallery_lines_bars_and_markers_bar_stacked.py`
- `sphx_glr_gallery_lines_bars_and_markers_errorbar_limits_simple.py`
- `sphx_glr_gallery_lines_bars_and_markers_horizontal_barchart_distribution.py`
- `sphx_glr_gallery_lines_bars_and_markers_masked_demo.py`
- `sphx_glr_gallery_lines_bars_and_markers_scatter_symbol.py`
- `sphx_glr_gallery_lines_bars_and_markers_scatter_with_legend.py`
- `sphx_glr_gallery_lines_bars_and_markers_step_demo.py`
- `sphx_glr_gallery_images_contours_and_fields_contourf_hatching.py`
- `sphx_glr_gallery_images_contours_and_fields_contourf_log.py`
- `sphx_glr_gallery_pie_and_polar_charts_pie_and_donut_labels.py`
- `sphx_glr_gallery_text_labels_and_annotations_legend.py`
- `sphx_glr_gallery_text_labels_and_annotations_usetex_demo.py`
- `sphx_glr_gallery_pyplots_whats_new_98_4_legend.py`
- `sphx_glr_gallery_axes_grid1_parasite_simple.py`



- sphx\_glr\_gallery\_misc\_findobj\_demo.py
- sphx\_glr\_gallery\_misc\_zorder\_demo.py
- sphx\_glr\_gallery\_specialty\_plots\_sankey\_basics.py
- sphx\_glr\_gallery\_user\_interfaces\_svg\_histogram\_sgskip.py
- sphx\_glr\_gallery\_userdemo\_pgf\_preamble\_sgskip.py
- sphx\_glr\_gallery\_userdemo\_simple\_legend01.py
- *Usage Guide*
- *Legend guide*

### matplotlib.pyplot.locator\_params

`matplotlib.pyplot.locator_params(axis='both', tight=None, **kwargs)`  
 Control behavior of major tick locators.

Because the locator is involved in autoscaling, `autoscale_view` is called automatically after the parameters are changed.

#### Parameters

**axis** [`'both'`, `'x'`, `'y'`], optional] The axis on which to operate.

**tight** [bool or None, optional] Parameter passed to *autoscale\_view*. Default is None, for no change.

### Other Parameters

**\*\*kwargs** Remaining keyword arguments are passed to directly to the *set\_params()* method of the locator. Supported keywords depend on the type of the locator. See for example *set\_params* for the *ticker*. *MaxNLocator* used by default for linear axes.

### Examples

When plotting small subplots, one might want to reduce the maximum number of ticks and use tight bounds, for example:

```
ax.locator_params(tight=True, nbins=4)
```

### matplotlib.pyplot.loglog

`matplotlib.pyplot.loglog(*args, **kwargs)`

Make a plot with log scaling on both the x and y axis.

Call signatures:

```
loglog([x], y, [fmt], data=None, **kwargs)
loglog([x], y, [fmt], [x2], y2, [fmt2], ..., **kwargs)
```

This is just a thin wrapper around *plot* which additionally changes both the x-axis and the y-axis to log scaling. All of the concepts and parameters of *plot* can be used here as well.

The additional parameters *basex/y*, *subsx/y* and *nonposx/y* control the x/y-axis properties. They are just forwarded to *Axes.set\_xscale* and *Axes.set\_yscale*.

### Parameters

**basex, basey** [scalar, optional, default 10] Base of the x/y logarithm.

**subsx, subsy** [sequence, optional] The location of the minor x/y ticks. If *None*, reasonable locations are automatically chosen depending on the number of decades in the plot. See *Axes.set\_xscale* / *Axes.set\_yscale* for details.

**nonposx, nonposy** [{'mask', 'clip'}], optional, default 'mask'] Non-positive values in x or y can be masked as invalid, or clipped to a very small positive number.

### Returns

**lines** A list of *Line2D* objects representing the plotted data.

### Other Parameters

**\*\*kwargs** All parameters supported by *plot*.

**matplotlib.pyplot.magma**

`matplotlib.pyplot.magma()`  
Set the colormap to "magma".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

**matplotlib.pyplot.magnitude\_spectrum**

`matplotlib.pyplot.magnitude_spectrum(x, Fs=None, Fc=None, window=None, pad_to=None, sides=None, scale=None, *, data=None, **kwargs)`

Plot the magnitude spectrum.

Compute the magnitude spectrum of  $x$ . Data is padded to a length of `pad_to` and the windowing function `window` is applied to the signal.

**Parameters**

**x** [1-D array or sequence] Array or sequence containing the data.

**Fs** [scalar] The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, `freqs`, in cycles per time unit. The default value is 2.

**window** [callable or ndarray] A function or a vector of length `NFFT`. To create window vectors see `window_hanning`, `window_none`, `numpy.blackman`, `numpy.hamming`, `numpy.bartlett`, `scipy.signal`, `scipy.signal.get_window`, etc. The default is `window_hanning`. If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.

**sides** [{'default', 'onesided', 'twosided'}] Specifies which sides of the spectrum to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. 'onesided' forces the return of a one-sided spectrum, while 'twosided' forces two-sided.

**pad\_to** [int] The number of points to which the data segment is padded when performing the FFT. While not increasing the actual resolution of the spectrum (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the `n` parameter in the call to `fft()`. The default is `None`, which sets `pad_to` equal to the length of the input signal (i.e. no padding).

**scale** [{'default', 'linear', 'dB'}] The scaling of the values in the `spec`. 'linear' is no scaling. 'dB' returns the values in dB scale, i.e., the dB amplitude ( $20 * \log_{10}$ ). 'default' is 'linear'.

**Fc** [int] The center frequency of  $x$  (defaults to 0), which offsets the x extents of the plot to reflect the frequency range used when a signal is acquired and then filtered and downsampled to baseband.

**Returns**

**spectrum** [1-D array] The values for the magnitude spectrum before scaling (real valued).

**freqs** [1-D array] The frequencies corresponding to the elements in *spectrum*.

**line** [a *Line2D* instance] The line created by this function.

**Other Parameters**

**\*\*kwargs** Keyword arguments control the *Line2D* properties:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<i>alpha</i>	float	
<i>animated</i>	bool	
<i>antialiased</i> or <i>aa</i>	bool	
<i>clip_box</i>	<i>Bbox</i>	
<i>clip_on</i>	bool	
<i>clip_path</i>	[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]	
<i>color</i> or <i>c</i>	color	
<i>contains</i>	callable	
<i>dash_capstyle</i>	{'butt', 'round', 'projecting'}	
<i>dash_joinstyle</i>	{'miter', 'round', 'bevel'}	
<i>dashes</i>	sequence of floats (on/off ink in points) or (None, None)	
<i>drawstyle</i> or <i>ds</i>	{'default', 'steps', 'steps-pre', 'steps-mid', 'steps-post'}, default: 'default'	
<i>figure</i>	<i>Figure</i>	
<i>fillstyle</i>	{'full', 'left', 'right', 'bottom', 'top', 'none'}	
<i>gid</i>	str	
<i>in_layout</i>	bool	
<i>label</i>	object	
<i>linestyle</i> or <i>ls</i>	{'-', '--', '-.', ':', '', (offset, on-off-seq), ...}	
<i>linewidth</i> or <i>lw</i>	float	
<i>marker</i>		marker style
<i>markeredgecolor</i> or <i>mec</i>		color
<i>markeredgewidth</i> or <i>mew</i>		float
<i>markerfacecolor</i> or <i>mfc</i>		color
<i>markerfacecoloralt</i> or <i>mfcalt</i>		color
<i>markersize</i> or <i>ms</i>		float
<i>markevery</i>		None or int or (int, int) or slice or List[int] or float or (float, float)
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		float or callable[[ <i>Artist</i> , <i>Event</i> ], Tuple[bool, dict]]
<i>pickradius</i>		float
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>solid_capstyle</i>		{'butt', 'round', 'projecting'}
<i>solid_joinstyle</i>		{'miter', 'round', 'bevel'}
<i>transform</i>		<i>matplotlib.transforms.Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>xdata</i>		1D array
<i>ydata</i>		1D array
<i>zorder</i>		float

**See also:**

`psd()` `psd()` plots the power spectral density.

`angle_spectrum()` `angle_spectrum()` plots the angles of the corresponding frequencies.

`phase_spectrum()` `phase_spectrum()` plots the phase (unwrapped angle) of the corresponding frequencies.

`specgram()` `specgram()` can plot the magnitude spectrum of segments within the signal in a colormap.

## Notes

---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

## matplotlib.pyplot.margins

`matplotlib.pyplot.margins(*margins, x=None, y=None, tight=True)`

Set or retrieve autoscaling margins.

The padding added to each limit of the axes is the *margin* times the data interval. All input parameters must be floats within the range [0, 1]. Passing both positional and keyword arguments is invalid and will raise a `TypeError`. If no arguments (positional or otherwise) are provided, the current margins will remain in place and simply be returned.

Specifying any margin changes only the autoscaling; for example, if *xmargin* is not `None`, then *xmargin* times the X data interval will be added to each end of that interval before it is used in autoscaling.

### Parameters

**\*margins** [float, optional] If a single positional argument is provided, it specifies both margins of the x-axis and y-axis limits. If two positional arguments are provided, they will be interpreted as *xmargin*, *ymargin*. If setting the margin on a single axis is desired, use the keyword arguments described below.

**x, y** [float, optional] Specific margin values for the x-axis and y-axis, respectively. These cannot be used with positional arguments, but can be used individually to alter on e.g., only the y-axis.

**tight** [bool or None, default is True] The *tight* parameter is passed to `autoscale_view()`, which is executed after a margin is changed; the default here is `True`, on the assumption that when margins are specified, no additional padding to match tick marks is usually desired. Set *tight* to `None` will preserve the previous setting.

### Returns

**xmargin, ymargin** [float]

## Notes

If a previously used Axes method such as `pcolor()` has set `use_sticky_edges` to `True`, only the limits not set by the "sticky artists" will be modified. To force all of the margins to be set, set `use_sticky_edges` to `False` before calling `margins()`.

## Examples using `matplotlib.pyplot.margins`

- `sphx_glr_gallery_subplots_axes_and_figures_axes_margins.py`
- `sphx_glr_gallery_ticks_and_spines_ticklabels_rotation.py`

## `matplotlib.pyplot.matshow`

`matplotlib.pyplot.matshow(A, fignum=None, **kwargs)`

Display an array as a matrix in a new figure window.

The origin is set at the upper left hand corner and rows (first dimension of the array) are displayed horizontally. The aspect ratio of the figure window is that of the array, unless this would make an excessively short or narrow figure.

Tick labels for the xaxis are placed on top.

### Parameters

**A** [array-like(M, N)] The matrix to be displayed.

**fignum** [None or int or False] If *None*, create a new figure window with automatic numbering.

If a nonzero integer, draw into the figure with the given number (create it if it does not exist).

If 0, use the current axes (or create one if it does not exist).

---

**Note:** Because of how `Axes.matshow` tries to set the figure aspect ratio to be the one of the array, strange things may happen if you reuse an existing figure.

---

### Returns

**image** [`AxesImage`]

### Other Parameters

**\*\*kwargs** [`imshow` arguments]

## Examples using `matplotlib.pyplot.matshow`

- `sphx_glr_gallery_images_contours_and_fields_matshow.py`

**matplotlib.pyplot.minorticks\_off**

`matplotlib.pyplot.minorticks_off()`  
Remove minor ticks from the axes.

**matplotlib.pyplot.minorticks\_on**

`matplotlib.pyplot.minorticks_on()`  
Display minor ticks on the axes.

Displaying minor ticks may reduce performance; you may turn them off using `minorticks_off()` if drawing speed is a problem.

**matplotlib.pyplot.nipy\_spectral**

`matplotlib.pyplot.nipy_spectral()`  
Set the colormap to "nipy\_spectral".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

**matplotlib.pyplot.pause**

`matplotlib.pyplot.pause(interval)`  
Pause for *interval* seconds.

If there is an active figure, it will be updated and displayed before the pause, and the GUI event loop (if any) will run during the pause.

This can be used for crude animation. For more complex animation, see `matplotlib.animation`.

**Notes**

This function is experimental; its behavior may be changed or extended in a future release.

**Examples using matplotlib.pyplot.pause**

- `sphx_glr_gallery_animation_animation_demo.py`
- `sphx_glr_gallery_mplot3d_rotate_axes3d_sgskip.py`
- `sphx_glr_gallery_mplot3d_wire3d_animation_sgskip.py`

`matplotlib.pyplot.pcolor`

```
matplotlib.pyplot.pcolor(*args, alpha=None, norm=None, cmap=None, vmin=None,
                          vmax=None, data=None, **kwargs)
```

Create a pseudocolor plot with a non-regular rectangular grid.

Call signature:

```
pcolor([X, Y,] C, **kwargs)
```

$X$  and  $Y$  can be used to specify the corners of the quadrilaterals.

---

**Hint:** `pcolor()` can be very slow for large arrays. In most cases you should use the similar but much faster `pcolormesh` instead. See there for a discussion of the differences.

---

### Parameters

**C** [array\_like] A scalar 2-D array. The values will be color-mapped.

**X, Y** [array like, optional] The coordinates of the quadrilateral corners. The quadrilateral for  $C[i, j]$  has corners at:

```
(X[i+1, j], Y[i+1, j])          (X[i+1, j+1], Y[i+1, j+1])
                                +-----+
                                | C[i, j] |
                                +-----+
(X[i, j], Y[i, j])             (X[i, j+1], Y[i, j+1]),
```

Note that the column index corresponds to the x-coordinate, and the row index corresponds to y. For details, see the *Notes* section below.

The dimensions of  $X$  and  $Y$  should be one greater than those of  $C$ . Alternatively,  $X$ ,  $Y$  and  $C$  may have equal dimensions, in which case the last row and column of  $C$  will be ignored.

If  $X$  and/or  $Y$  are 1-D arrays or column vectors they will be expanded as needed into the appropriate 2-D arrays, making a rectangular grid.

**cmap** [str or *Colormap*, optional] A *Colormap* instance or registered colormap name. The colormap maps the  $C$  values to colors. Defaults to `rcParams["image.cmap"]`.

**norm** [*Normalize*, optional] The *Normalize* instance scales the data values to the canonical colormap range [0, 1] for mapping to colors. By default, the data range is mapped to the colorbar range using linear scaling.

**vmin, vmax** [scalar, optional, default: None] The colorbar range. If *None*, suitable min/max values are automatically chosen by the *Normalize* instance (defaults to the respective min/max values of  $C$  in case of the default linear scaling).

**edgecolors** [{'none', None, 'face', color, color sequence}, optional] The color of the edges. Defaults to 'none'. Possible values:

- 'none' or "": No edge.

- *None*: `rcParams["patch.edgecolor"]` will be used. Note that currently `rcParams["patch.force_edgecolor"]` has to be `True` for this to work.
- `'face'`: Use the adjacent face color.
- An `mpl` color or sequence of colors will set the edge color.

The singular form *edgecolor* works as an alias.

**alpha** [scalar, optional, default: `None`] The alpha blending value of the face color, between 0 (transparent) and 1 (opaque). Note: The edgecolor is currently not affected by this.

**snap** [bool, optional, default: `False`] Whether to snap the mesh to pixel boundaries.

**Returns**

**collection** [*matplotlib.collections.Collection*]

**Other Parameters**

**antialiaseds** [bool, optional, default: `False`] The default *antialiaseds* is `False` if the default *edgecolors*="none" is used. This eliminates artificial lines at patch boundaries, and works regardless of the value of *alpha*. If *edgecolors* is not "none", then the default *antialiaseds* is taken from `rcParams["patch.antialiased"]`, which defaults to `True`. Stroking the edges may be preferred if *alpha* is 1, but will cause artifacts otherwise.

**\*\*kwargs** Additionally, the following arguments are allowed. They are passed along to the *PolyCollection* constructor:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and
<i>alpha</i>		float or <code>None</code>
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i> or <i>antialiaseds</i>		bool or sequence of bools
<i>array</i>		ndarray
<i>capstyle</i>		{'butt', 'round', 'projecting'}
<i>clim</i>		a length 2 sequence of floats; may be overridden in methods that have
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   <code>None</code> ]
<i>cmap</i>		colormap or registered colormap name
<i>color</i>		color or sequence of rgba tuples
<i>contains</i>		callable
<i>edgecolor</i> or <i>ec</i> or <i>edgecolors</i>		color or sequence of colors or 'face'
<i>facecolor</i> or <i>facecolors</i> or <i>fc</i>		color or sequence of colors
<i>figure</i>		<i>Figure</i>
<i>gid</i>		str
<i>hatch</i>		{'/', '\', ' ', '-', '+', 'x', 'o', 'O', '.', '*'}
<i>in_layout</i>		bool
<i>joinstyle</i>		{'miter', 'round', 'bevel'}
<i>label</i>		object
<i>linestyle</i> or <i>dashes</i> or <i>linestyles</i> or <i>ls</i>		{'-', '--', '-.', ':', '', (offset, on-off-seq), ...}

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Property	Description
<i>linewidth</i> or <i>linewidths</i> or <i>lw</i>	float or sequence of floats
<i>norm</i>	<i>Normalize</i>
<i>offset_position</i>	{'screen', 'data'}
<i>offsets</i>	float or sequence of floats
<i>path_effects</i>	<i>AbstractPathEffect</i>
<i>picker</i>	None or bool or float or callable
<i>pickradius</i>	unknown
<i>rasterized</i>	bool or None
<i>sketch_params</i>	(scale: float, length: float, randomness: float)
<i>snap</i>	bool or None
<i>transform</i>	<i>Transform</i>
<i>url</i>	str
<i>urls</i>	List[str] or None
<i>visible</i>	bool
<i>zorder</i>	float

**See also:**

*pcolormesh* for an explanation of the differences between *pcolor* and *pcolormesh*.  
*imshow* If *X* and *Y* are each equidistant, *imshow* can be a faster alternative.

**Notes****Masked arrays**

*X*, *Y* and *C* may be masked arrays. If either *C*[*i*, *j*], or one of the vertices surrounding *C*[*i*, *j*] (*X* or *Y* at [*i*, *j*], [*i*+1, *j*], [*i*, *j*+1], [*i*+1, *j*+1]) is masked, nothing is plotted.

**Grid orientation**

The grid orientation follows the standard matrix convention: An array *C* with shape (*nrows*, *ncolumns*) is plotted with the column number as *X* and the row number as *Y*.

**Handling of *pcolor()* end-cases**

*pcolor()* displays all columns of *C* if *X* and *Y* are not specified, or if *X* and *Y* have one more column than *C*. If *X* and *Y* have the same number of columns as *C* then the last column of *C* is dropped. Similarly for the rows.

Note: This behavior is different from MATLAB's *pcolor()*, which always discards the last row and column of *C*.

---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

Objects passed as **data** must support item access (*data*[<arg>]) and membership test (<arg> in *data*).

---

**Examples using `matplotlib.pyplot.pcolor`**

- `sphx_glr_gallery_images_contours_and_fields_pcolor_demo.py`
- `sphx_glr_gallery_subplots_axes_and_figures_axes_margins.py`

**`matplotlib.pyplot.pcolormesh`**

```
matplotlib.pyplot.pcolormesh(*args, alpha=None, norm=None, cmap=None,
                             vmin=None, vmax=None, shading='flat', anti-
                             aliased=False, data=None, **kwargs)
```

Create a pseudocolor plot with a non-regular rectangular grid.

Call signature:

```
pcolor([X, Y,] C, **kwargs)
```

`X` and `Y` can be used to specify the corners of the quadrilaterals.

---

**Note:** `pcolormesh()` is similar to `pcolor()`. It's much faster and preferred in most cases. For a detailed discussion on the differences see *Differences between `pcolor()` and `pcolormesh()`*.

---

**Parameters**

**C** [array\_like] A scalar 2-D array. The values will be color-mapped.

**X, Y** [array\_like, optional] The coordinates of the quadrilateral corners. The quadrilateral for `C[i, j]` has corners at:

```
(X[i+1, j], Y[i+1, j])          (X[i+1, j+1], Y[i+1, j+1])
      +-----+
      | C[i, j] |
      +-----+
(X[i, j], Y[i, j])          (X[i, j+1], Y[i, j+1]),
```

Note that the column index corresponds to the x-coordinate, and the row index corresponds to y. For details, see the *Notes* section below.

The dimensions of `X` and `Y` should be one greater than those of `C`. Alternatively, `X`, `Y` and `C` may have equal dimensions, in which case the last row and column of `C` will be ignored.

If `X` and/or `Y` are 1-D arrays or column vectors they will be expanded as needed into the appropriate 2-D arrays, making a rectangular grid.

**cmap** [str or *Colormap*, optional] A *Colormap* instance or registered colormap name. The colormap maps the `C` values to colors. Defaults to `rcParams["image.cmap"]`.

**norm** [*Normalize*, optional] The *Normalize* instance scales the data values to the canonical colormap range [0, 1] for mapping to colors. By default, the data range is mapped to the colorbar range using linear scaling.

**vmin, vmax** [scalar, optional, default: None] The colorbar range. If *None*, suitable min/max values are automatically chosen by the *Normalize* instance (defaults to the respective min/max values of *C* in case of the default linear scaling).

**edgecolors** [{'none', None, 'face', color, color sequence}, optional] The color of the edges. Defaults to 'none'. Possible values:

- 'none' or "": No edge.
- *None*: `rcParams["patch.edgecolor"]` will be used. Note that currently `rcParams["patch.force_edgecolor"]` has to be True for this to work.
- 'face': Use the adjacent face color.
- An mpl color or sequence of colors will set the edge color.

The singular form *edgecolor* works as an alias.

**alpha** [scalar, optional, default: None] The alpha blending value, between 0 (transparent) and 1 (opaque).

**shading** [{'flat', 'gouraud'}, optional] The fill style, Possible values:

- 'flat': A solid color is used for each quad. The color of the quad (i, j), (i+1, j), (i, j+1), (i+1, j+1) is given by `C[i, j]`.
- 'gouraud': Each quad will be Gouraud shaded: The color of the corners (i', j') are given by `C[i', j']`. The color values of the area in between is interpolated from the corner values. When Gouraud shading is used, *edgecolors* is ignored.

**snap** [bool, optional, default: False] Whether to snap the mesh to pixel boundaries.

**Returns**

**mesh** [`matplotlib.collections.QuadMesh`]

**Other Parameters**

**\*\*kwargs** Additionally, the following arguments are allowed. They are passed along to the *QuadMesh* constructor:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and
<i>alpha</i>		float or None
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i> or <i>antialiaseds</i>		bool or sequence of bools
<i>array</i>		ndarray
<i>capstyle</i>		{'butt', 'round', 'projecting'}
<i>clim</i>		a length 2 sequence of floats; may be overridden in methods that have
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path, Transform</i> )   <i>Patch</i>   None]
<i>cmap</i>		colormap or registered colormap name
<i>color</i>		color or sequence of rgba tuples
<i>contains</i>		callable
<i>edgecolor</i> or <i>ec</i> or <i>edgecolors</i>		color or sequence of colors or 'face'

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	Property	Description
<i>facecolor</i> or <i>facecolors</i> or <i>fc</i>		color or sequence of colors
<i>figure</i>		<i>Figure</i>
<i>gid</i>		str
<i>hatch</i>		{ '/', '\', ' ', '-', '+', 'x', 'o', 'O', '.', '*' }
<i>in_layout</i>		bool
<i>joinstyle</i>		{ 'miter', 'round', 'bevel' }
<i>label</i>		object
<i>linestyle</i> or <i>dashes</i> or <i>linestyles</i> or <i>ls</i>		{ '-', '-.', '-:', ':', '', (offset, on-off-seq), ... }
<i>linewidth</i> or <i>linewidths</i> or <i>lw</i>		float or sequence of floats
<i>norm</i>		<i>Normalize</i>
<i>offset_position</i>		{ 'screen', 'data' }
<i>offsets</i>		float or sequence of floats
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		None or bool or float or callable
<i>pickradius</i>		unknown
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>transform</i>		<i>Transform</i>
<i>url</i>		str
<i>urls</i>		List[str] or None
<i>visible</i>		bool
<i>zorder</i>		float

**See also:**

*pcolor* An alternative implementation with slightly different features. For a detailed discussion on the differences see *Differences between pcolor() and pcolormesh()*.

*imshow* If *X* and *Y* are each equidistant, *imshow* can be a faster alternative.

**Notes****Masked arrays**

*C* may be a masked array. If *C*[*i*, *j*] is masked, the corresponding quadrilateral will be transparent. Masking of *X* and *Y* is not supported. Use *pcolor* if you need this functionality.

**Grid orientation**

The grid orientation follows the standard matrix convention: An array *C* with shape (nrows, ncolumns) is plotted with the column number as *X* and the row number as *Y*.

**Differences between pcolor() and pcolormesh()**

Both methods are used to create a pseudocolor plot of a 2-D array using quadrilaterals.

The main difference lies in the created object and internal data handling: While *pcolor* returns a *PolyCollection*, *pcolormesh* returns a *QuadMesh*. The latter is more specialized for the given purpose and thus is faster. It should almost always be preferred.

There is also a slight difference in the handling of masked arrays. Both *pcolor* and *pcolormesh* support masked arrays for *C*. However, only *pcolor* supports masked arrays

for  $X$  and  $Y$ . The reason lies in the internal handling of the masked values. `pcolor` leaves out the respective polygons from the `PolyCollection`. `pcolormesh` sets the facecolor of the masked elements to transparent. You can see the difference when using edgecolors. While all edges are drawn irrespective of masking in a `QuadMesh`, the edge between two adjacent masked quadrilaterals in `pcolor` is not drawn as the corresponding polygons do not exist in the `PolyCollection`.

Another difference is the support of Gouraud shading in `pcolormesh`, which is not available with `pcolor`.

---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

#### Examples using `matplotlib.pyplot.pcolormesh`

- `sphx_glr_gallery_images_contours_and_fields_pcolor_demo.py`
- `sphx_glr_gallery_images_contours_and_fields_pcolormesh_levels.py`
- `sphx_glr_gallery_images_contours_and_fields_quadmesh_demo.py`

#### `matplotlib.pyplot.phase_spectrum`

```
matplotlib.pyplot.phase_spectrum(x, Fs=None, Fc=None, window=None, pad_to=None,
                                sides=None, *, data=None, **kwargs)
```

Plot the phase spectrum.

Compute the phase spectrum (unwrapped angle spectrum) of  $x$ . Data is padded to a length of `pad_to` and the windowing function `window` is applied to the signal.

##### Parameters

**x** [1-D array or sequence] Array or sequence containing the data

**Fs** [scalar] The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, `freqs`, in cycles per time unit. The default value is 2.

**window** [callable or ndarray] A function or a vector of length `NFFT`. To create window vectors see `window_hanning`, `window_none`, `numpy.blackman`, `numpy.hamming`, `numpy.bartlett`, `scipy.signal`, `scipy.signal.get_window`, etc. The default is `window_hanning`. If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.

**sides** [{'default', 'onesided', 'twosided'}] Specifies which sides of the spectrum to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. 'onesided' forces the return of a one-sided spectrum, while 'twosided' forces two-sided.

**pad\_to** [int] The number of points to which the data segment is padded when performing the FFT. While not increasing the actual resolution of the spectrum (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the  $n$  parameter in the call to `fft()`. The default is `None`, which sets `pad_to` equal to the length of the input signal (i.e. no padding).

**Fc** [int] The center frequency of  $x$  (defaults to 0), which offsets the x extents of the plot to reflect the frequency range used when a signal is acquired and then filtered and downsampled to baseband.

### Returns

**spectrum** [1-D array] The values for the phase spectrum in radians (real valued).

**freqs** [1-D array] The frequencies corresponding to the elements in `spectrum`.

**line** [a `Line2D` instance] The line created by this function.

### Other Parameters

**\*\*kwargs** Keyword arguments control the `Line2D` properties:

	Property	Description
<code>agg_filter</code>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<code>alpha</code>	float	
<code>animated</code>	bool	
<code>antialiased</code> or <code>aa</code>	bool	
<code>clip_box</code>	<code>Bbox</code>	
<code>clip_on</code>	bool	
<code>clip_path</code>	<code>[(Path, Transform)   Patch   None]</code>	
<code>color</code> or <code>c</code>	color	
<code>contains</code>	callable	
<code>dash_capstyle</code>	<code>{'butt', 'round', 'projecting'}</code>	
<code>dash_joinstyle</code>	<code>{'miter', 'round', 'bevel'}</code>	
<code>dashes</code>	sequence of floats (on/off ink in points) or (None, None)	
<code>drawstyle</code> or <code>ds</code>	<code>{'default', 'steps', 'steps-pre', 'steps-mid', 'steps-post'}</code> , default: 'default'	
<code>figure</code>	<code>Figure</code>	
<code>fillstyle</code>	<code>{'full', 'left', 'right', 'bottom', 'top', 'none'}</code>	
<code>gid</code>	str	
<code>in_layout</code>	bool	
<code>label</code>	object	
<code>linestyle</code> or <code>ls</code>	<code>{'-', '--', '-.', ':', "", (offset, on-off-seq), ...}</code>	
<code>linewidth</code> or <code>lw</code>	float	
<code>marker</code>		marker style
<code>markeredgewidth</code> or <code>mew</code>	float	
<code>markerfacecolor</code> or <code>mfc</code>	color	
<code>markerfacecoloralt</code> or <code>mfcalt</code>	color	
<code>markersize</code> or <code>ms</code>	float	
<code>markevery</code>	None or int or (int, int) or slice or List[int] or float or (float, float)	
<code>path_effects</code>	<code>AbstractPathEffect</code>	
<code>picker</code>	float or callable[[ <code>Artist</code> , <code>Event</code> ], Tuple[bool, dict]]	

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	Property	Description
<i>pickradius</i>		float
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>solid_capstyle</i>		{'butt', 'round', 'projecting'}
<i>solid_joinstyle</i>		{'miter', 'round', 'bevel'}
<i>transform</i>		<i>matplotlib.transforms.Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>xdata</i>		1D array
<i>ydata</i>		1D array
<i>zorder</i>		float

**See also:**

*magnitude\_spectrum()* *magnitude\_spectrum()* plots the magnitudes of the corresponding frequencies.

*angle\_spectrum()* *angle\_spectrum()* plots the wrapped version of this function.

*specgram()* *specgram()* can plot the phase spectrum of segments within the signal in a colormap.

**Notes**

**Note:** In addition to the above described arguments, this function can take a **data** key-word argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

**matplotlib.pyplot.pie**

```
matplotlib.pyplot.pie(x, explode=None, labels=None, colors=None, autopct=None,
    pctdistance=0.6, shadow=False, labeldistance=1.1, startangle=None, radius=None,
    counterclock=True, wedgeprops=None, textprops=None, center=(0, 0), frame=False,
    rotatelabels=False, *, data=None)
```

Plot a pie chart.

Make a pie chart of array `x`. The fractional area of each wedge is given by `x/sum(x)`. If `sum(x) < 1`, then the values of `x` give the fractional area directly and the array will not be normalized. The resulting pie will have an empty wedge of size `1 - sum(x)`.

The wedges are plotted counterclockwise, by default starting from the x-axis.

**Parameters**

- x** [array-like] The wedge sizes.
- explode** [array-like, optional, default: None] If not *None*, is a `len(x)` array which specifies the fraction of the radius with which to offset each wedge.
- labels** [list, optional, default: None] A sequence of strings providing the labels for each wedge
- colors** [array-like, optional, default: None] A sequence of matplotlib color args through which the pie chart will cycle. If *None*, will use the colors in the currently active cycle.
- autopct** [None (default), string, or function, optional] If not *None*, is a string or function used to label the wedges with their numeric value. The label will be placed inside the wedge. If it is a format string, the label will be `fmt%pct`. If it is a function, it will be called.
- pctdistance** [float, optional, default: 0.6] The ratio between the center of each pie slice and the start of the text generated by *autopct*. Ignored if *autopct* is *None*.
- shadow** [bool, optional, default: False] Draw a shadow beneath the pie.
- labeldistance** [float or None, optional, default: 1.1] The radial distance at which the pie labels are drawn. If set to *None*, labels are not drawn, but are stored for use in `legend()`
- startangle** [float, optional, default: None] If not *None*, rotates the start of the pie chart by *angle* degrees counterclockwise from the x-axis.
- radius** [float, optional, default: None] The radius of the pie, if *radius* is *None* it will be set to 1.
- counterclock** [bool, optional, default: True] Specify fractions direction, clockwise or counterclockwise.
- wedgeprops** [dict, optional, default: None] Dict of arguments passed to the wedge objects making the pie. For example, you can pass in `wedgeprops = {'linewidth': 3}` to set the width of the wedge border lines equal to 3. For more details, look at the doc/arguments of the wedge object. By default `clip_on=False`.
- textprops** [dict, optional, default: None] Dict of arguments to pass to the text objects.
- center** [list of float, optional, default: (0, 0)] Center position of the chart. Takes value (0, 0) or is a sequence of 2 scalars.
- frame** [bool, optional, default: False] Plot axes frame with the chart if true.
- rotatelabels** [bool, optional, default: False] Rotate each label to the angle of the corresponding slice if true.

### Returns

- patches** [list] A sequence of `matplotlib.patches.Wedge` instances
- texts** [list] A list of the label `matplotlib.text.Text` instances.
- autotexts** [list] A list of `Text` instances for the numeric labels. This will only be returned if the parameter *autopct* is not *None*.

## Notes

The pie chart will probably look best if the figure and axes are square, or the Axes aspect is equal. This method sets the aspect ratio of the axis to "equal". The axes aspect ratio can be controlled with `Axes.set_aspect`.

---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'colors', 'explode', 'labels', 'x'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

## Examples using `matplotlib.pyplot.pie`

- `sphx_glr_gallery_pie_and_polar_charts_pie_features.py`
- `sphx_glr_gallery_pie_and_polar_charts_pie_demo2.py`
- `sphx_glr_gallery_pie_and_polar_charts_nested_pie.py`
- `sphx_glr_gallery_pie_and_polar_charts_pie_and_donut_labels.py`

## `matplotlib.pyplot.pink`

`matplotlib.pyplot.pink()`  
Set the colormap to "pink".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

## `matplotlib.pyplot.plasma`

`matplotlib.pyplot.plasma()`  
Set the colormap to "plasma".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

## `matplotlib.pyplot.plot`

`matplotlib.pyplot.plot(*args, scalex=True, scaley=True, data=None, **kwargs)`  
Plot y versus x as lines and/or markers.

Call signatures:

```
plot([x], y, [fmt], *, data=None, **kwargs)
plot([x], y, [fmt], [x2], y2, [fmt2], ..., **kwargs)
```

The coordinates of the points or line nodes are given by  $x$ ,  $y$ .

The optional parameter *fmt* is a convenient way for defining basic formatting like color, marker and linestyle. It's a shortcut string notation described in the *Notes* section below.

```
>>> plot(x, y)           # plot x and y using default line style and color
>>> plot(x, y, 'bo')    # plot x and y using blue circle markers
>>> plot(y)             # plot y using x as index array 0..N-1
>>> plot(y, 'r+')       # ditto, but with red plusses
```

You can use *Line2D* properties as keyword arguments for more control on the appearance. Line properties and *fmt* can be mixed. The following two calls yield identical results:

```
>>> plot(x, y, 'go--', linewidth=2, markersize=12)
>>> plot(x, y, color='green', marker='o', linestyle='dashed',
...      linewidth=2, markersize=12)
```

When conflicting with *fmt*, keyword arguments take precedence.

### Plotting labelled data

There's a convenient way for plotting objects with labelled data (i.e. data that can be accessed by index `obj['y']`). Instead of giving the data in  $x$  and  $y$ , you can provide the object in the *data* parameter and just give the labels for  $x$  and  $y$ :

```
>>> plot('xlabel', 'ylabel', data=obj)
```

All indexable objects are supported. This could e.g. be a `dict`, a `pandas.DataFrame` or a structured numpy array.

### Plotting multiple sets of data

There are various ways to plot multiple sets of data.

- The most straight forward way is just to call *plot* multiple times. Example:

```
>>> plot(x1, y1, 'bo')
>>> plot(x2, y2, 'go')
```

- Alternatively, if your data is already a 2d array, you can pass it directly to  $x$ ,  $y$ . A separate data set will be drawn for every column.

Example: an array `a` where the first column represents the  $x$  values and the other columns are the  $y$  columns:

```
>>> plot(a[0], a[1:])
```

- The third way is to specify multiple sets of  $[x]$ ,  $y$ , *[fmt]* groups:

```
>>> plot(x1, y1, 'g^', x2, y2, 'g-')
```

In this case, any additional keyword argument applies to all datasets. Also this syntax cannot be combined with the *data* parameter.

By default, each line is assigned a different style specified by a 'style cycle'. The *fmt* and line property parameters are only necessary if you want explicit deviations from these defaults. Alternatively, you can also change the style cycle using the 'axes.prop\_cycle' rcParam.

### Parameters

**x, y** [array-like or scalar] The horizontal / vertical coordinates of the data points. *x* values are optional and default to `range(len(y))`.

Commonly, these parameters are 1D arrays.

They can also be scalars, or two-dimensional (in that case, the columns represent separate data sets).

These arguments cannot be passed as keywords.

**fmt** [str, optional] A format string, e.g. 'ro' for red circles. See the *Notes* section for a full description of the format strings.

Format strings are just an abbreviation for quickly setting basic line properties. All of these and more can also be controlled by keyword arguments.

This argument cannot be passed as keyword.

**data** [indexable object, optional] An object with labelled data. If given, provide the label names to plot in *x* and *y*.

---

**Note:** Technically there's a slight ambiguity in calls where the second label is a valid *fmt*. `plot('n', 'o', data=obj)` could be `plt(x, y)` or `plt(y, fmt)`. In such cases, the former interpretation is chosen, but a warning is issued. You may suppress the warning by adding an empty format string `plot('n', 'o', '', data=obj)`.

---

**Returns**

**lines** A list of *Line2D* objects representing the plotted data.

**Other Parameters**

**scalex, scaley** [bool, optional, default: True] These parameters determined if the view limits are adapted to the data limits. The values are passed on to `autoscale_view`.

**\*\*kwargs** [*Line2D* properties, optional] *kwargs* are used to specify properties like a line label (for auto legends), linewidth, antialiasing, marker face color. Example:

```
>>> plot([1,2,3], [1,2,3], 'go-', label='line 1', linewidth=2)
>>> plot([1,2,3], [1,4,9], 'rs', label='line 2')
```

If you make multiple lines with one plot command, the *kwargs* apply to all those lines.

Here is a list of available *Line2D* properties:

	Property	Description
	<i>agg_filter</i>	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m,
	<i>alpha</i>	float
	<i>animated</i>	bool
	<i>antialiased</i> or <i>aa</i>	bool
	<i>clip_box</i>	<i>Bbox</i>
	<i>clip_on</i>	bool
	<i>clip_path</i>	<code>[(Path, Transform)   Patch   None]</code>

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Property	Description
<code>color</code> or <code>c</code>	color
<code>contains</code>	callable
<code>dash_capstyle</code>	{'butt', 'round', 'projecting'}
<code>dash_joinstyle</code>	{'miter', 'round', 'bevel'}
<code>dashes</code>	sequence of floats (on/off ink in points) or (None, None)
<code>drawstyle</code> or <code>ds</code>	{'default', 'steps', 'steps-pre', 'steps-mid', 'steps-post'}, default: 'default'
<code>figure</code>	<i>Figure</i>
<code>fillstyle</code>	{'full', 'left', 'right', 'bottom', 'top', 'none'}
<code>gid</code>	str
<code>in_layout</code>	bool
<code>label</code>	object
<code>linestyle</code> or <code>ls</code>	{'-', '--', '-.', ':', '', (offset, on-off-seq), ...}
<code>linewidth</code> or <code>lw</code>	float
<code>marker</code>	marker style
<code>markeredgewidth</code> or <code>mec</code>	color
<code>markeredgewidth</code> or <code>mew</code>	float
<code>markerfacecolor</code> or <code>mfc</code>	color
<code>markerfacecoloralt</code> or <code>mfcalt</code>	color
<code>markersize</code> or <code>ms</code>	float
<code>markevery</code>	None or int or (int, int) or slice or List[int] or float or (float, float)
<code>path_effects</code>	<i>AbstractPathEffect</i>
<code>picker</code>	float or callable[[Artist, Event], Tuple[bool, dict]]
<code>pickradius</code>	float
<code>rasterized</code>	bool or None
<code>sketch_params</code>	(scale: float, length: float, randomness: float)
<code>snap</code>	bool or None
<code>solid_capstyle</code>	{'butt', 'round', 'projecting'}
<code>solid_joinstyle</code>	{'miter', 'round', 'bevel'}
<code>transform</code>	<i>matplotlib.transforms.Transform</i>
<code>url</code>	str
<code>visible</code>	bool
<code>xdata</code>	1D array
<code>ydata</code>	1D array
<code>zorder</code>	float

**See also:**

`scatter` XY scatter plot with markers of varying size and/or color ( sometimes also called bubble chart).

**Notes****Format Strings**

A format string consists of a part for color, marker and line:

```
fmt = '[marker][line][color]'
```

Each of them is optional. If not provided, the value from the style cycle is used. Exception: If `line` is given, but no marker, the data will be a line without markers.

Other combinations such as [color] [marker] [line] are also supported, but note that their parsing may be ambiguous.

### Markers

character	description
'.'	point marker
','	pixel marker
'o'	circle marker
'v'	triangle_down marker
'^'	triangle_up marker
'<'	triangle_left marker
'>'	triangle_right marker
'1'	tri_down marker
'2'	tri_up marker
'3'	tri_left marker
'4'	tri_right marker
's'	square marker
'p'	pentagon marker
'*'	star marker
'h'	hexagon1 marker
'H'	hexagon2 marker
'+'	plus marker
'x'	x marker
'D'	diamond marker
'd'	thin_diamond marker
' '	vline marker
'_'	hline marker

### Line Styles

character	description
'-'	solid line style
'--'	dashed line style
'-.'	dash-dot line style
':'	dotted line style

Example format strings:

```
'b'      # blue markers with default shape
'or'     # red circles
'-g'     # green solid line
'--'     # dashed line with default color
'^k:'    # black triangle_up markers connected by a dotted line
```

### Colors

The supported color abbreviations are the single letter codes

character	color
'b'	blue
'g'	green
'r'	red
'c'	cyan
'm'	magenta
'y'	yellow
'k'	black
'w'	white

and the 'CN' colors that index into the default property cycle.

If the color is the only part of the format string, you can additionally use any *matplotlib.colors* spec, e.g. full names ('green') or hex strings ('#008000').

#### Examples using `matplotlib.pyplot.plot`

- `sphx_glr_gallery_lines_bars_and_markers_joinstyle.py`
- `sphx_glr_gallery_lines_bars_and_markers_masked_demo.py`
- `sphx_glr_gallery_lines_bars_and_markers_nan_test.py`
- `sphx_glr_gallery_lines_bars_and_markers_psd_demo.py`
- `sphx_glr_gallery_lines_bars_and_markers_scatter_masked.py`
- `sphx_glr_gallery_lines_bars_and_markers_simple_plot.py`
- `sphx_glr_gallery_lines_bars_and_markers_step_demo.py`
- `sphx_glr_gallery_images_contours_and_fields_triinterp_demo.py`
- `sphx_glr_gallery_subplots_axes_and_figures_axes_demo.py`
- `sphx_glr_gallery_subplots_axes_and_figures_axhspan_demo.py`
- `sphx_glr_gallery_subplots_axes_and_figures_invert_axes.py`
- `sphx_glr_gallery_subplots_axes_and_figures_multiple_figs_demo.py`
- `sphx_glr_gallery_subplots_axes_and_figures_shared_axis_demo.py`
- `sphx_glr_gallery_subplots_axes_and_figures_subplot.py`
- `sphx_glr_gallery_text_labels_and_annotations_legend.py`
- `sphx_glr_gallery_text_labels_and_annotations_multiline.py`
- `sphx_glr_gallery_text_labels_and_annotations_text_fontdict.py`
- `sphx_glr_gallery_text_labels_and_annotations_text_rotation_relative_to_line.py`
- `sphx_glr_gallery_text_labels_and_annotations_titles_demo.py`
- `sphx_glr_gallery_text_labels_and_annotations_usetex_demo.py`
- `sphx_glr_gallery_pyplots_align_ylabel.py`
- `sphx_glr_gallery_pyplots_pyplot_formatstr.py`
- `sphx_glr_gallery_pyplots_pyplot_mathtext.py`

- sphx\_glr\_gallery\_pyplots\_pyplot\_scales.py
- sphx\_glr\_gallery\_pyplots\_pyplot\_simple.py
- sphx\_glr\_gallery\_pyplots\_pyplot\_three.py
- sphx\_glr\_gallery\_pyplots\_pyplot\_two\_subplots.py
- sphx\_glr\_gallery\_pyplots\_whats\_new\_98\_4\_legend.py
- sphx\_glr\_gallery\_color\_color\_by\_yvalue.py
- sphx\_glr\_gallery\_shapes\_and\_collections\_dolphin.py
- sphx\_glr\_gallery\_shapes\_and\_collections\_marker\_path.py
- sphx\_glr\_gallery\_style\_sheets\_plot\_solarizedlight2.py
- *Frame grabbing*
- sphx\_glr\_gallery\_misc\_agg\_buffer.py
- sphx\_glr\_gallery\_misc\_coords\_report.py
- sphx\_glr\_gallery\_misc\_custom\_projection.py
- sphx\_glr\_gallery\_misc\_customize\_rc.py
- sphx\_glr\_gallery\_misc\_findobj\_demo.py
- sphx\_glr\_gallery\_misc\_multipage\_pdf.py
- sphx\_glr\_gallery\_misc\_print\_stdout\_sgskip.py
- sphx\_glr\_gallery\_misc\_set\_and\_get.py
- sphx\_glr\_gallery\_misc\_transoffset.py
- sphx\_glr\_gallery\_misc\_zorder\_demo.py
- sphx\_glr\_gallery\_scales\_custom\_scale.py
- sphx\_glr\_gallery\_scales\_symlog\_demo.py
- sphx\_glr\_gallery\_ticks\_and\_spines\_ticklabels\_rotation.py
- sphx\_glr\_gallery\_user\_interfaces\_toolmanager\_sgskip.py
- sphx\_glr\_gallery\_userdemo\_pgf\_fonts.py
- sphx\_glr\_gallery\_userdemo\_pgf\_preamble\_sgskip.py
- sphx\_glr\_gallery\_userdemo\_pgf\_texsystem.py
- sphx\_glr\_gallery\_userdemo\_simple\_legend01.py
- sphx\_glr\_gallery\_widgets\_buttons.py
- sphx\_glr\_gallery\_widgets\_rectangle\_selector.py
- sphx\_glr\_gallery\_widgets\_slider\_demo.py
- sphx\_glr\_gallery\_widgets\_textbox.py
- *Usage Guide*
- *Pyplot tutorial*
- *Customizing Matplotlib with style sheets and rcParams*
- *Legend guide*

- *Path effects guide*

## matplotlib.pyplot.plot\_date

```
matplotlib.pyplot.plot_date(x, y, fmt='o', tz=None, xdate=True, ydate=False, *,
                           data=None, **kwargs)
```

Plot data that contains dates.

Similar to *plot*, this plots *y* vs. *x* as lines or markers. However, the axis labels are formatted as dates depending on *xdate* and *ydate*.

### Parameters

- x, y** [array-like] The coordinates of the data points. If *xdate* or *ydate* is *True*, the respective values *x* or *y* are interpreted as *Matplotlib dates*.
- fmt** [str, optional] The plot format string. For details, see the corresponding parameter in *plot*.
- tz** [[ *None* | timezone string | *tzinfo* instance]] The time zone to use in labeling dates. If *None*, defaults to `rcParam.timezone`.
- xdate** [bool, optional, default: *True*] If *True*, the x-axis will be interpreted as *Matplotlib dates*.
- ydate** [bool, optional, default: *False*] If *True*, the y-axis will be interpreted as *Matplotlib dates*.

### Returns

- lines** A list of *Line2D* objects representing the plotted data.

### Other Parameters

- \*\*kwargs** Keyword arguments control the *Line2D* properties:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<i>alpha</i>		float
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i>		bool
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   <i>None</i> ]
<i>color</i> or <i>c</i>		color
<i>contains</i>		callable
<i>dash_capstyle</i>		{'butt', 'round', 'projecting'}
<i>dash_joinstyle</i>		{'miter', 'round', 'bevel'}
<i>dashes</i>		sequence of floats (on/off ink in points) or (None, None)
<i>drawstyle</i> or <i>ds</i>		{'default', 'steps', 'steps-pre', 'steps-mid', 'steps-post'}, default: 'default'
<i>figure</i>		<i>Figure</i>
<i>fillstyle</i>		{'full', 'left', 'right', 'bottom', 'top', 'none'}
<i>gid</i>		str
<i>in_layout</i>		bool
<i>label</i>		object
<i>linestyle</i> or <i>ls</i>		{'-', '--', '-.', ':', "", (offset, on-off-seq), ...}

Continued on next page

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Property	Description
<i>linewidth</i> or <i>lw</i>	float
<i>marker</i>	marker style
<i>markeredgewidth</i> or <i>mec</i>	color
<i>markeredgewidth</i> or <i>mew</i>	float
<i>markerfacecolor</i> or <i>mfc</i>	color
<i>markerfacecoloralt</i> or <i>mfcalt</i>	color
<i>markersize</i> or <i>ms</i>	float
<i>markevery</i>	None or int or (int, int) or slice or List[int] or float or (float, float)
<i>path_effects</i>	<i>AbstractPathEffect</i>
<i>picker</i>	float or callable[[Artist, Event], Tuple[bool, dict]]
<i>pickradius</i>	float
<i>rasterized</i>	bool or None
<i>sketch_params</i>	(scale: float, length: float, randomness: float)
<i>snap</i>	bool or None
<i>solid_capstyle</i>	{'butt', 'round', 'projecting'}
<i>solid_joinstyle</i>	{'miter', 'round', 'bevel'}
<i>transform</i>	<i>matplotlib.transforms.Transform</i>
<i>url</i>	str
<i>visible</i>	bool
<i>xdata</i>	1D array
<i>ydata</i>	1D array
<i>zorder</i>	float

**See also:**

*matplotlib.dates* Helper functions on dates.

*matplotlib.dates.date2num* Convert dates to num.

*matplotlib.dates.num2date* Convert num to dates.

*matplotlib.dates.drange* Create an equally spaced sequence of dates.

**Notes**

If you are using custom date tickers and formatters, it may be necessary to set the formatters/locators after the call to *plot\_date*. *plot\_date* will set the default tick locator to *AutoDateLocator* (if the tick locator is not already set to a *DateLocator* instance) and the default tick formatter to *AutoDateFormatter* (if the tick formatter is not already set to a *DateFormatter* instance).

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x', 'y'.

Objects passed as **data** must support item access (*data[<arg>]*) and membership test (*<arg> in data*).

**Examples using `matplotlib.pyplot.plot_date`**

- `sphx_glr_gallery_ticks_and_spines_date_demo_rrule.py`

**`matplotlib.pyplot.plotfile`**

```
matplotlib.pyplot.plotfile(fname, cols=(0, ), plotfuncs=None, comments='#',
                           skiprows=0, checkrows=5, delimiter=', ', names=None,
                           subplots=True, newfig=True, **kwargs)
```

Plot the data in a file.

`cols` is a sequence of column identifiers to plot. An identifier is either an int or a string. If it is an int, it indicates the column number. If it is a string, it indicates the column header. `matplotlib` will make column headers lower case, replace spaces with underscores, and remove all illegal characters; so `'Adj Close*'` will have name `'adj_close'`.

- If `len(cols) == 1`, only that column will be plotted on the y axis.
- If `len(cols) > 1`, the first element will be an identifier for data for the x axis and the remaining elements will be the column indexes for multiple subplots if `subplots` is `True` (the default), or for lines in a single subplot if `subplots` is `False`.

`plotfuncs`, if not `None`, is a dictionary mapping identifier to an *Axes* plotting function as a string. Default is `'plot'`, other choices are `'semilogy'`, `'fill'`, `'bar'`, etc. You must use the same type of identifier in the `cols` vector as you use in the `plotfuncs` dictionary, e.g., integer column numbers in both or column names in both. If `subplots` is `False`, then including any function such as `'semilogy'` that changes the axis scaling will set the scaling for all columns.

- `comments`: the character used to indicate the start of a comment in the file, or `None` to switch off the removal of comments
- `skiprows`: is the number of rows from the top to skip
- `checkrows`: is the number of rows to check to validate the column data type. When set to zero all rows are validated.
- `delimiter`: is the character(s) separating row items
- `names`: if not `None`, is a list of header names. In this case, no header will be read from the file

If `newfig` is `True`, the plot always will be made in a new figure; if `False`, it will be made in the current figure if one exists, else in a new figure.

`kwargs` are passed on to plotting functions.

Example usage:

```
# plot the 2nd and 4th column against the 1st in two subplots
plotfile(fname, (0,1,3))

# plot using column names; specify an alternate plot type for volume
plotfile(fname, ('date', 'volume', 'adj_close'),
          plotfuncs={'volume': 'semilogy'})
```

Note: `plotfile` is intended as a convenience for quickly plotting data from flat files; it is not intended as an alternative interface to general plotting with `pyplot` or `matplotlib`.

**Examples using `matplotlib.pyplot.plotfile`**

- `sphinx_glr_gallery_misc_plotfile_demo.py`

**`matplotlib.pyplot.polar`**`matplotlib.pyplot.polar(*args, **kwargs)`

Make a polar plot.

call signature:

```
polar(theta, r, **kwargs)
```

Multiple *theta*, *r* arguments are supported, with format strings, as in `plot()`.**Examples using `matplotlib.pyplot.polar`**

- `sphinx_glr_gallery_misc_transoffset.py`

**`matplotlib.pyplot.prism`**`matplotlib.pyplot.prism()`

Set the colormap to "prism".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.**`matplotlib.pyplot.psd`**`matplotlib.pyplot.psd(x, NFFT=None, Fs=None, Fc=None, detrend=None, window=None, noverlap=None, pad_to=None, sides=None, scale_by_freq=None, return_line=None, *, data=None, **kwargs)`

Plot the power spectral density.

The power spectral density  $P_{xx}$  by Welch's average periodogram method. The vector  $x$  is divided into  $NFFT$  length segments. Each segment is detrended by function *detrend* and windowed by function *window*. *noverlap* gives the length of the overlap between segments. The  $|\text{fft}(i)|^2$  of each segment  $i$  are averaged to compute  $P_{xx}$ , with a scaling to correct for power loss due to windowing.If  $\text{len}(x) < NFFT$ , it will be zero padded to  $NFFT$ .**Parameters****x** [1-D array or sequence] Array or sequence containing the data**Fs** [scalar] The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, freqs, in cycles per time unit. The default value is 2.

**window** [callable or ndarray] A function or a vector of length  $NFFT$ . To create window vectors see `window_hanning`, `window_none`, `numpy.blackman`, `numpy.hamming`, `numpy.bartlett`, `scipy.signal`, `scipy.signal.get_window`, etc. The default is `window_hanning`. If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.

**sides** [{'default', 'onesided', 'twosided'}] Specifies which sides of the spectrum to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. 'onesided' forces the return of a one-sided spectrum, while 'twosided' forces two-sided.

**pad\_to** [int] The number of points to which the data segment is padded when performing the FFT. This can be different from  $NFFT$ , which specifies the number of data points used. While not increasing the actual resolution of the spectrum (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the  $n$  parameter in the call to `fft()`. The default is `None`, which sets `pad_to` equal to  $NFFT$ .

**NFFT** [int] The number of data points used in each block for the FFT. A power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use `pad_to` for this instead.

**detrend** [{'none', 'mean', 'linear'} or callable, default 'none'] The function applied to each segment before `fft`-ing, designed to remove the mean or linear trend. Unlike in MATLAB, where the `detrend` parameter is a vector, in Matplotlib it is a function. The `mlab` module defines `detrend_none`, `detrend_mean`, and `detrend_linear`, but you can use a custom function as well. You can also use a string to choose one of the functions: 'none' calls `detrend_none`. 'mean' calls `detrend_mean`. 'linear' calls `detrend_linear`.

**scale\_by\_freq** [bool, optional] Specifies whether the resulting density values should be scaled by the scaling frequency, which gives density in units of  $\text{Hz}^{-1}$ . This allows for integration over the returned frequency values. The default is `True` for MATLAB compatibility.

**noverlap** [int] The number of points of overlap between segments. The default value is 0 (no overlap).

**Fc** [int] The center frequency of  $x$  (defaults to 0), which offsets the  $x$  extents of the plot to reflect the frequency range used when a signal is acquired and then filtered and downsampled to baseband.

**return\_line** [bool] Whether to include the line object plotted in the returned values. Default is `False`.

### Returns

**Pxx** [1-D array] The values for the power spectrum  $P_{\{xx\}}$  before scaling (real valued).

**freqs** [1-D array] The frequencies corresponding to the elements in  $P_{xx}$ .

**line** [a `Line2D` instance] The line created by this function. Only returned if `return_line` is `True`.

### Other Parameters

**\*\*kwargs** Keyword arguments control the *Line2D* properties:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m,
<i>alpha</i>		float
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i>		bool
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>color</i> or <i>c</i>		color
<i>contains</i>		callable
<i>dash_capstyle</i>		{'butt', 'round', 'projecting'}
<i>dash_joinstyle</i>		{'miter', 'round', 'bevel'}
<i>dashes</i>		sequence of floats (on/off ink in points) or (None, None)
<i>drawstyle</i> or <i>ds</i>		{'default', 'steps', 'steps-pre', 'steps-mid', 'steps-post'}, default: 'default'
<i>figure</i>		<i>Figure</i>
<i>fillstyle</i>		{'full', 'left', 'right', 'bottom', 'top', 'none'}
<i>gid</i>		str
<i>in_layout</i>		bool
<i>label</i>		object
<i>linestyle</i> or <i>ls</i>		{'-', '--', '-.', ':', '', (offset, on-off-seq), ...}
<i>linewidth</i> or <i>lw</i>		float
<i>marker</i>		marker style
<i>markeredgewidth</i> or <i>mec</i>		color
<i>markeredgewidth</i> or <i>mew</i>		float
<i>markerfacecolor</i> or <i>mfc</i>		color
<i>markerfacecoloralt</i> or <i>mfcalt</i>		color
<i>markersize</i> or <i>ms</i>		float
<i>markevery</i>		None or int or (int, int) or slice or List[int] or float or (float, float)
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		float or callable[[ <i>Artist</i> , <i>Event</i> ], Tuple[bool, dict]]
<i>pickradius</i>		float
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>solid_capstyle</i>		{'butt', 'round', 'projecting'}
<i>solid_joinstyle</i>		{'miter', 'round', 'bevel'}
<i>transform</i>		<i>matplotlib.transforms.Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>xdata</i>		1D array
<i>ydata</i>		1D array
<i>zorder</i>		float

**See also:**

*specgram()* *specgram()* differs in the default overlap; in not returning the mean of the segment periodograms; in returning the times of the segments; and in plotting a colormap instead of a line.

*magnitude\_spectrum()* *magnitude\_spectrum()* plots the magnitude spectrum.

`csd()` `csd()` plots the spectral density between two signals.

### Notes

For plotting, the power is plotted as  $10 \log_{10}(P_{xx})$  for decibels, though  $P_{xx}$  itself is returned.

### References

Bendat & Piersol - Random Data: Analysis and Measurement Procedures, John Wiley & Sons (1986)

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

### Examples using `matplotlib.pyplot.psd`

- `sphx_glr_gallery_lines_bars_and_markers_psd_demo.py`

### `matplotlib.pyplot.quiver`

`matplotlib.pyplot.quiver(*args, data=None, **kw)`

Plot a 2D field of arrows.

Call signature:

```
quiver([X, Y], U, V, [C], **kw)
```

Where  $X, Y$  define the arrow locations,  $U, V$  define the arrow directions, and  $C$  optionally sets the color.

#### Arrow size

The default settings auto-scales the length of the arrows to a reasonable size. To change this behavior see the `scale` and `scale_units` parameters.

#### Arrow shape

The defaults give a slightly swept-back arrow; to make the head a triangle, make `headaxislength` the same as `headlength`. To make the arrow more pointed, reduce `headwidth` or increase `headlength` and `headaxislength`. To make the head smaller relative to the shaft, scale down all the head parameters. You will probably do best to leave `minshaft` alone.

#### Arrow outline

`linewidths` and `edgecolors` can be used to customize the arrow outlines.

## Parameters

**X, Y** [1D or 2D array-like, optional] The x and y coordinates of the arrow locations.

If not given, they will be generated as a uniform integer meshgrid based on the dimensions of  $U$  and  $V$ .

If  $X$  and  $Y$  are 1D but  $U$ ,  $V$  are 2D,  $X$ ,  $Y$  are expanded to 2D using  $x$ ,  $Y = \text{np.meshgrid}(X, Y)$ . In this case  $\text{len}(X)$  and  $\text{len}(Y)$  must match the column and row dimensions of  $U$  and  $V$ .

**U, V** [1D or 2D array-like] The x and y direction components of the arrow vectors.

**C** [1D or 2D array-like, optional] Numeric data that defines the arrow colors by colormapping via *norm* and *cmap*.

This does not support explicit colors. If you want to set colors directly, use *color* instead.

**units** [{*'width'*, *'height'*, *'dots'*, *'inches'*, *'x'*, *'y'*, *'xy'*}, default: *'width'*] The arrow dimensions (except for *length*) are measured in multiples of this unit.

The following values are supported:

- *'width'*, *'height'*: The width or height of the axis.
- *'dots'*, *'inches'*: Pixels or inches based on the figure dpi.
- *'x'*, *'y'*, *'xy'*:  $X$ ,  $Y$  or  $\sqrt{X^2 + Y^2}$  in data units.

The arrows scale differently depending on the units. For *'x'* or *'y'*, the arrows get larger as one zooms in; for other units, the arrow size is independent of the zoom state. For *'width'* or *'height'*, the arrow size increases with the width and height of the axes, respectively, when the window is resized; for *'dots'* or *'inches'*, resizing does not change the arrows.

**angles** [{*'uv'*, *'xy'*} or array-like, optional, default: *'uv'*] Method for determining the angle of the arrows.

- *'uv'*: The arrow axis aspect ratio is 1 so that if  $U == V$  the orientation of the arrow on the plot is 45 degrees counter-clockwise from the horizontal axis (positive to the right).

Use this if the arrows symbolize a quantity that is not based on  $X$ ,  $Y$  data coordinates.

- *'xy'*: Arrows point from  $(x,y)$  to  $(x+u, y+v)$ . Use this for plotting a gradient field, for example.
- Alternatively, arbitrary angles may be specified explicitly as an array of values in degrees, counter-clockwise from the horizontal axis.

In this case  $U$ ,  $V$  is only used to determine the length of the arrows.

Note: inverting a data axis will correspondingly invert the arrows only with `angles='xy'`.

**scale** [float, optional] Number of data units per arrow length unit, e.g., m/s per plot width; a smaller scale parameter makes the arrow longer. Default is *None*.

If *None*, a simple autoscaling algorithm is used, based on the average vector length and the number of vectors. The arrow length unit is given by the *scale\_units* parameter.

**scale\_units** [{'width', 'height', 'dots', 'inches', 'x', 'y', 'xy'}, optional] If the *scale* kwarg is *None*, the arrow length unit. Default is *None*.

e.g. *scale\_units* is 'inches', *scale* is 2.0, and  $(u,v) = (1,0)$ , then the vector will be 0.5 inches long.

If *scale\_units* is 'width' or 'height', then the vector will be half the width/height of the axes.

If *scale\_units* is 'x' then the vector will be 0.5 x-axis units. To plot vectors in the x-y plane, with *u* and *v* having the same units as *x* and *y*, use *angles='xy'*, *scale\_units='xy'*, *scale=1*.

**width** [float, optional] Shaft width in arrow units; default depends on choice of units, above, and number of vectors; a typical starting value is about 0.005 times the width of the plot.

**headwidth** [float, optional, default: 3] Head width as multiple of shaft width.

**headlength** [float, optional, default: 5] Head length as multiple of shaft width.

**headaxislength** [float, optional, default: 4.5] Head length at shaft intersection.

**minshaft** [float, optional, default: 1] Length below which arrow scales, in units of head length. Do not set this to less than 1, or small arrows will look terrible!

**minlength** [float, optional, default: 1] Minimum length as a multiple of shaft width; if an arrow length is less than this, plot a dot (hexagon) of this diameter instead.

**pivot** [{'tail', 'mid', 'middle', 'tip'}, optional, default: 'tail'] The part of the arrow that is anchored to the *X*, *Y* grid. The arrow rotates about this point.

'mid' is a synonym for 'middle'.

**color** [color or color sequence, optional] Explicit color(s) for the arrows. If *C* has been set, *color* has no effect.

This is a synonym for the *PolyCollection facecolor* parameter.

### Other Parameters

**\*\*kwargs** [*PolyCollection* properties, optional] All other keyword arguments are passed on to *PolyCollection*:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and
<i>alpha</i>		float or None

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	Property	Description
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i> or <i>antialiaseds</i>		bool or sequence of bools
<i>array</i>		ndarray
<i>capstyle</i>		{'butt', 'round', 'projecting'}
<i>clim</i>		a length 2 sequence of floats; may be overridden in methods that have
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>cmap</i>		colormap or registered colormap name
<i>color</i>		color or sequence of rgba tuples
<i>contains</i>		callable
<i>edgecolor</i> or <i>ec</i> or <i>edgecolors</i>		color or sequence of colors or 'face'
<i>facecolor</i> or <i>facecolors</i> or <i>fc</i>		color or sequence of colors
<i>figure</i>		<i>Figure</i>
<i>gid</i>		str
<i>hatch</i>		{'/', '\', ' ', '-', '+', 'x', 'o', 'O', '.', '*'}
<i>in_layout</i>		bool
<i>joinstyle</i>		{'miter', 'round', 'bevel'}
<i>label</i>		object
<i>linestyle</i> or <i>dashes</i> or <i>linestyles</i> or <i>ls</i>		{'-', '--', '-.', ':', "", (offset, on-off-seq), ...}
<i>linewidth</i> or <i>linewidths</i> or <i>lw</i>		float or sequence of floats
<i>norm</i>		<i>Normalize</i>
<i>offset_position</i>		{'screen', 'data'}
<i>offsets</i>		float or sequence of floats
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		None or bool or float or callable
<i>pickradius</i>		unknown
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>transform</i>		<i>Transform</i>
<i>url</i>		str
<i>urls</i>		List[str] or None
<i>visible</i>		bool
<i>zorder</i>		float

**See also:**

`quiverkey` Add a key to a quiver plot.

**Examples using `matplotlib.pyplot.quiver`**

- `sphx_glr_gallery_images_contours_and_fields_quiver_demo.py`
- `sphx_glr_gallery_images_contours_and_fields_quiver_simple_demo.py`
- `sphx_glr_gallery_images_contours_and_fields_trigradient_demo.py`

**matplotlib.pyplot.quiverkey**

`matplotlib.pyplot.quiverkey(Q, X, Y, U, label, **kw)`

Add a key to a quiver plot.

Call signature:

```
quiverkey(Q, X, Y, U, label, **kw)
```

Arguments:

**Q:** The Quiver instance returned by a call to `quiver`.

**X, Y:** The location of the key; additional explanation follows.

**U:** The length of the key

**label:** A string with the length and units of the key

Keyword arguments:

**angle = 0** The angle of the key arrow. Measured in degrees anti-clockwise from the x-axis.

**coordinates = [ 'axes' | 'figure' | 'data' | 'inches' ]** Coordinate system and units for X, Y: 'axes' and 'figure' are normalized coordinate systems with 0,0 in the lower left and 1,1 in the upper right; 'data' are the axes data coordinates (used for the locations of the vectors in the quiver plot itself); 'inches' is position in the figure in inches, with 0,0 at the lower left corner.

**color:** overrides face and edge colors from Q.

**labelpos = [ 'N' | 'S' | 'E' | 'W' ]** Position the label above, below, to the right, to the left of the arrow, respectively.

**labelsep:** Distance in inches between the arrow and the label. Default is 0.1

**labelcolor:** defaults to default *Text* color.

**fontproperties:** A dictionary with keyword arguments accepted by the *FontProperties* initializer: *family, style, variant, size, weight*

Any additional keyword arguments are used to override vector properties taken from Q.

The positioning of the key depends on X, Y, *coordinates*, and *labelpos*. If *labelpos* is 'N' or 'S', X, Y give the position of the middle of the key arrow. If *labelpos* is 'E', X, Y positions the head, and if *labelpos* is 'W', X, Y positions the tail; in either of these two cases, X, Y is somewhere in the middle of the arrow+label key object.

**Examples using matplotlib.pyplot.quiverkey**

- sphx\_glr\_gallery\_images\_contours\_and\_fields\_quiver\_demo.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_quiver\_simple\_demo.py

**matplotlib.pyplot.rc**

`matplotlib.pyplot.rc(group, **kwargs)`

Set the current rc params. *group* is the grouping for the rc, e.g., for `lines.linewidth` the group is `lines`, for `axes.facecolor`, the group is `axes`, and so on. Group may also be a list or tuple of group names, e.g., (*xtick*, *ytick*). *kwargs* is a dictionary attribute name/value pairs, e.g.,:

```
rc('lines', linewidth=2, color='r')
```

sets the current rc params and is equivalent to:

```
rcParams['lines.linewidth'] = 2
rcParams['lines.color'] = 'r'
```

The following aliases are available to save typing for interactive users:

Alias	Property
'lw'	'linewidth'
'ls'	'linestyle'
'c'	'color'
'fc'	'facecolor'
'ec'	'edgecolor'
'mew'	'markeredgewidth'
'aa'	'antialiased'

Thus you could abbreviate the above rc command as:

```
rc('lines', lw=2, c='r')
```

Note you can use python's `kwargs` dictionary facility to store dictionaries of default parameters. e.g., you can customize the font rc as follows:

```
font = {'family' : 'monospace',
        'weight' : 'bold',
        'size'   : 'larger'}

rc('font', **font) # pass in the font dict as kwargs
```

This enables you to easily switch between several configurations. Use `matplotlib.style.use('default')` or `rcdefaults()` to restore the default rc params after changes.

**Examples using matplotlib.pyplot.rc**

- `sphinx_glr_gallery_pie_and_polar_charts_polar_legend.py`
- `sphinx_glr_gallery_text_labels_and_annotations_usetex_demo.py`
- `sphinx_glr_gallery_color_color_cycler.py`
- `sphinx_glr_gallery_misc_customize_rc.py`
- `sphinx_glr_gallery_misc_multipage_pdf.py`
- *Styling with cycler*

**matplotlib.pyplot.rc\_context**

`matplotlib.pyplot.rc_context(rc=None, fname=None)`  
 Return a context manager for managing rc settings.

This allows one to do:

```
with mpl.rc_context(fname='screen.rc'):
    plt.plot(x, a)
    with mpl.rc_context(fname='print.rc'):
        plt.plot(x, b)
    plt.plot(x, c)
```

The 'a' vs 'x' and 'c' vs 'x' plots would have settings from 'screen.rc', while the 'b' vs 'x' plot would have settings from 'print.rc'.

A dictionary can also be passed to the context manager:

```
with mpl.rc_context(rc={'text.usetex': True}, fname='screen.rc'):
    plt.plot(x, a)
```

The 'rc' dictionary takes precedence over the settings loaded from 'fname'. Passing a dictionary only is also valid. For example a common usage is:

```
with mpl.rc_context(rc={'interactive': False}):
    fig, ax = plt.subplots()
    ax.plot(range(3), range(3))
    fig.savefig('A.png', format='png')
    plt.close(fig)
```

**Examples using matplotlib.pyplot.rc\_context**

- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_usetex\_baseline\_test.py
- sphx\_glr\_gallery\_misc\_logos2.py
- sphx\_glr\_gallery\_ticks\_and\_spines\_auto\_ticks.py

**matplotlib.pyplot.rcdefaults**

`matplotlib.pyplot.rcdefaults()`  
 Restore the rc params from Matplotlib's internal default style.

Style-blacklisted rc params (defined in `matplotlib.style.core.STYLE_BLACKLIST`) are not updated.

**See also:**

`rc_file_defaults` Restore the rc params from the rc file originally loaded by Matplotlib.  
`matplotlib.style.use` Use a specific style file. Call `style.use('default')` to restore the default style.

**Examples using `matplotlib.pyplot.rcParams`**

- `sphx_glr_gallery_lines_bars_and_markers_barh.py`
- `sphx_glr_gallery_misc_customize_rc.py`

**`matplotlib.pyplot.rgrids`**`matplotlib.pyplot.rgrids(*args, **kwargs)`

Get or set the radial gridlines on the current polar plot.

Call signatures:

```
lines, labels = rgrids()
lines, labels = rgrids(radii, labels=None, angle=22.5, fmt=None, **kwargs)
```

When called with no arguments, `rgrids` simply returns the tuple *(lines, labels)*. When called with arguments, the labels will appear at the specified radial distances and angle.

**Parameters****radii** [tuple with floats] The radii for the radial gridlines**labels** [tuple with strings or None] The labels to use at each radial gridline. The `matplotlib.ticker.ScalarFormatter` will be used if None.**angle** [float] The angular position of the radius labels in degrees.**fmt** [str or None] Format string used in `matplotlib.ticker.FormatStrFormatter`. For example `'%f'`.**Returns****lines, labels** [list of `lines.Line2D`, list of `text.Text`] *lines* are the radial gridlines and *labels* are the tick labels.**Other Parameters****\*\*kwargs** *kwargs* are optional `Text` properties for the labels.**See also:**`pyplot.thetagrids``projections.polar.PolarAxes.set_rgrids``Axis.get_gridlines``Axis.get_ticklabels`**Examples**

```
# set the locations of the radial gridlines
lines, labels = rgrids( (0.25, 0.5, 1.0) )

# set the locations and labels of the radial gridlines
lines, labels = rgrids( (0.25, 0.5, 1.0), ('Tom', 'Dick', 'Harry' ))
```

**matplotlib.pyplot.savefig**

`matplotlib.pyplot.savefig(*args, **kwargs)`

Save the current figure.

Call signature:

```
savefig(fname, dpi=None, facecolor='w', edgecolor='w',
        orientation='portrait', papertype=None, format=None,
        transparent=False, bbox_inches=None, pad_inches=0.1,
        frameon=None, metadata=None)
```

The output formats available depend on the backend being used.

**Parameters**

**fname** [str or PathLike or file-like object] A path, or a Python file-like object, or possibly some backend-dependent object such as `matplotlib.backends.backend_pdf.PdfPages`.

If *format* is not set, then the output format is inferred from the extension of *fname*, if any, and from `rcParams["savefig.format"]` otherwise. If *format* is set, it determines the output format.

Hence, if *fname* is not a path or has no extension, remember to specify *format* to ensure that the correct backend is used.

**Other Parameters**

**dpi** [[ *None* | scalar > 0 | 'figure' ]] The resolution in dots per inch. If *None*, defaults to `rcParams["savefig.dpi"]`. If 'figure', uses the figure's dpi value.

**quality** [[ *None* | 1 <= scalar <= 100 ]] The image quality, on a scale from 1 (worst) to 95 (best). Applicable only if *format* is jpg or jpeg, ignored otherwise. If *None*, defaults to `rcParams["savefig.jpeg_quality"]` (95 by default). Values above 95 should be avoided; 100 completely disables the JPEG quantization stage.

**optimize** [bool] If *True*, indicates that the JPEG encoder should make an extra pass over the image in order to select optimal encoder settings. Applicable only if *format* is jpg or jpeg, ignored otherwise. Is *False* by default.

**progressive** [bool] If *True*, indicates that this image should be stored as a progressive JPEG file. Applicable only if *format* is jpg or jpeg, ignored otherwise. Is *False* by default.

**facecolor** [color spec or None, optional] The facecolor of the figure; if *None*, defaults to `rcParams["savefig.facecolor"]`.

**edgecolor** [color spec or None, optional] The edgecolor of the figure; if *None*, defaults to `rcParams["savefig.edgecolor"]`

**orientation** [{'landscape', 'portrait'}] Currently only supported by the postscript backend.

**papertype** [str] One of 'letter', 'legal', 'executive', 'ledger', 'a0' through 'a10', 'b0' through 'b10'. Only supported for postscript output.

**format** [str] The file format, e.g. 'png', 'pdf', 'svg', ... The behavior when this is unset is documented under *fname*.

**transparent** [bool] If *True*, the axes patches will all be transparent; the figure patch will also be transparent unless *facecolor* and/or *edgecolor* are specified via *kwargs*. This is useful, for example, for displaying a plot on top of a colored background on a web page. The transparency of these patches will be restored to their original values upon exit of this function.

**bbox\_inches** [str or *Bbox*, optional] Bbox in inches. Only the given portion of the figure is saved. If 'tight', try to figure out the tight bbox of the figure. If *None*, use *savefig.bbox*

**pad\_inches** [scalar, optional] Amount of padding around the figure when *bbox\_inches* is 'tight'. If *None*, use *savefig.pad\_inches*

**bbox\_extra\_artists** [list of *Artist*, optional] A list of extra artists that will be considered when the tight bbox is calculated.

**metadata** [dict, optional] Key/value pairs to store in the image metadata. The supported keys and defaults depend on the image format and backend:

- 'png' with Agg backend: See the parameter *metadata* of *print\_png*.
- 'pdf' with pdf backend: See the parameter *metadata* of *PdfPages*.
- 'eps' and 'ps' with PS backend: Only 'Creator' is supported.

**pil\_kwargs** [dict, optional] Additional keyword arguments that are passed to *PIL.Image.save* when saving the figure. Only applicable for formats that are saved using Pillow, i.e. JPEG, TIFF, and (if the keyword is set to a non-None value) PNG.

#### Examples using `matplotlib.pyplot.savefig`

- `sphx_glr_gallery_text_labels_and_annotations_usetex_fonteffects.py`
- `sphx_glr_gallery_misc_print_stdout_sgskip.py`
- `sphx_glr_gallery_misc_rasterization_demo.py`
- `sphx_glr_gallery_misc_svg_filter_line.py`
- `sphx_glr_gallery_misc_svg_filter_pie.py`
- `sphx_glr_gallery_user_interfaces_svg_histogram_sgskip.py`
- `sphx_glr_gallery_user_interfaces_svg_tooltip_sgskip.py`
- `sphx_glr_gallery_userdemo_pgf_fonts.py`
- `sphx_glr_gallery_userdemo_pgf_preamble_sgskip.py`
- `sphx_glr_gallery_userdemo_pgf_texsystem.py`

#### `matplotlib.pyplot.sca`

`matplotlib.pyplot.sca(ax)`

Set the current Axes instance to *ax*.

The current Figure is updated to the parent of *ax*.

### matplotlib.pyplot.scatter

```
matplotlib.pyplot.scatter(x, y, s=None, c=None, marker=None, cmap=None,
                          norm=None, vmin=None, vmax=None, alpha=None,
                          linewidths=None, verts=None, edgecolors=None, *, plot-
                          nonfinite=False, data=None, **kwargs)
```

A scatter plot of *y* vs *x* with varying marker size and/or color.

#### Parameters

- x, y** [array\_like, shape (n, )] The data positions.
- s** [scalar or array\_like, shape (n, ), optional] The marker size in points\*\*2. Default is `rcParams['lines.markersize'] ** 2`.
- c** [color, sequence, or sequence of color, optional] The marker color. Possible values:
- A single color format string.
  - A sequence of color specifications of length *n*.
  - A sequence of *n* numbers to be mapped to colors using *cmap* and *norm*.
  - A 2-D array in which the rows are RGB or RGBA.

Note that *c* should not be a single numeric RGB or RGBA sequence because that is indistinguishable from an array of values to be colormapped. If you want to specify the same RGB or RGBA value for all points, use a 2-D array with a single row. Otherwise, value-matching will have precedence in case of a size matching with *x* and *y*.

Defaults to `None`. In that case the marker color is determined by the value of `color`, `facecolor` or `facecolors`. In case those are not specified or `None`, the marker color is determined by the next color of the Axes' current "shape and fill" color cycle. This cycle defaults to `rcParams["axes.prop_cycle"]`.

**marker** [*MarkerStyle*, optional] The marker style. *marker* can be either an instance of the class or the text shorthand for a particular marker. Defaults to `None`, in which case it takes the value of `rcParams["scatter.marker"] = 'o'`. See *markers* for more information about marker styles.

**cmap** [*Colormap*, optional, default: `None`] A *Colormap* instance or registered colormap name. *cmap* is only used if *c* is an array of floats. If `None`, defaults to `rc image.cmap`.

**norm** [*Normalize*, optional, default: `None`] A *Normalize* instance is used to scale luminance data to 0, 1. *norm* is only used if *c* is an array of floats. If `None`, use the default `colors.Normalize`.

**vmin, vmax** [scalar, optional, default: `None`] *vmin* and *vmax* are used in conjunction with *norm* to normalize luminance data. If `None`, the respective min and max of the color array is used. *vmin* and *vmax* are ignored if you pass a *norm* instance.

**alpha** [scalar, optional, default: None] The alpha blending value, between 0 (transparent) and 1 (opaque).

**linewidths** [scalar or array\_like, optional, default: None] The linewidth of the marker edges. Note: The default *edgecolors* is 'face'. You may want to change this as well. If *None*, defaults to rcParams *lines.linewidth*.

**edgecolors** [{'face', 'none', None} or color or sequence of color, optional.] The edge color of the marker. Possible values:

- 'face': The edge color will always be the same as the face color.
- 'none': No patch boundary will be drawn.
- A Matplotlib color or sequence of color.

Defaults to *None*, in which case it takes the value of `rcParams["scatter.edgecolors"] = 'face'`.

For non-filled markers, the *edgecolors* kwarg is ignored and forced to 'face' internally.

**plotnonfinite** [boolean, optional, default: False] Set to plot points with nonfinite *c*, in conjunction with *set\_bad*.

### Returns

**paths** [*PathCollection*]

### Other Parameters

**\*\*kwargs** [*Collection* properties]

### See also:

*plot* To plot scatter plots when markers are identical in size and color.

### Notes

- The *plot* function will be faster for scatterplots where markers don't vary in size or color.
- Any or all of *x*, *y*, *s*, and *c* may be masked arrays, in which case all masks will be combined and only unmasked points will be plotted.
- Fundamentally, scatter works with 1-D arrays; *x*, *y*, *s*, and *c* may be input as 2-D arrays, but within scatter they will be flattened. The exception is *c*, which will be flattened only if its size matches the size of *x* and *y*.

---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'c', 'color', 'edgecolors', 'facecolor', 'facecolors', 'linewidths', 's', 'x', 'y'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

**Examples using `matplotlib.pyplot.scatter`**

- `sphinx_gallery_gallery_lines_bars_and_markers_scatter_masked.py`
- `sphinx_gallery_gallery_lines_bars_and_markers_scatter_piecharts.py`
- `sphinx_gallery_gallery_lines_bars_and_markers_scatter_star_poly.py`
- `sphinx_gallery_gallery_lines_bars_and_markers_scatter_symbol.py`
- `sphinx_gallery_gallery_lines_bars_and_markers_scatter_with_legend.py`
- `sphinx_gallery_gallery_pie_and_polar_charts_polar_scatter.py`
- `sphinx_gallery_gallery_shapes_and_collections_scatter.py`
- `sphinx_gallery_gallery_misc_hyperlinks_sgskip.py`
- `sphinx_gallery_gallery_misc_zorder_demo.py`
- *Pyplot tutorial*

**`matplotlib.pyplot.sci`**

`matplotlib.pyplot.sci(im)`  
Set the current image.

This image will be the target of colormap functions like *viridis*, and other functions such as *clim*. The current image is an attribute of the current axes.

**Examples using `matplotlib.pyplot.sci`**

- `sphinx_gallery_gallery_shapes_and_collections_line_collection.py`

**`matplotlib.pyplot.semilogx`**

`matplotlib.pyplot.semilogx(*args, **kwargs)`  
Make a plot with log scaling on the x axis.

Call signatures:

```
semilogx([x], y, [fmt], data=None, **kwargs)
semilogx([x], y, [fmt], [x2], y2, [fmt2], ..., **kwargs)
```

This is just a thin wrapper around *plot* which additionally changes the x-axis to log scaling. All of the concepts and parameters of *plot* can be used here as well.

The additional parameters *basex*, *subsx* and *nonposx* control the x-axis properties. They are just forwarded to *Axes.set\_xscale*.

**Parameters**

**basex** [scalar, optional, default 10] Base of the x logarithm.

**subsx** [array\_like, optional] The location of the minor xticks. If *None*, reasonable locations are automatically chosen depending on the number of decades in the plot. See *Axes.set\_xscale* for details.

**nonposx** [{'mask', 'clip'}, optional, default 'mask'] Non-positive values in *x* can be masked as invalid, or clipped to a very small positive number.

**Returns**

**lines** A list of *Line2D* objects representing the plotted data.

**Other Parameters**

**\*\*kwargs** All parameters supported by *plot*.

**matplotlib.pyplot.semilogy**

`matplotlib.pyplot.semilogy(*args, **kwargs)`  
Make a plot with log scaling on the y axis.

Call signatures:

```
semilogy([x], y, [fmt], data=None, **kwargs)
semilogy([x], y, [fmt], [x2], y2, [fmt2], ..., **kwargs)
```

This is just a thin wrapper around *plot* which additionally changes the y-axis to log scaling. All of the concepts and parameters of *plot* can be used here as well.

The additional parameters *basesy*, *subsy* and *nonposy* control the y-axis properties. They are just forwarded to *Axes.set\_yscale*.

**Parameters**

**basesy** [scalar, optional, default 10] Base of the y logarithm.

**subsy** [array\_like, optional] The location of the minor yticks. If *None*, reasonable locations are automatically chosen depending on the number of decades in the plot. See *Axes.set\_yscale* for details.

**nonposy** [{'mask', 'clip'}, optional, default 'mask'] Non-positive values in *y* can be masked as invalid, or clipped to a very small positive number.

**Returns**

**lines** A list of *Line2D* objects representing the plotted data.

**Other Parameters**

**\*\*kwargs** All parameters supported by *plot*.

**matplotlib.pyplot.set\_cmap**

`matplotlib.pyplot.set_cmap(cmap)`  
Set the default colormap. Applies to the current image if any. See `help(colormaps)` for more information.

*cmap* must be a *Colormap* instance, or the name of a registered colormap.

See `matplotlib.cm.register_cmap()` and `matplotlib.cm.get_cmap()`.

**matplotlib.pyplot.setp**

`matplotlib.pyplot.setp(obj, *args, **kwargs)`

Set a property on an artist object.

matplotlib supports the use of `setp()` ("set property") and `getp()` to set and get object properties, as well as to do introspection on the object. For example, to set the linestyle of a line to be dashed, you can do:

```
>>> line, = plot([1,2,3])
>>> setp(line, linestyle='--')
```

If you want to know the valid types of arguments, you can provide the name of the property you want to set without a value:

```
>>> setp(line, 'linestyle')
linestyle: [ '-' | '--' | '-.' | ':' | 'steps' | 'None' ]
```

If you want to see all the properties that can be set, and their possible values, you can do:

```
>>> setp(line)
... long output listing omitted
```

You may specify another output file to `setp` if `sys.stdout` is not acceptable for some reason using the `file` keyword-only argument:

```
>>> with fopen('output.log') as f:
>>>     setp(line, file=f)
```

`setp()` operates on a single instance or a iterable of instances. If you are in query mode introspecting the possible values, only the first instance in the sequence is used. When actually setting values, all the instances will be set. e.g., suppose you have a list of two lines, the following will make both lines thicker and red:

```
>>> x = arange(0,1.0,0.01)
>>> y1 = sin(2*pi*x)
>>> y2 = sin(4*pi*x)
>>> lines = plot(x, y1, x, y2)
>>> setp(lines, linewidth=2, color='r')
```

`setp()` works with the MATLAB style string/value pairs or with python kwargs. For example, the following are equivalent:

```
>>> setp(lines, 'linewidth', 2, 'color', 'r') # MATLAB style
>>> setp(lines, linewidth=2, color='r')      # python style
```

**Examples using matplotlib.pyplot.setp**

- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_masked\_demo.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_timeline.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_contour\_demo.py

- sphx\_glr\_gallery\_images\_contours\_and\_fields\_image\_annotated\_heatmap.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_shared\_axis\_demo.py
- sphx\_glr\_gallery\_statistics\_boxplot\_demo.py
- sphx\_glr\_gallery\_statistics\_boxplot\_vs\_violin.py
- sphx\_glr\_gallery\_pie\_and\_polar\_charts\_pie\_demo2.py
- sphx\_glr\_gallery\_pie\_and\_polar\_charts\_pie\_and\_donut\_labels.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_usetex\_fonteffects.py
- sphx\_glr\_gallery\_axes\_grid1\_demo\_axes\_divider.py
- sphx\_glr\_gallery\_axes\_grid1\_inset\_locator\_demo2.py
- sphx\_glr\_gallery\_event\_handling\_ginput\_manual\_clabel\_sgskip.py
- sphx\_glr\_gallery\_misc\_patheffect\_demo.py
- sphx\_glr\_gallery\_misc\_set\_and\_get.py
- sphx\_glr\_gallery\_specialty\_plots\_topographic\_hillshading.py
- sphx\_glr\_gallery\_units\_evans\_test.py
- *The Lifecycle of a Plot*

### matplotlib.pyplot.show

`matplotlib.pyplot.show(*args, **kw)`

Display a figure.

When running in ipython with its pylab mode, display all figures and return to the ipython prompt.

In non-interactive mode, display all figures and block until the figures have been closed; in interactive mode it has no effect unless figures were created prior to a change from non-interactive to interactive mode (not recommended). In that case it displays the figures but does not block.

A single experimental keyword argument, *block*, may be set to True or False to override the blocking behavior described above.

### Examples using matplotlib.pyplot.show

- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_bar\_stacked.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_barchart.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_barh.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_broken\_barh.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_categorical\_variables.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_cohere.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_csd\_demo.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_errorbar\_limits\_simple.py

- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_errorbar\_subsample.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_eventcollection\_demo.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_eventplot\_demo.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_fill.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_fill\_between\_demo.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_fill\_betweenx\_demo.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_filled\_step.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_gradient\_bar.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_jointstyle.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_line\_demo\_dash\_control.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_linestyles.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_marker\_fillstyle\_reference.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_marker\_reference.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_markevery\_demo.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_markevery\_prop\_cycle.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_masked\_demo.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_multicolored\_line.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_nan\_test.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_psd\_demo.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_scatter\_custom\_symbol.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_scatter\_demo2.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_scatter\_hist.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_scatter\_masked.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_scatter\_piecharts.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_scatter\_star\_poly.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_scatter\_symbol.py
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### matplotlib.pyplot.specgram

```
matplotlib.pyplot.specgram(x, NFFT=None, Fs=None, Fc=None, detrend=None, window=None, noverlap=None, cmap=None, xextent=None, pad_to=None, sides=None, scale_by_freq=None, mode=None, scale=None, vmin=None, vmax=None, *, data=None, **kwargs)
```

Plot a spectrogram.

Compute and plot a spectrogram of data in *x*. Data are split into *NFFT* length segments and the spectrum of each section is computed. The windowing function *window* is applied to each segment, and the amount of overlap of each segment is specified with *noverlap*. The spectrogram is plotted as a colormap (using *imshow*).

## Parameters

- x** [1-D array or sequence] Array or sequence containing the data.
- Fs** [scalar] The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, `freqs`, in cycles per time unit. The default value is 2.
- window** [callable or ndarray] A function or a vector of length *NFFT*. To create window vectors see `window_hanning`, `window_none`, `numpy.blackman`, `numpy.hamming`, `numpy.bartlett`, `scipy.signal`, `scipy.signal.get_window`, etc. The default is `window_hanning`. If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.
- sides** [{'default', 'onesided', 'twosided'}] Specifies which sides of the spectrum to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. 'onesided' forces the return of a one-sided spectrum, while 'twosided' forces two-sided.
- pad\_to** [int] The number of points to which the data segment is padded when performing the FFT. This can be different from *NFFT*, which specifies the number of data points used. While not increasing the actual resolution of the spectrum (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the *n* parameter in the call to `fft()`. The default is `None`, which sets `pad_to` equal to *NFFT*.
- NFFT** [int] The number of data points used in each block for the FFT. A power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use `pad_to` for this instead.
- detrend** [{'none', 'mean', 'linear'} or callable, default 'none'] The function applied to each segment before `fft`-ing, designed to remove the mean or linear trend. Unlike in MATLAB, where the `detrend` parameter is a vector, in Matplotlib it is a function. The `mlab` module defines `detrend_none`, `detrend_mean`, and `detrend_linear`, but you can use a custom function as well. You can also use a string to choose one of the functions: 'none' calls `detrend_none`. 'mean' calls `detrend_mean`. 'linear' calls `detrend_linear`.
- scale\_by\_freq** [bool, optional] Specifies whether the resulting density values should be scaled by the scaling frequency, which gives density in units of  $\text{Hz}^{-1}$ . This allows for integration over the returned frequency values. The default is `True` for MATLAB compatibility.
- mode** [{'default', 'psd', 'magnitude', 'angle', 'phase'}] What sort of spectrum to use. Default is 'psd', which takes the power spectral density. 'magnitude' returns the magnitude spectrum. 'angle' returns the phase spectrum without unwrapping. 'phase' returns the phase spectrum with unwrapping.
- noverlap** [int] The number of points of overlap between blocks. The default value is 128.
- scale** [{'default', 'linear', 'dB'}] The scaling of the values in the `spec`. 'linear' is no scaling. 'dB' returns the values in dB scale. When `mode` is 'psd', this is dB power ( $10 * \log_{10}$ ). Otherwise this is dB amplitude (20

\* log10). 'default' is 'dB' if *mode* is 'psd' or 'magnitude' and 'linear' otherwise. This must be 'linear' if *mode* is 'angle' or 'phase'.

**Fc** [int] The center frequency of *x* (defaults to 0), which offsets the *x* extents of the plot to reflect the frequency range used when a signal is acquired and then filtered and downsampled to baseband.

**cmap** A `matplotlib.colors.Colormap` instance; if *None*, use default determined by `rc`

**xextent** [*None* or (xmin, xmax)] The image extent along the *x*-axis. The default sets *xmin* to the left border of the first bin (*spectrum* column) and *xmax* to the right border of the last bin. Note that for *noverlap*>0 the width of the bins is smaller than those of the segments.

**\*\*kwargs** Additional kwargs are passed on to `imshow` which makes the spectrogram image.

### Returns

**spectrum** [2-D array] Columns are the periodograms of successive segments.

**freqs** [1-D array] The frequencies corresponding to the rows in *spectrum*.

**t** [1-D array] The times corresponding to midpoints of segments (i.e., the columns in *spectrum*).

**im** [instance of class *AxesImage*] The image created by `imshow` containing the spectrogram

### See also:

*psd()* *psd()* differs in the default overlap; in returning the mean of the segment periodograms; in not returning times; and in generating a line plot instead of colormap.

*magnitude\_spectrum()* A single spectrum, similar to having a single segment when *mode* is 'magnitude'. Plots a line instead of a colormap.

*angle\_spectrum()* A single spectrum, similar to having a single segment when *mode* is 'angle'. Plots a line instead of a colormap.

*phase\_spectrum()* A single spectrum, similar to having a single segment when *mode* is 'phase'. Plots a line instead of a colormap.

### Notes

The parameters *detrend* and *scale\_by\_freq* do only apply when *mode* is set to 'psd'.

---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

**Examples using `matplotlib.pyplot.specgram`**

- `sphx_glr_gallery_images_contours_and_fields_specgram_demo.py`

**`matplotlib.pyplot.spring`**

`matplotlib.pyplot.spring()`

Set the colormap to "spring".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

**`matplotlib.pyplot.spy`**

`matplotlib.pyplot.spy(Z, precision=0, marker=None, markersize=None, aspect='equal', origin='upper', **kwargs)`

Plot the sparsity pattern of a 2D array.

This visualizes the non-zero values of the array.

Two plotting styles are available: image and marker. Both are available for full arrays, but only the marker style works for `scipy.sparse.spmatrix` instances.

**Image style**

If `marker` and `markersize` are `None`, `imshow` is used. Any extra remaining kwargs are passed to this method.

**Marker style**

If `Z` is a `scipy.sparse.spmatrix` or `marker` or `markersize` are `None`, a `Line2D` object will be returned with the value of `marker` determining the marker type, and any remaining kwargs passed to `plot`.

**Parameters**

**Z** [array-like (M, N)] The array to be plotted.

**precision** [float or 'present', optional, default: 0] If `precision` is 0, any non-zero value will be plotted. Otherwise, values of  $|Z| > precision$  will be plotted.

For `scipy.sparse.spmatrix` instances, you can also pass 'present'. In this case any value present in the array will be plotted, even if it is identically zero.

**origin** [{'upper', 'lower'}, optional] Place the [0,0] index of the array in the upper left or lower left corner of the axes. The convention 'upper' is typically used for matrices and images. If not given, `rcParams["image.origin"]` is used, defaulting to 'upper'.

**aspect** [{'equal', 'auto', None} or float, optional] Controls the aspect ratio of the axes. The aspect is of particular relevance for images since it may distort the image, i.e. pixel will not be square.

This parameter is a shortcut for explicitly calling `Axes.set_aspect`. See there for further details.

- 'equal': Ensures an aspect ratio of 1. Pixels will be square.

- 'auto': The axes is kept fixed and the aspect is adjusted so that the data fit in the axes. In general, this will result in non-square pixels.
- *None*: Use `rcParams["image.aspect"]` (default: 'equal').

Default: 'equal'

**Returns**

**ret** [*AxesImage* or *Line2D*] The return type depends on the plotting style (see above).

**Other Parameters**

**\*\*kwargs** The supported additional parameters depend on the plotting style.

For the image style, you can pass the following additional parameters of *imshow*:

- *cmap*
- *alpha*
- *url*
- any *Artist* properties (passed on to the *AxesImage*)

For the marker style, you can pass any *Line2D* property except for *linestyle*:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<i>alpha</i>		float
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i>		bool
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   <i>None</i> ]
<i>color</i> or <i>c</i>		color
<i>contains</i>		callable
<i>dash_capstyle</i>		{'butt', 'round', 'projecting'}
<i>dash_joinstyle</i>		{'miter', 'round', 'bevel'}
<i>dashes</i>		sequence of floats (on/off ink in points) or ( <i>None</i> , <i>None</i> )
<i>drawstyle</i> or <i>ds</i>		{'default', 'steps', 'steps-pre', 'steps-mid', 'steps-post'}, default: 'default'
<i>figure</i>		<i>Figure</i>
<i>fillstyle</i>		{'full', 'left', 'right', 'bottom', 'top', 'none'}
<i>gid</i>		str
<i>in_layout</i>		bool
<i>label</i>		object
<i>linestyle</i> or <i>ls</i>		{'-', '-.', '-.-', ':', ' ', (offset, on-off-seq), ...}
<i>linewidth</i> or <i>lw</i>		float
<i>marker</i>		marker style
<i>markeredgewidth</i> or <i>mec</i>		color
<i>markeredgewidth</i> or <i>mew</i>		float
<i>markerfacecolor</i> or <i>mfc</i>		color
<i>markerfacecoloralt</i> or <i>mfcalt</i>		color
<i>markersize</i> or <i>ms</i>		float

Continued on next page

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	Property	Description
<i>markevery</i>	None or int or (int, int) or slice or List[int] or float or (float, float)	
<i>path_effects</i>	<i>AbstractPathEffect</i>	
<i>picker</i>	float or callable[[Artist, Event], Tuple[bool, dict]]	
<i>pickradius</i>	float	
<i>rasterized</i>	bool or None	
<i>sketch_params</i>	(scale: float, length: float, randomness: float)	
<i>snap</i>	bool or None	
<i>solid_capstyle</i>	{'butt', 'round', 'projecting'}	
<i>solid_joinstyle</i>	{'miter', 'round', 'bevel'}	
<i>transform</i>	<i>matplotlib.transforms.Transform</i>	
<i>url</i>	str	
<i>visible</i>	bool	
<i>xdata</i>	1D array	
<i>ydata</i>	1D array	
<i>zorder</i>	float	

### Examples using `matplotlib.pyplot.spy`

- `sphx_glr_gallery_images_contours_and_fields_spy_demos.py`

### `matplotlib.pyplot.stackplot`

```
matplotlib.pyplot.stackplot(x, *args, labels=(), colors=None, baseline='zero',
                             data=None, **kwargs)
```

Draw a stacked area plot.

#### Parameters

**x** [1d array of dimension N]

**y** [2d array (dimension MxN), or sequence of 1d arrays (each dimension 1xN)] The data is assumed to be unstacked. Each of the following calls is legal:

```
stackplot(x, y) # where y is MxN
stackplot(x, y1, y2, y3, y4) # where y1, y2, y3, y4, are all 1xNm
```

**baseline** [{'zero', 'sym', 'wobble', 'weighted\_wobble'}] Method used to calculate the baseline:

- 'zero': Constant zero baseline, i.e. a simple stacked plot.
- 'sym': Symmetric around zero and is sometimes called 'The-meRiver'.
- 'wobble': Minimizes the sum of the squared slopes.
- 'weighted\_wobble': Does the same but weights to account for size of each layer. It is also called 'Streamgraph'-layout. More details can be found at <http://leebyron.com/streamgraph/>.

**labels** [Length N sequence of strings] Labels to assign to each data series.

**colors** [Length N sequence of colors] A list or tuple of colors. These will be cycled through and used to colour the stacked areas.

**\*\*kwargs** All other keyword arguments are passed to `Axes.fill_between()`.

### Returns

**list** [list of *PolyCollection*] A list of *PolyCollection* instances, one for each element in the stacked area plot.

### Notes

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

### matplotlib.pyplot.stem

```
matplotlib.pyplot.stem(*args, linefmt=None, markerfmt=None, basefmt=None, bottom=0, label=None, use_line_collection=False, data=None)
```

Create a stem plot.

A stem plot plots vertical lines at each x location from the baseline to y, and places a marker there.

Call signature:

```
stem([x,] y, linefmt=None, markerfmt=None, basefmt=None)
```

The x-positions are optional. The formats may be provided either as positional or as keyword-arguments.

### Parameters

**x** [array-like, optional] The x-positions of the stems. Default: (0, 1, ..., len(y) - 1).

**y** [array-like] The y-values of the stem heads.

**linefmt** [str, optional] A string defining the properties of the vertical lines. Usually, this will be a color or a color and a linestyle:

Character	Line Style
'-'	solid line
'--'	dashed line
'-.'	dash-dot line
':'	dotted line

Default: 'C0-', i.e. solid line with the first color of the color cycle.

Note: While it is technically possible to specify valid formats other than color or color and linestyle (e.g. 'rx' or '-.'), this is beyond the intention of the method and will most likely not result in a reasonable reasonable plot.

**markerfmt** [str, optional] A string defining the properties of the markers at the stem heads. Default: 'C0o', i.e. filled circles with the first color of the color cycle.

**basefmt** [str, optional] A format string defining the properties of the baseline.

Default: 'C3-' ('C2-' in classic mode).

**bottom** [float, optional, default: 0] The y-position of the baseline.

**label** [str, optional, default: None] The label to use for the stems in legends.

**use\_line\_collection** [bool, optional, default: False] If `True`, store and plot the stem lines as a *LineCollection* instead of individual lines. This significantly increases performance, and will become the default option in Matplotlib 3.3. If `False`, defaults to the old behavior of using a list of *Line2D* objects.

### Returns

**container** [*StemContainer*] The container may be treated like a tuple (*markerline*, *stemlines*, *baseline*)

### Notes

#### See also:

The MATLAB function `stem` which inspired this method.

---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

### Examples using `matplotlib.pyplot.stem`

- `sphx_glr_gallery_lines_bars_and_markers_stem_plot.py`

### `matplotlib.pyplot.step`

`matplotlib.pyplot.step(x, y, *args, where='pre', data=None, **kwargs)`  
 Make a step plot.

Call signatures:

```
step(x, y, [fmt], *, data=None, where='pre', **kwargs)
step(x, y, [fmt], x2, y2, [fmt2], ..., *, where='pre', **kwargs)
```

This is just a thin wrapper around `plot` which changes some formatting options. Most of the concepts and parameters of `plot` can be used here as well.

### Parameters

**x** [array\_like] 1-D sequence of x positions. It is assumed, but not checked, that it is uniformly increasing.

**y** [array\_like] 1-D sequence of y levels.

**fmt** [str, optional] A format string, e.g. 'g' for a green line. See `plot` for a more detailed description.

Note: While full format strings are accepted, it is recommended to only specify the color. Line styles are currently ignored (use the keyword argument `linestyle` instead). Markers are accepted and plotted on the given positions, however, this is a rarely needed feature for step plots.

**data** [indexable object, optional] An object with labelled data. If given, provide the label names to plot in x and y.

**where** [{'pre', 'post', 'mid'}], optional, default 'pre' Define where the steps should be placed:

- 'pre': The y value is continued constantly to the left from every x position, i.e. the interval  $(x[i-1], x[i])$  has the value  $y[i]$ .
- 'post': The y value is continued constantly to the right from every x position, i.e. the interval  $[x[i], x[i+1])$  has the value  $y[i]$ .
- 'mid': Steps occur half-way between the x positions.

### Returns

**lines** A list of `Line2D` objects representing the plotted data.

### Other Parameters

**\*\*kwargs** Additional parameters are the same as those for `plot`.

### Notes

#### Examples using `matplotlib.pyplot.step`

- `sphinx_glr_gallery_lines_bars_and_markers_step_demo.py`

#### `matplotlib.pyplot.streamplot`

```
matplotlib.pyplot.streamplot(x, y, u, v, density=1, linewidth=None, color=None,
                             cmap=None, norm=None, arrowsize=1, arrowstyle='->',
                             minlength=0.1, transform=None, zorder=None,
                             start_points=None, maxlength=4.0, integration_direction='both', *, data=None)
```

Draw streamlines of a vector flow.

## Parameters

- x, y** [1D arrays] An evenly spaced grid.
- u, v** [2D arrays]  $x$  and  $y$ -velocities. The number of rows and columns must match the length of  $y$  and  $x$ , respectively.
- density** [float or (float, float)] Controls the closeness of streamlines. When `density = 1`, the domain is divided into a 30x30 grid. `density` linearly scales this grid. Each cell in the grid can have, at most, one traversing streamline. For different densities in each direction, use a tuple (`density_x`, `density_y`).
- linewidth** [float or 2D array] The width of the stream lines. With a 2D array the line width can be varied across the grid. The array must have the same shape as  $u$  and  $v$ .
- color** [matplotlib color code, or 2D array] The streamline color. If given an array, its values are converted to colors using `cmap` and `norm`. The array must have the same shape as  $u$  and  $v$ .
- cmap** [*Colormap*] Colormap used to plot streamlines and arrows. This is only used if `color` is an array.
- norm** [*Normalize*] Normalize object used to scale luminance data to 0, 1. If `None`, stretch (min, max) to (0, 1). This is only used if `color` is an array.
- arrowsize** [float] Scaling factor for the arrow size.
- arrowstyle** [str] Arrow style specification. See *FancyArrowPatch*.
- minlength** [float] Minimum length of streamline in axes coordinates.
- start\_points** [Nx2 array] Coordinates of starting points for the streamlines in data coordinates (the same coordinates as the  $x$  and  $y$  arrays).
- zorder** [int] The zorder of the stream lines and arrows. Artists with lower zorder values are drawn first.
- maxlength** [float] Maximum length of streamline in axes coordinates.
- integration\_direction** [{'forward', 'backward', 'both'}] Integrate the streamline in forward, backward or both directions. default is 'both'.

## Returns

**stream\_container** [StreamplotSet] Container object with attributes

- `lines`: *LineCollection* of streamlines
- `arrows`: *PatchCollection* containing *FancyArrowPatch* objects representing the arrows half-way along stream lines.

This container will probably change in the future to allow changes to the colormap, alpha, etc. for both lines and arrows, but these changes should be backward compatible.

## Notes

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'start\_points', 'u', 'v', 'x', 'y'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

#### Examples using `matplotlib.pyplot.streamplot`

- `sphx_glr_gallery_images_contours_and_fields_plot_streamplot.py`

#### `matplotlib.pyplot.subplot`

`matplotlib.pyplot.subplot(*args, **kwargs)`

Add a subplot to the current figure.

Wrapper of `Figure.add_subplot` with a difference in behavior explained in the notes section.

Call signatures:

```
subplot(nrows, ncols, index, **kwargs)
subplot(pos, **kwargs)
subplot(ax)
```

#### Parameters

**\*args** Either a 3-digit integer or three separate integers describing the position of the subplot. If the three integers are *nrows*, *ncols*, and *index* in order, the subplot will take the *index* position on a grid with *nrows* rows and *ncols* columns. *index* starts at 1 in the upper left corner and increases to the right.

*pos* is a three digit integer, where the first digit is the number of rows, the second the number of columns, and the third the index of the subplot. i.e. `fig.add_subplot(235)` is the same as `fig.add_subplot(2, 3, 5)`. Note that all integers must be less than 10 for this form to work.

**projection** [{None, 'aitoff', 'hammer', 'lambert', 'mollweide', 'polar', 'rectilinear', str}, optional] The projection type of the subplot (*Axes*). *str* is the name of a costum projection, see *projections*. The default None results in a 'rectilinear' projection.

**polar** [boolean, optional] If True, equivalent to `projection='polar'`.

**sharex, sharey** [*Axes*, optional] Share the x or y *axis* with `sharex` and/or `sharey`. The axis will have the same limits, ticks, and scale as the axis of the shared axes.

**label** [str] A label for the returned axes.

#### Returns

**axes** [an *axes.SubplotBase* subclass of *Axes* (or a subclass of *Axes*)] The axes of the subplot. The returned axes base class depends on the projection used. It is *Axes* if rectilinear projection are used and *projections.polar.PolarAxes* if polar projection are used. The returned axes is then a subplot subclass of the base class.

**Other Parameters**

**\*\*kwargs** This method also takes the keyword arguments for the returned axes base class. The keyword arguments for the rectilinear base class *Axes* can be found in the following table but there might also be other keyword arguments if another projection is used.

	Property	Description
<i>adjustable</i>		{'box', 'datalim'}
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3)
<i>alpha</i>		float
<i>anchor</i>		2-tuple of floats or {'C', 'SW', 'S', 'SE', ...}
<i>animated</i>		bool
<i>aspect</i>		{'auto', 'equal'} or num
<i>autoscale_on</i>		bool
<i>autoscalex_on</i>		bool
<i>autoscaley_on</i>		bool
<i>axes_locator</i>		Callable[[ <i>Axes</i> , <i>Renderer</i> ], <i>Bbox</i> ]
<i>axisbelow</i>		bool or 'line'
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>contains</i>		callable
<i>facecolor</i>		color
<i>fc</i>		color
<i>figure</i>		<i>Figure</i>
<i>frame_on</i>		bool
<i>gid</i>		str
<i>in_layout</i>		bool
<i>label</i>		object
<i>navigate</i>		bool
<i>navigate_mode</i>		unknown
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		None or bool or float or callable
<i>position</i>		[left, bottom, width, height] or <i>Bbox</i>
<i>rasterization_zorder</i>		float or None
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>title</i>		str
<i>transform</i>		<i>Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>xbound</i>		unknown
<i>xlabel</i>		str
<i>xlim</i>		(left: float, right: float)

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	Property	Description
<i>xmargin</i>	float	greater than -0.5
<i>xscale</i>	{	"linear", "log", "symlog", "logit", ...}
<i>xticklabels</i>	List[str]	
<i>xticks</i>	list	
<i>ybound</i>	unknown	
<i>ylabel</i>	str	
<i>ylim</i>	(bottom: float, top: float)	
<i>ymargin</i>	float	greater than -0.5
<i>yscale</i>	{	"linear", "log", "symlog", "logit", ...}
<i>yticklabels</i>	List[str]	
<i>yticks</i>	list	
<i>zorder</i>	float	

**See also:***Figure.add\_subplot**pyplot.subplots**pyplot.axes**Figure.subplots***Notes**

Creating a subplot will delete any pre-existing subplot that overlaps with it beyond sharing a boundary:

```
import matplotlib.pyplot as plt
# plot a line, implicitly creating a subplot(111)
plt.plot([1,2,3])
# now create a subplot which represents the top plot of a grid
# with 2 rows and 1 column. Since this subplot will overlap the
# first, the plot (and its axes) previously created, will be removed
plt.subplot(211)
```

If you do not want this behavior, use the *Figure.add\_subplot* method or the *pyplot.axes* function instead.

If the figure already has a subplot with key (*args*, *kwargs*) then it will simply make that subplot current and return it. This behavior is deprecated. Meanwhile, if you do not want this behavior (i.e., you want to force the creation of a new subplot), you must use a unique set of *args* and *kwargs*. The axes *label* attribute has been exposed for this purpose: if you want two subplots that are otherwise identical to be added to the figure, make sure you give them unique labels.

In rare circumstances, *add\_subplot* may be called with a single argument, a subplot axes instance already created in the present figure but not in the figure's list of axes.

## Examples

```
plt.subplot(221)

# equivalent but more general
ax1=plt.subplot(2, 2, 1)

# add a subplot with no frame
ax2=plt.subplot(222, frameon=False)

# add a polar subplot
plt.subplot(223, projection='polar')

# add a red subplot that shares the x-axis with ax1
plt.subplot(224, sharex=ax1, facecolor='red')

# delete ax2 from the figure
plt.delaxes(ax2)

# add ax2 to the figure again
plt.subplot(ax2)
```

## Examples using matplotlib.pyplot.subplot

- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_nan\_test.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_psd\_demo.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_scatter\_star\_poly.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_axes\_margins.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_axes\_zoom\_effect.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_demo\_tight\_layout.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_geo\_demo.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_multiple\_figs\_demo.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_shared\_axis\_demo.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_subplot.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_subplots\_adjust.py
- sphx\_glr\_gallery\_pie\_and\_polar\_charts\_polar\_bar.py
- sphx\_glr\_gallery\_pie\_and\_polar\_charts\_polar\_demo.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_demo\_text\_path.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_multiline.py
- sphx\_glr\_gallery\_pyplots\_pyplot\_scales.py
- sphx\_glr\_gallery\_pyplots\_pyplot\_two\_subplots.py
- sphx\_glr\_gallery\_pyplots\_whats\_new\_98\_4\_legend.py
- sphx\_glr\_gallery\_shapes\_and\_collections\_ellipse\_demo.py

- sphx\_glr\_gallery\_shapes\_and\_collections\_fancybox\_demo.py
- sphx\_glr\_gallery\_axes\_grid1\_simple\_colorbar.py
- *MATPLOTLIB UNCHAINED*
- sphx\_glr\_gallery\_event\_handling\_trifinder\_event\_demo.py
- sphx\_glr\_gallery\_misc\_custom\_projection.py
- sphx\_glr\_gallery\_misc\_customize\_rc.py
- sphx\_glr\_gallery\_misc\_demo\_agg\_filter.py
- sphx\_glr\_gallery\_misc\_patheffect\_demo.py
- sphx\_glr\_gallery\_misc\_transoffset.py
- sphx\_glr\_gallery\_misc\_zorder\_demo.py
- sphx\_glr\_gallery\_recipes\_share\_axis\_lims\_views.py
- sphx\_glr\_gallery\_scales\_symlog\_demo.py
- sphx\_glr\_gallery\_ticks\_and\_spines\_tick-locators.py
- sphx\_glr\_gallery\_userdemo\_simple\_legend01.py
- *Pyplot tutorial*
- *Legend guide*
- *Constrained Layout Guide*
- *Tight Layout guide*

### matplotlib.pyplot.subplot2grid

matplotlib.pyplot.subplot2grid(*shape*, *loc*, *rowspan=1*, *colspan=1*, *fig=None*,  
*\*\*kwargs*)

Create an axis at specific location inside a regular grid.

#### Parameters

**shape** [sequence of 2 ints] Shape of grid in which to place axis. First entry is number of rows, second entry is number of columns.

**loc** [sequence of 2 ints] Location to place axis within grid. First entry is row number, second entry is column number.

**rowspan** [int] Number of rows for the axis to span to the right.

**colspan** [int] Number of columns for the axis to span downwards.

**fig** [Figure, optional] Figure to place axis in. Defaults to current figure.

**\*\*kwargs** Additional keyword arguments are handed to `add_subplot`.

#### Notes

The following call

```
subplot2grid(shape, loc, rowspan=1, colspan=1)
```

is identical to

```
gridspec=GridSpec(shape[0], shape[1])
subplotspec=gridspec.new_subplotspec(loc, rowspan, colspan)
subplot(subplotspec)
```

#### Examples using `matplotlib.pyplot.subplot2grid`

- `sphx_glr_gallery_subplots_axes_and_figures_demo_tight_layout.py`
- `sphx_glr_gallery_userdemo_demo_gridspec01.py`
- *Constrained Layout Guide*
- *Tight Layout guide*

#### `matplotlib.pyplot.subplot_tool`

`matplotlib.pyplot.subplot_tool(targetfig=None)`

Launch a subplot tool window for a figure.

A `matplotlib.widgets.SubplotTool` instance is returned.

#### Examples using `matplotlib.pyplot.subplot_tool`

- `sphx_glr_gallery_subplots_axes_and_figures_subplot_toolbar.py`

#### `matplotlib.pyplot.subplots`

```
matplotlib.pyplot.subplots(nrows=1, ncols=1, sharex=False, sharey=False,
                           squeeze=True, subplot_kw=None, gridspec_kw=None,
                           **fig_kw)
```

Create a figure and a set of subplots.

This utility wrapper makes it convenient to create common layouts of subplots, including the enclosing figure object, in a single call.

##### Parameters

**nrows, ncols** [int, optional, default: 1] Number of rows/columns of the subplot grid.

**sharex, sharey** [bool or {'none', 'all', 'row', 'col'}, default: False] Controls sharing of properties among x (sharex) or y (sharey) axes:

- True or 'all': x- or y-axis will be shared among all subplots.
- False or 'none': each subplot x- or y-axis will be independent.
- 'row': each subplot row will share an x- or y-axis.
- 'col': each subplot column will share an x- or y-axis.

When subplots have a shared x-axis along a column, only the x tick labels of the bottom subplot are created. Similarly, when subplots have a shared y-axis along a row, only the y tick labels of the first column subplot are created. To later turn other subplots' ticklabels on, use *tick\_params*.

**squeeze** [bool, optional, default: True]

- If True, extra dimensions are squeezed out from the returned array of *Axes*:
  - if only one subplot is constructed (*nrows=ncols=1*), the resulting single *Axes* object is returned as a scalar.
  - for *Nx1* or *1xM* subplots, the returned object is a 1D numpy object array of *Axes* objects.
  - for *NxM*, subplots with *N>1* and *M>1* are returned as a 2D array.
- If False, no squeezing at all is done: the returned *Axes* object is always a 2D array containing *Axes* instances, even if it ends up being *1x1*.

**num** [integer or string, optional, default: None] A *pyplot.figure* keyword that sets the figure number or label.

**subplot\_kw** [dict, optional] Dict with keywords passed to the *add\_subplot* call used to create each subplot.

**gridspec\_kw** [dict, optional] Dict with keywords passed to the *GridSpec* constructor used to create the grid the subplots are placed on.

**\*\*fig\_kw** All additional keyword arguments are passed to the *pyplot.figure* call.

### Returns

**fig** [*Figure*]

**ax** [*axes.Axes* object or array of *Axes* objects.] *ax* can be either a single *Axes* object or an array of *Axes* objects if more than one subplot was created. The dimensions of the resulting array can be controlled with the *squeeze* keyword, see above.

### See also:

*pyplot.figure*

*pyplot.subplot*

*pyplot.axes*

*Figure.subplots*

*Figure.add\_subplot*

### Examples

```
# First create some toy data:
x = np.linspace(0, 2*np.pi, 400)
y = np.sin(x**2)
```

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```
# Creates just a figure and only one subplot
fig, ax = plt.subplots()
ax.plot(x, y)
ax.set_title('Simple plot')

# Creates two subplots and unpacks the output array immediately
f, (ax1, ax2) = plt.subplots(1, 2, sharey=True)
ax1.plot(x, y)
ax1.set_title('Sharing Y axis')
ax2.scatter(x, y)

# Creates four polar axes, and accesses them through the returned array
fig, axes = plt.subplots(2, 2, subplot_kw=dict(polar=True))
axes[0, 0].plot(x, y)
axes[1, 1].scatter(x, y)

# Share a X axis with each column of subplots
plt.subplots(2, 2, sharex='col')

# Share a Y axis with each row of subplots
plt.subplots(2, 2, sharey='row')

# Share both X and Y axes with all subplots
plt.subplots(2, 2, sharex='all', sharey='all')

# Note that this is the same as
plt.subplots(2, 2, sharex=True, sharey=True)

# Creates figure number 10 with a single subplot
# and clears it if it already exists.
fig, ax=plt.subplots(num=10, clear=True)
```

#### Examples using `matplotlib.pyplot.subplots`

- `sphx_glr_gallery_lines_bars_and_markers_barchart.py`
- `sphx_glr_gallery_lines_bars_and_markers_barh.py`
- `sphx_glr_gallery_lines_bars_and_markers_broken_barh.py`
- `sphx_glr_gallery_lines_bars_and_markers_categorical_variables.py`
- `sphx_glr_gallery_lines_bars_and_markers_cohere.py`
- `sphx_glr_gallery_lines_bars_and_markers_csd_demo.py`
- `sphx_glr_gallery_lines_bars_and_markers_errorbar_subsample.py`
- `sphx_glr_gallery_lines_bars_and_markers_eventplot_demo.py`
- `sphx_glr_gallery_lines_bars_and_markers_fill.py`
- `sphx_glr_gallery_lines_bars_and_markers_fill_between_demo.py`
- `sphx_glr_gallery_lines_bars_and_markers_fill_betweenx_demo.py`

- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_filled\_step.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_gradient\_bar.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_horizontal\_barchart\_distribution.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_joinstyle.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_line\_demo\_dash\_control.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_linestyles.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_marker\_fillstyle\_reference.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_marker\_reference.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_markevery\_demo.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_multicolored\_line.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_psd\_demo.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_scatter\_custom\_symbol.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_scatter\_demo2.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_scatter\_piecharts.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_scatter\_with\_legend.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_simple\_plot.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_span\_regions.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_spectrum\_demo.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_stackplot\_demo.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_timeline.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_vline\_hline\_demo.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_xcorr\_acorr\_demo.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_affine\_image.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_barb\_demo.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_contour\_corner\_mask.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_contour\_demo.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_contour\_image.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_contour\_label\_demo.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_contourf\_demo.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_contourf\_hatching.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_contourf\_log.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_demo\_bboximage.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_image\_annotated\_heatmap.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_image\_clip\_path.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_image\_demo.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_image\_masked.py

- sphx\_glr\_gallery\_images\_contours\_and\_fields\_image\_nonuniform.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_image\_transparency\_blend.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_image\_zcoord.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_interpolation\_methods.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_irregulardatagrid.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_multi\_image.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_pcolor\_demo.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_pcolormesh\_levels.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_quadmesh\_demo.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_quiver\_demo.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_quiver\_simple\_demo.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_shading\_example.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_specgram\_demo.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_spy\_demos.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_tricontour\_demo.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_tricontour\_smooth\_delaunay.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_tricontour\_smooth\_user.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_trigradient\_demo.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_triinterp\_demo.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_tripcolor\_demo.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_tripplot\_demo.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_watermark\_image.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_axes\_margins.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_axes\_props.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_axis\_equal\_demo.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_broken\_axis.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_colorbar\_placement.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_demo\_constrained\_layout.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_demo\_tight\_layout.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_fahrenheit\_celsius\_scales.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_figure\_title.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_ganged\_plots.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_gridspec\_and\_subplots.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_secondary\_axis.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_subplot\_demo.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_subplot\_toolbar.py

- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_subplots\_demo.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_two\_scales.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_zoom\_inset\_axes.py
- sphx\_glr\_gallery\_statistics\_barchart\_demo.py
- sphx\_glr\_gallery\_statistics\_boxplot.py
- sphx\_glr\_gallery\_statistics\_boxplot\_color.py
- sphx\_glr\_gallery\_statistics\_boxplot\_demo.py
- sphx\_glr\_gallery\_statistics\_boxplot\_vs\_violin.py
- sphx\_glr\_gallery\_statistics\_bxp.py
- sphx\_glr\_gallery\_statistics\_confidence\_ellipse.py
- sphx\_glr\_gallery\_statistics\_customized\_violin.py
- sphx\_glr\_gallery\_statistics\_errorbar.py
- sphx\_glr\_gallery\_statistics\_errorbar\_features.py
- sphx\_glr\_gallery\_statistics\_errorbar\_limits.py
- sphx\_glr\_gallery\_statistics\_errorbars\_and\_boxes.py
- sphx\_glr\_gallery\_statistics\_hexbin\_demo.py
- sphx\_glr\_gallery\_statistics\_hist.py
- sphx\_glr\_gallery\_statistics\_histogram\_cumulative.py
- sphx\_glr\_gallery\_statistics\_histogram\_features.py
- sphx\_glr\_gallery\_statistics\_histogram\_histtypes.py
- sphx\_glr\_gallery\_statistics\_histogram\_multihist.py
- sphx\_glr\_gallery\_statistics\_multiple\_histograms\_side\_by\_side.py
- sphx\_glr\_gallery\_statistics\_violinplot.py
- sphx\_glr\_gallery\_pie\_and\_polar\_charts\_pie\_features.py
- sphx\_glr\_gallery\_pie\_and\_polar\_charts\_pie\_demo2.py
- sphx\_glr\_gallery\_pie\_and\_polar\_charts\_nested\_pie.py
- sphx\_glr\_gallery\_pie\_and\_polar\_charts\_pie\_and\_donut\_labels.py
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- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_font\_family\_rc\_sgskip.py
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- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_legend\_demo.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_line\_with\_text.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_mathtext\_demo.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_tex\_demo.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_text\_rotation.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_unicode\_minus.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_watermark\_text.py
- sphx\_glr\_gallery\_pyplots\_align\_ylabel.py
- sphx\_glr\_gallery\_pyplots\_annotate\_transform.py
- sphx\_glr\_gallery\_pyplots\_annotation\_basic.py
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- sphx\_glr\_gallery\_shapes\_and\_collections\_hatch\_demo.py
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- sphx\_glr\_gallery\_axes\_grid1\_demo\_colorbar\_with\_axes\_divider.py
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- sphx\_glr\_gallery\_axes\_grid1\_inset\_locator\_demo.py
- sphx\_glr\_gallery\_axes\_grid1\_inset\_locator\_demo2.py
- sphx\_glr\_gallery\_axes\_grid1\_scatter\_hist\_locatable\_axes.py
- sphx\_glr\_gallery\_showcase\_bachelors\_degrees\_by\_gender.py
- sphx\_glr\_gallery\_showcase\_integral.py
- *Decay*
- *Animated histogram*
- sphx\_glr\_gallery\_animation\_animation\_demo.py
- *The Bayes update*
- *Animated line plot*
- *Oscilloscope*
- sphx\_glr\_gallery\_event\_handling\_coords\_demo.py
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- sphx\_glr\_gallery\_event\_handling\_legend\_picking.py
- sphx\_glr\_gallery\_event\_handling\_looking\_glass.py
- sphx\_glr\_gallery\_event\_handling\_path\_editor.py
- sphx\_glr\_gallery\_event\_handling\_pick\_event\_demo.py
- sphx\_glr\_gallery\_event\_handling\_pick\_event\_demo2.py

- sphx\_glr\_gallery\_event\_handling\_poly\_editor.py
- sphx\_glr\_gallery\_event\_handling\_pong\_sgskip.py
- sphx\_glr\_gallery\_event\_handling\_resample.py
- sphx\_glr\_gallery\_event\_handling\_timers.py
- sphx\_glr\_gallery\_event\_handling\_viewlims.py
- sphx\_glr\_gallery\_event\_handling\_zoom\_window.py
- sphx\_glr\_gallery\_frontpage\_3D.py
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- sphx\_glr\_gallery\_misc\_agg\_buffer\_to\_array.py
- sphx\_glr\_gallery\_misc\_bbox\_intersect.py
- sphx\_glr\_gallery\_misc\_contour\_manual.py
- sphx\_glr\_gallery\_misc\_coords\_report.py
- sphx\_glr\_gallery\_misc\_cursor\_demo\_sgskip.py
- sphx\_glr\_gallery\_misc\_demo\_ribbon\_box.py
- sphx\_glr\_gallery\_misc\_findobj\_demo.py
- sphx\_glr\_gallery\_misc\_histogram\_path.py
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- sphx\_glr\_gallery\_specialty\_plots\_mri\_demo.py
- sphx\_glr\_gallery\_specialty\_plots\_radar\_chart.py
- sphx\_glr\_gallery\_specialty\_plots\_topographic\_hillshading.py
- sphx\_glr\_gallery\_ticks\_and\_spines\_auto\_ticks.py
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- sphx\_glr\_gallery\_ticks\_and\_spines\_colorbar\_tick\_labelling\_demo.py
- sphx\_glr\_gallery\_ticks\_and\_spines\_custom\_ticker1.py
- sphx\_glr\_gallery\_ticks\_and\_spines\_date\_concise\_formatter.py
- sphx\_glr\_gallery\_ticks\_and\_spines\_date\_demo\_convert.py
- sphx\_glr\_gallery\_ticks\_and\_spines\_date\_demo\_rrule.py
- sphx\_glr\_gallery\_ticks\_and\_spines\_date\_index\_formatter2.py
- sphx\_glr\_gallery\_ticks\_and\_spines\_major\_minor\_demo.py
- sphx\_glr\_gallery\_ticks\_and\_spines\_multiple\_yaxis\_with\_spines.py
- sphx\_glr\_gallery\_ticks\_and\_spines\_scalarformatter.py
- sphx\_glr\_gallery\_ticks\_and\_spines\_spines.py
- sphx\_glr\_gallery\_ticks\_and\_spines\_spines\_bounds.py
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- sphx\_glr\_gallery\_ticks\_and\_spines\_tick\_labels\_from\_values.py
- sphx\_glr\_gallery\_ticks\_and\_spines\_tick\_xlabel\_top.py
- sphx\_glr\_gallery\_units\_annotate\_with\_units.py
- sphx\_glr\_gallery\_units\_artist\_tests.py
- sphx\_glr\_gallery\_units\_bar\_demo2.py
- sphx\_glr\_gallery\_units\_bar\_unit\_demo.py
- sphx\_glr\_gallery\_units\_evans\_test.py
- sphx\_glr\_gallery\_units\_radian\_demo.py
- sphx\_glr\_gallery\_units\_units\_sample.py
- sphx\_glr\_gallery\_units\_units\_scatter.py
- sphx\_glr\_gallery\_user\_interfaces\_pylab\_with\_gtk\_sgskip.py
- sphx\_glr\_gallery\_user\_interfaces\_svg\_tooltip\_sgskip.py
- sphx\_glr\_gallery\_userdemo\_anchored\_box01.py
- sphx\_glr\_gallery\_userdemo\_anchored\_box02.py
- sphx\_glr\_gallery\_userdemo\_anchored\_box03.py
- sphx\_glr\_gallery\_userdemo\_anchored\_box04.py

- sphx\_glr\_gallery\_userdemo\_annotate\_explain.py
- sphx\_glr\_gallery\_userdemo\_annotate\_simple01.py
- sphx\_glr\_gallery\_userdemo\_annotate\_simple02.py
- sphx\_glr\_gallery\_userdemo\_annotate\_simple03.py
- sphx\_glr\_gallery\_userdemo\_annotate\_simple04.py
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- sphx\_glr\_gallery\_userdemo\_annotate\_simple\_coord02.py
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- sphx\_glr\_gallery\_userdemo\_colormap\_normalizations\_custom.py
- sphx\_glr\_gallery\_userdemo\_colormap\_normalizations\_diverging.py
- sphx\_glr\_gallery\_userdemo\_colormap\_normalizations\_lognorm.py
- sphx\_glr\_gallery\_userdemo\_colormap\_normalizations\_power.py
- sphx\_glr\_gallery\_userdemo\_colormap\_normalizations\_symlognorm.py
- sphx\_glr\_gallery\_userdemo\_connect\_simple01.py
- sphx\_glr\_gallery\_userdemo\_connectionstyle\_demo.py
- sphx\_glr\_gallery\_userdemo\_custom\_boxstyle01.py
- sphx\_glr\_gallery\_userdemo\_custom\_boxstyle02.py
- sphx\_glr\_gallery\_userdemo\_simple\_annotate01.py
- sphx\_glr\_gallery\_userdemo\_simple\_legend02.py
- sphx\_glr\_gallery\_widgets\_buttons.py
- sphx\_glr\_gallery\_widgets\_check\_buttons.py
- sphx\_glr\_gallery\_widgets\_lasso\_selector\_demo\_sgskip.py
- sphx\_glr\_gallery\_widgets\_multicursor.py
- sphx\_glr\_gallery\_widgets\_polygon\_selector\_demo.py
- sphx\_glr\_gallery\_widgets\_radio\_buttons.py
- sphx\_glr\_gallery\_widgets\_rectangle\_selector.py
- sphx\_glr\_gallery\_widgets\_slider\_demo.py
- sphx\_glr\_gallery\_widgets\_span\_selector.py
- sphx\_glr\_gallery\_widgets\_textbox.py
- *Usage Guide*
- *Sample plots in Matplotlib*
- *The Lifecycle of a Plot*
- *Artist tutorial*

- *Styling with cyclcr*
- *Customizing Figure Layouts Using GridSpec and Other Functions*
- *Constrained Layout Guide*
- *Tight Layout guide*
- *Path Tutorial*
- *Transformations Tutorial*
- *Specifying Colors*
- *Customized Colorbars Tutorial*
- *Creating Colormaps in Matplotlib*
- *Colormap Normalization*
- *Choosing Colormaps in Matplotlib*
- *Text in Matplotlib Plots*

### `matplotlib.pyplot.subplots_adjust`

`matplotlib.pyplot.subplots_adjust(left=None, bottom=None, right=None, top=None, wspace=None, hspace=None)`

Tune the subplot layout.

The parameter meanings (and suggested defaults) are:

```
left = 0.125 # the left side of the subplots of the figure
right = 0.9 # the right side of the subplots of the figure
bottom = 0.1 # the bottom of the subplots of the figure
top = 0.9 # the top of the subplots of the figure
wspace = 0.2 # the amount of width reserved for space between subplots,
             # expressed as a fraction of the average axis width
hspace = 0.2 # the amount of height reserved for space between subplots,
             # expressed as a fraction of the average axis height
```

The actual defaults are controlled by the rc file

### Examples using `matplotlib.pyplot.subplots_adjust`

- `sphinx_glr_gallery_images_contours_and_fields_irregulardatagrid.py`
- `sphinx_glr_gallery_subplots_axes_and_figures_subplots_adjust.py`
- `sphinx_glr_gallery_statistics_customized_violin.py`
- `sphinx_glr_gallery_text_labels_and_annotations_multiline.py`
- `sphinx_glr_gallery_text_labels_and_annotations_text_fontdict.py`
- `sphinx_glr_gallery_pyplots_pyplot_scales.py`
- `sphinx_glr_gallery_axisartist_demo_parasite_axes2.py`
- `sphinx_glr_gallery_misc_demo_agg_filter.py`
- `sphinx_glr_gallery_misc_table_demo.py`

- sphx\_glr\_gallery\_ticks\_and\_spines\_spines.py
- sphx\_glr\_gallery\_ticks\_and\_spines\_tick-locators.py
- sphx\_glr\_gallery\_ticks\_and\_spines\_ticklabels\_rotation.py
- sphx\_glr\_gallery\_widgets\_buttons.py
- sphx\_glr\_gallery\_widgets\_check\_buttons.py
- sphx\_glr\_gallery\_widgets\_radio\_buttons.py
- sphx\_glr\_gallery\_widgets\_slider\_demo.py
- sphx\_glr\_gallery\_widgets\_textbox.py
- *Pyplot tutorial*

### matplotlib.pyplot.summer

`matplotlib.pyplot.summer()`  
Set the colormap to "summer".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

### matplotlib.pyplot.suptitle

`matplotlib.pyplot.suptitle(t, **kwargs)`  
Add a centered title to the figure.

#### Parameters

**t** [str] The title text.

**x** [float, default 0.5] The x location of the text in figure coordinates.

**y** [float, default 0.98] The y location of the text in figure coordinates.

**horizontalalignment, ha** [{'center', 'left', 'right'}, default: 'center'] The horizontal alignment of the text relative to (x, y).

**verticalalignment, va** [{'top', 'center', 'bottom', 'baseline'}, default: 'top'] The vertical alignment of the text relative to (x, y).

**fontsize, size** [default: `rcParams["figure.titlesize"]`] The font size of the text. See `Text.set_size` for possible values.

**fontweight, weight** [default: `rcParams["figure.titleweight"]`] The font weight of the text. See `Text.set_weight` for possible values.

#### Returns

**text** The `Text` instance of the title.

#### Other Parameters

**fontproperties** [None or dict, optional] A dict of font properties. If `fontproperties` is given the default values for font size and weight are taken from the `FontProperties` defaults. `rcParams["figure.titlesize"]` and `rcParams["figure.titleweight"]` are ignored in this case.

**\*\*kwargs** Additional kwargs are `matplotlib.text.Text` properties.

### Examples

```
>>> fig.suptitle('This is the figure title', fontsize=12)
```

### Examples using `matplotlib.pyplot.suptitle`

- `sphinx_gallery_subplots_axes_and_figures_gridspec_nested.py`
- *Pyplot tutorial*

### `matplotlib.pyplot.switch_backend`

`matplotlib.pyplot.switch_backend(newbackend)`

Close all open figures and set the Matplotlib backend.

The argument is case-insensitive. Switching to an interactive backend is possible only if no event loop for another interactive backend has started. Switching to and from non-interactive backends is always possible.

#### Parameters

**newbackend** [str] The name of the backend to use.

### `matplotlib.pyplot.table`

```
matplotlib.pyplot.table(cellText=None, cellColours=None, cellLoc='right', col-
                        Widths=None, rowLabels=None, rowColours=None,
                        rowLoc='left', colLabels=None, colColours=None, col-
                        Loc='center', loc='bottom', bbox=None, edges='closed',
                        **kwargs)
```

Add a table to an *Axes*.

At least one of *cellText* or *cellColours* must be specified. These parameters must be 2D lists, in which the outer lists define the rows and the inner list define the column values per row. Each row must have the same number of elements.

The table can optionally have row and column headers, which are configured using *rowLabels*, *rowColours*, *rowLoc* and *colLabels*, *colColours*, *colLoc* respectively.

For finer grained control over tables, use the *Table* class and add it to the axes with *Axes.add\_table*.

#### Parameters

**cellText** [2D list of str, optional] The texts to place into the table cells.

*Note:* Line breaks in the strings are currently not accounted for and will result in the text exceeding the cell boundaries.

**cellColours** [2D list of matplotlib color specs, optional] The background colors of the cells.

- cellLoc** [({'left', 'center', 'right'}, default: 'right')] The alignment of the text within the cells.
- colWidths** [list of float, optional] The column widths in units of the axes. If not given, all columns will have a width of  $1 / ncols$ .
- rowLabels** [list of str, optional] The text of the row header cells.
- rowColours** [list of matplotlib color specs, optional] The colors of the row header cells.
- rowLoc** [({'left', 'center', 'right'}, optional, default: 'left')] The text alignment of the row header cells.
- colLabels** [list of str, optional] The text of the column header cells.
- colColours** [list of matplotlib color specs, optional] The colors of the column header cells.
- rowLoc** [({'left', 'center', 'right'}, optional, default: 'left')] The text alignment of the column header cells.
- loc** [str, optional] The position of the cell with respect to *ax*. This must be one of the *codes*.
- bbox** [*Bbox*, optional] A bounding box to draw the table into. If this is not *None*, this overrides *loc*.
- edges** [substring of 'BRTL' or {'open', 'closed', 'horizontal', 'vertical'}] The cell edges to be drawn with a line. See also *visible\_edges*.

**Returns**

**table** [*Table*] The created table.

**Other Parameters**

**\*\*kwargs** *Table* properties.

Property	Description
<i>agg_filter</i>	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
<i>alpha</i>	float
<i>animated</i>	bool
<i>clip_box</i>	<i>Bbox</i>
<i>clip_on</i>	bool
<i>clip_path</i>	[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>contains</i>	callable
<i>figure</i>	<i>Figure</i>
<i>fontsize</i>	float
<i>gid</i>	str
<i>in_layout</i>	bool
<i>label</i>	object
<i>path_effects</i>	<i>AbstractPathEffect</i>
<i>picker</i>	None or bool or float or callable
<i>rasterized</i>	bool or None
<i>sketch_params</i>	(scale: float, length: float, randomness: float)
<i>snap</i>	bool or None
<i>transform</i>	<i>Transform</i>
<i>url</i>	str
<i>visible</i>	bool
<i>zorder</i>	float

#### Examples using `matplotlib.pyplot.table`

- `sphx_glr_gallery_misc_table_demo.py`

#### `matplotlib.pyplot.text`

```
matplotlib.pyplot.text(x, y, s, fontdict=None, withdash=<deprecated parameter>,
                      **kwargs)
```

Add text to the axes.

Add the text *s* to the axes at location *x*, *y* in data coordinates.

#### Parameters

**x, y** [scalars] The position to place the text. By default, this is in data coordinates. The coordinate system can be changed using the *transform* parameter.

**s** [str] The text.

**fontdict** [dictionary, optional, default: None] A dictionary to override the default text properties. If *fontdict* is None, the defaults are determined by your rc parameters.

**withdash** [boolean, optional, default: False] Creates a *TextWithDash* instance instead of a *Text* instance.

#### Returns

**text** [*Text*] The created *Text* instance.

## Other Parameters

**\*\*kwargs** [*Text* properties.] Other miscellaneous text parameters.

### Examples

Individual keyword arguments can be used to override any given parameter:

```
>>> text(x, y, s, fontsize=12)
```

The default transform specifies that text is in data coords, alternatively, you can specify text in axis coords (0,0 is lower-left and 1,1 is upper-right). The example below places text in the center of the axes:

```
>>> text(0.5, 0.5, 'matplotlib', horizontalalignment='center',
...      verticalalignment='center', transform=ax.transAxes)
```

You can put a rectangular box around the text instance (e.g., to set a background color) by using the keyword `bbox`. `bbox` is a dictionary of *Rectangle* properties. For example:

```
>>> text(x, y, s, bbox=dict(facecolor='red', alpha=0.5))
```

### Examples using `matplotlib.pyplot.text`

- `sphinx_glr_gallery_lines_bars_and_markers_horizontal_barchart_distribution.py`
- `sphinx_glr_gallery_text_labels_and_annotations_arrow_demo.py`
- `sphinx_glr_gallery_text_labels_and_annotations_autowrap.py`
- `sphinx_glr_gallery_text_labels_and_annotations_fancytextbox_demo.py`
- `sphinx_glr_gallery_text_labels_and_annotations_multiline.py`
- `sphinx_glr_gallery_text_labels_and_annotations_text_fontdict.py`
- `sphinx_glr_gallery_text_labels_and_annotations_text_rotation_relative_to_line.py`
- `sphinx_glr_gallery_text_labels_and_annotations_usetex_demo.py`
- `sphinx_glr_gallery_text_labels_and_annotations_usetex_fonteffects.py`
- `sphinx_glr_gallery_pyplots_pyplot_mathtext.py`
- `sphinx_glr_gallery_pyplots_pyplot_text.py`
- `sphinx_glr_gallery_pyplots_text_layout.py`
- `sphinx_glr_gallery_shapes_and_collections_artist_reference.py`
- `sphinx_glr_gallery_event_handling_close_event.py`
- `sphinx_glr_gallery_misc_transoffset.py`
- `sphinx_glr_gallery_userdemo_pgf_fonts.py`
- `sphinx_glr_gallery_userdemo_pgf_textrsystem.py`
- *Pyplot tutorial*
- *Path effects guide*

## matplotlib.pyplot.thetagrids

matplotlib.pyplot.thetagrids(\*args, \*\*kwargs)

Get or set the theta gridlines on the current polar plot.

Call signatures:

```
lines, labels = thetagrids()  
lines, labels = thetagrids(angles, labels=None, fmt=None, **kwargs)
```

When called with no arguments, *thetagrids* simply returns the tuple (*lines*, *labels*). When called with arguments, the labels will appear at the specified angles.

### Parameters

**angles** [tuple with floats, degrees] The angles of the theta gridlines.

**labels** [tuple with strings or None] The labels to use at each radial gridline. The *projections.polar.ThetaFormatter* will be used if None.

**fmt** [str or None] Format string used in *matplotlib.ticker.FormatStrFormatter*. For example '%f'. Note that the angle in radians will be used.

### Returns

**lines, labels** [list of *lines.Line2D*, list of *text.Text*] *lines* are the theta gridlines and *labels* are the tick labels.

### Other Parameters

**\*\*kwargs** *kwargs* are optional *Text* properties for the labels.

### See also:

*pyplot.rgrids*

*projections.polar.PolarAxes.set\_thetagrids*

*Axis.get\_gridlines*

*Axis.get\_ticklabels*

### Examples

```
# set the locations of the angular gridlines  
lines, labels = thetagrids( range(45,360,90) )  
  
# set the locations and labels of the angular gridlines  
lines, labels = thetagrids( range(45,360,90), ('NE', 'NW', 'SW','SE') )
```

## matplotlib.pyplot.tick\_params

matplotlib.pyplot.tick\_params(axis='both', \*\*kwargs)

Change the appearance of ticks, tick labels, and gridlines.

### Parameters

**axis** [{'x', 'y', 'both'}] optional] Which axis to apply the parameters to.

### Other Parameters

**axis** [{'x', 'y', 'both'}] Axis on which to operate; default is 'both'.

**reset** [bool] If *True*, set all parameters to defaults before processing other keyword arguments. Default is *False*.

**which** [{'major', 'minor', 'both'}] Default is 'major'; apply arguments to *which* ticks.

**direction** [{'in', 'out', 'inout'}] Puts ticks inside the axes, outside the axes, or both.

**length** [float] Tick length in points.

**width** [float] Tick width in points.

**color** [color] Tick color; accepts any mpl color spec.

**pad** [float] Distance in points between tick and label.

**labelsize** [float or str] Tick label font size in points or as a string (e.g., 'large').

**labelcolor** [color] Tick label color; mpl color spec.

**colors** [color] Changes the tick color and the label color to the same value: mpl color spec.

**zorder** [float] Tick and label zorder.

**bottom, top, left, right** [bool] Whether to draw the respective ticks.

**labelbottom, labeltop, labeleft, labelright** [bool] Whether to draw the respective tick labels.

**labelrotation** [float] Tick label rotation

**grid\_color** [color] Changes the gridline color to the given mpl color spec.

**grid\_alpha** [float] Transparency of gridlines: 0 (transparent) to 1 (opaque).

**grid\_linewidth** [float] Width of gridlines in points.

**grid\_linestyle** [string] Any valid *Line2D* line style spec.

### Examples

#### Usage

```
ax.tick_params(direction='out', length=6, width=2, colors='r',
               grid_color='r', grid_alpha=0.5)
```

This will make all major ticks be red, pointing out of the box, and with dimensions 6 points by 2 points. Tick labels will also be red. Gridlines will be red and translucent.

`matplotlib.pyplot.ticklabel_format`

`matplotlib.pyplot.ticklabel_format(*, axis='both', style="", scilimits=None, useOffset=None, useLocale=None, useMathText=None)`

Change the *ScalarFormatter* used by default for linear axes.

Optional keyword arguments:

Key-word	Description
<code>axis</code>	[ 'x'   'y'   'both' ]
<code>style</code>	[ 'sci' (or 'scientific')   'plain' ] plain turns off scientific notation
<code>scilimits</code>	(m, n), pair of integers; if <code>style</code> is 'sci', scientific notation will be used for numbers outside the range $10^m$ to $10^n$ . Use (0,0) to include all numbers. Use (m,m) where $m <> 0$ to fix the order of magnitude to $10^m$ .
<code>useOffset</code>	[ bool   offset ]; if True, the offset will be calculated as needed; if False, no offset will be used; if a numeric offset is specified, it will be used.
<code>useLocale</code>	If True, format the number according to the current locale. This affects things such as the character used for the decimal separator. If False, use C-style (English) formatting. The default setting is controlled by the <code>axes.formatter.use_locale</code> rparam.
<code>useMathText</code>	If True, render the offset and scientific notation in <code>mathtext</code>

Only the major ticks are affected. If the method is called when the *ScalarFormatter* is not the *Formatter* being used, an `AttributeError` will be raised.

`matplotlib.pyplot.tight_layout`

`matplotlib.pyplot.tight_layout(pad=1.08, h_pad=None, w_pad=None, rect=None)`

Automatically adjust subplot parameters to give specified padding.

**Parameters**

**pad** [float] Padding between the figure edge and the edges of subplots, as a fraction of the font size.

**h\_pad, w\_pad** [float, optional] Padding (height/width) between edges of adjacent subplots, as a fraction of the font size. Defaults to `pad`.

**rect** [tuple (left, bottom, right, top), optional] A rectangle (left, bottom, right, top) in the normalized figure coordinate that the whole subplots area (including labels) will fit into. Default is (0, 0, 1, 1).

**Examples using `matplotlib.pyplot.tight_layout`**

- `sphx_glr_gallery_lines_bars_and_markers_linestyles.py`
- `sphx_glr_gallery_lines_bars_and_markers_nan_test.py`
- `sphx_glr_gallery_images_contours_and_fields_image_annotated_heatmap.py`

- sphx\_glr\_gallery\_images\_contours\_and\_fields\_interpolation\_methods.py
- sphx\_glr\_gallery\_images\_contours\_and\_fields\_plot\_streamplot.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_demo\_tight\_layout.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_engineering\_formatter.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_figlegend\_demo.py
- sphx\_glr\_gallery\_shapes\_and\_collections\_artist\_reference.py
- sphx\_glr\_gallery\_misc\_zorder\_demo.py
- sphx\_glr\_gallery\_mplot3d\_wire3d\_zero\_stride.py
- sphx\_glr\_gallery\_scales\_symlog\_demo.py
- sphx\_glr\_gallery\_specialty\_plots\_mri\_with\_eeg.py
- sphx\_glr\_gallery\_userdemo\_pgf\_fonts.py
- sphx\_glr\_gallery\_userdemo\_pgf\_preamble\_sgskip.py
- sphx\_glr\_gallery\_userdemo\_pgf\_texsystem.py
- *Tight Layout guide*

## matplotlib.pyplot.title

`matplotlib.pyplot.title(label, fontdict=None, loc='center', pad=None, **kwargs)`  
 Set a title for the axes.

Set one of the three available axes titles. The available titles are positioned above the axes in the center, flush with the left edge, and flush with the right edge.

### Parameters

**label** [str] Text to use for the title

**fontdict** [dict] A dictionary controlling the appearance of the title text, the default fontdict is:

```
{'fontsize': rcParams['axes.titlesize'],
 'fontweight' : rcParams['axes.titleweight'],
 'verticalalignment': 'baseline',
 'horizontalalignment': loc}
```

**loc** [{ 'center', 'left', 'right' }, str, optional] Which title to set, defaults to 'center'

**pad** [float] The offset of the title from the top of the axes, in points. Default is None to use `rcParams['axes.titlepad']`.

### Returns

**text** [*Text*] The matplotlib text instance representing the title

### Other Parameters

**\*\*kwargs** [*Text* properties] Other keyword arguments are text properties, see *Text* for a list of valid text properties.

### Examples using `matplotlib.pyplot.title`

- `sphx_glr_gallery_lines_bars_and_markers_bar_stacked.py`
- `sphx_glr_gallery_lines_bars_and_markers_markevery_prop_cycle.py`
- `sphx_glr_gallery_lines_bars_and_markers_masked_demo.py`
- `sphx_glr_gallery_lines_bars_and_markers_nan_test.py`
- `sphx_glr_gallery_lines_bars_and_markers_psd_demo.py`
- `sphx_glr_gallery_subplots_axes_and_figures_axes_demo.py`
- `sphx_glr_gallery_subplots_axes_and_figures_geo_demo.py`
- `sphx_glr_gallery_subplots_axes_and_figures_invert_axes.py`
- `sphx_glr_gallery_subplots_axes_and_figures_subplot.py`
- `sphx_glr_gallery_text_labels_and_annotations_multiline.py`
- `sphx_glr_gallery_text_labels_and_annotations_text_fontdict.py`
- `sphx_glr_gallery_text_labels_and_annotations_titles_demo.py`
- `sphx_glr_gallery_text_labels_and_annotations_usetex_fonteffects.py`
- `sphx_glr_gallery_pyplots_pyplot_mathtext.py`
- `sphx_glr_gallery_pyplots_pyplot_scales.py`
- `sphx_glr_gallery_pyplots_pyplot_text.py`
- `sphx_glr_gallery_style_sheets_plot_solarizedlight2.py`
- `sphx_glr_gallery_event_handling_ginput_manual_clabel_sgskip.py`
- `sphx_glr_gallery_event_handling_trifinder_event_demo.py`
- `sphx_glr_gallery_misc_findobj_demo.py`
- `sphx_glr_gallery_misc_multipage_pdf.py`
- `sphx_glr_gallery_misc_set_and_get.py`
- `sphx_glr_gallery_misc_table_demo.py`
- `sphx_glr_gallery_misc_zorder_demo.py`
- `sphx_glr_gallery_scales_custom_scale.py`
- `sphx_glr_gallery_specialty_plots_sankey_basics.py`
- `sphx_glr_gallery_user_interfaces_svg_histogram_sgskip.py`
- *Usage Guide*
- *Pyplot tutorial*

### `matplotlib.pyplot.tricontour`

`matplotlib.pyplot.tricontour(*args, **kwargs)`

Draw contours on an unstructured triangular grid.

`tricontour` and `tricontourf` draw contour lines and filled contours, respectively. Except as noted, function signatures and return values are the same for both versions.

The triangulation can be specified in one of two ways; either

```
tricontour(triangulation, ...)
```

where *triangulation* is a `matplotlib.tri.Triangulation` object, or

```
tricontour(x, y, ...)
tricontour(x, y, triangles, ...)
tricontour(x, y, triangles=triangles, ...)
tricontour(x, y, mask=mask, ...)
tricontour(x, y, triangles, mask=mask, ...)
```

in which case a *Triangulation* object will be created. See that class' docstring for an explanation of these cases.

The remaining arguments may be:

```
tricontour(..., Z)
```

where *Z* is the array of values to contour, one per point in the triangulation. The level values are chosen automatically.

```
tricontour(..., Z, N)
```

contour up to  $N+1$  automatically chosen contour levels ( $N$  intervals).

```
tricontour(..., Z, V)
```

draw contour lines at the values specified in sequence *V*, which must be in increasing order.

```
tricontourf(..., Z, V)
```

fill the  $(\text{len}(V)-1)$  regions between the values in *V*, which must be in increasing order.

```
tricontour(Z, **kwargs)
```

Use keyword args to control colors, linewidth, origin, cmap ... see below for more details.

`tricontour(...)` returns a `TriContourSet` object.

Optional keyword arguments:

*colors*: [ *None* | string | (mpl\_colors) ] If *None*, the colormap specified by `cmap` will be used.

If a string, like 'r' or 'red', all levels will be plotted in this color.

If a tuple of matplotlib color args (string, float, rgb, etc), different levels will be plotted in different colors in the order specified.

*alpha*: float The alpha blending value

*cmap*: [ *None* | Colormap ] A `cm.Colormap` instance or *None*. If *cmap* is *None* and *colors* is *None*, a default `Colormap` is used.

*norm*: [ *None* | Normalize ] A `matplotlib.colors.Normalize` instance for scaling data values to colors. If *norm* is *None* and *colors* is *None*, the default linear scaling is used.

*levels* [level0, level1, ..., leveln] A list of floating point numbers indicating the level curves to draw, in increasing order; e.g., to draw just the zero contour pass `levels=[0]`

*origin*: [ *None* | 'upper' | 'lower' | 'image' ] If *None*, the first value of *Z* will correspond to the lower left corner, location (0,0). If 'image', the rc value for `image.origin` will be used.

This keyword is not active if *X* and *Y* are specified in the call to `contour`.

*extent*: [ *None* | (x0,x1,y0,y1) ]

If *origin* is not *None*, then *extent* is interpreted as in `matplotlib.pyplot.imshow()`: it gives the outer pixel boundaries. In this case, the position of `Z[0,0]` is the center of the pixel, not a corner. If *origin* is *None*, then (x0, y0) is the position of `Z[0,0]`, and (x1, y1) is the position of `Z[-1,-1]`.

This keyword is not active if *X* and *Y* are specified in the call to `contour`.

*locator*: [ *None* | `ticker.Locator` subclass ] If *locator* is *None*, the default `MaxNLocator` is used. The locator is used to determine the contour levels if they are not given explicitly via the *V* argument.

*extend*: [ 'neither' | 'both' | 'min' | 'max' ] Unless this is 'neither', contour levels are automatically added to one or both ends of the range so that all data are included. These added ranges are then mapped to the special colormap values which default to the ends of the colormap range, but can be set via `matplotlib.colors.Colormap.set_under()` and `matplotlib.colors.Colormap.set_over()` methods.

*xunits, yunits*: [ *None* | registered units ] Override axis units by specifying an instance of a `matplotlib.units.ConversionInterface`.

tricontour-only keyword arguments:

*linewidths*: [ *None* | number | tuple of numbers ] If *linewidths* is *None*, defaults to `rc:lines.linewidth`.

If a number, all levels will be plotted with this linewidth.

If a tuple, different levels will be plotted with different linewidths in the order specified

*linestyles*: [ *None* | 'solid' | 'dashed' | 'dashdot' | 'dotted' ] If *linestyles* is *None*, the 'solid' is used.

*linestyles* can also be an iterable of the above strings specifying a set of linestyles to be used. If this iterable is shorter than the number of contour levels it will be repeated as necessary.

If `contour` is using a monochrome colormap and the contour level is less than 0, then the linestyle specified in `rcParams["contour.negative_linestyle"]` will be used.

tricontourf-only keyword arguments:

*antialiased*: bool enable antialiasing

Note: `tricontourf` fills intervals that are closed at the top; that is, for boundaries *z1* and *z2*, the filled region is:

$$z1 < Z \leq z2$$

except for the lowest interval, which is closed on both sides (i.e. it includes the lowest value).

#### Examples using `matplotlib.pyplot.tricontour`

- `sphx_glr_gallery_images_contours_and_fields_irregulardatagrid.py`
- `sphx_glr_gallery_images_contours_and_fields_tricontour_smooth_delaunay.py`
- `sphx_glr_gallery_images_contours_and_fields_tricontour_smooth_user.py`
- `sphx_glr_gallery_images_contours_and_fields_trigradient_demo.py`

#### `matplotlib.pyplot.tricontourf`

`matplotlib.pyplot.tricontourf(*args, **kwargs)`

Draw contours on an unstructured triangular grid.

`tricontour` and `tricontourf` draw contour lines and filled contours, respectively. Except as noted, function signatures and return values are the same for both versions.

The triangulation can be specified in one of two ways; either

```
tricontour(triangulation, ...)
```

where `triangulation` is a `matplotlib.tri.Triangulation` object, or

```
tricontour(x, y, ...)
tricontour(x, y, triangles, ...)
tricontour(x, y, triangles=triangles, ...)
tricontour(x, y, mask=mask, ...)
tricontour(x, y, triangles, mask=mask, ...)
```

in which case a `Triangulation` object will be created. See that class' docstring for an explanation of these cases.

The remaining arguments may be:

```
tricontour(..., Z)
```

where `Z` is the array of values to contour, one per point in the triangulation. The level values are chosen automatically.

```
tricontour(..., Z, N)
```

contour up to  $N+1$  automatically chosen contour levels ( $N$  intervals).

```
tricontour(..., Z, V)
```

draw contour lines at the values specified in sequence `V`, which must be in increasing order.

```
tricontourf(..., Z, V)
```

fill the  $(\text{len}(V)-1)$  regions between the values in `V`, which must be in increasing order.

```
tricontour(Z, **kwargs)
```

Use keyword args to control colors, linewidth, origin, cmap ... see below for more details.

`tricontour(...)` returns a `TriContourSet` object.

Optional keyword arguments:

*colors*: [ *None* | string | (mpl\_colors) ] If *None*, the colormap specified by *cmap* will be used.

If a string, like 'r' or 'red', all levels will be plotted in this color.

If a tuple of matplotlib color args (string, float, rgb, etc), different levels will be plotted in different colors in the order specified.

*alpha*: float The alpha blending value

*cmap*: [ *None* | Colormap ] A `cm.Colormap` instance or *None*. If *cmap* is *None* and *colors* is *None*, a default `Colormap` is used.

*norm*: [ *None* | Normalize ] A `matplotlib.colors.Normalize` instance for scaling data values to colors. If *norm* is *None* and *colors* is *None*, the default linear scaling is used.

*levels* [level0, level1, ..., leveln] A list of floating point numbers indicating the level curves to draw, in increasing order; e.g., to draw just the zero contour pass `levels=[0]`

*origin*: [ *None* | 'upper' | 'lower' | 'image' ] If *None*, the first value of *Z* will correspond to the lower left corner, location (0,0). If 'image', the `rc` value for `image.origin` will be used.

This keyword is not active if *X* and *Y* are specified in the call to `contour`.

*extent*: [ *None* | (x0,x1,y0,y1) ]

If *origin* is not *None*, then *extent* is interpreted as in `matplotlib.pyplot.imshow()`: it gives the outer pixel boundaries. In this case, the position of `Z[0,0]` is the center of the pixel, not a corner. If *origin* is *None*, then (x0, y0) is the position of `Z[0,0]`, and (x1, y1) is the position of `Z[-1,-1]`.

This keyword is not active if *X* and *Y* are specified in the call to `contour`.

*locator*: [ *None* | `ticker.Locator` subclass ] If *locator* is *None*, the default `MaxNLocator` is used. The locator is used to determine the contour levels if they are not given explicitly via the *V* argument.

*extend*: [ 'neither' | 'both' | 'min' | 'max' ] Unless this is 'neither', contour levels are automatically added to one or both ends of the range so that all data are included. These added ranges are then mapped to the special colormap values which default to the ends of the colormap range, but can be set via `matplotlib.colors.Colormap.set_under()` and `matplotlib.colors.Colormap.set_over()` methods.

*xunits, yunits*: [ *None* | registered units ] Override axis units by specifying an instance of a `matplotlib.units.ConversionInterface`.

tricontour-only keyword arguments:

*linewidths*: [ *None* | number | tuple of numbers ] If *linewidths* is *None*, defaults to `rc:lines.linewidth`.

If a number, all levels will be plotted with this linewidth.

If a tuple, different levels will be plotted with different linewidths in the order specified

*linestyles*: [ *None* | 'solid' | 'dashed' | 'dashdot' | 'dotted' ] If *linestyles* is *None*, the 'solid' is used.

*linestyles* can also be an iterable of the above strings specifying a set of linestyles to be used. If this iterable is shorter than the number of contour levels it will be repeated as necessary.

If contour is using a monochrome colormap and the contour level is less than 0, then the linestyle specified in `rcParams["contour.negative_linestyle"]` will be used.

tricontourf-only keyword arguments:

*antialiased*: bool enable antialiasing

Note: *tricontourf* fills intervals that are closed at the top; that is, for boundaries *z1* and *z2*, the filled region is:

```
z1 < Z <= z2
```

except for the lowest interval, which is closed on both sides (i.e. it includes the lowest value).

#### Examples using `matplotlib.pyplot.tricontourf`

- `sphx_glr_gallery_images_contours_and_fields_irregulardatagrid.py`
- `sphx_glr_gallery_images_contours_and_fields_tricontour_demo.py`
- `sphx_glr_gallery_images_contours_and_fields_tricontour_smooth_delaunay.py`
- `sphx_glr_gallery_images_contours_and_fields_tricontour_smooth_user.py`
- `sphx_glr_gallery_images_contours_and_fields_triinterp_demo.py`

#### `matplotlib.pyplot.tripcolor`

`matplotlib.pyplot.tripcolor(*args, alpha=1.0, norm=None, cmap=None, vmin=None, vmax=None, shading='flat', facecolors=None, **kwargs)`

Create a pseudocolor plot of an unstructured triangular grid.

The triangulation can be specified in one of two ways; either:

```
tripcolor(triangulation, ...)
```

where *triangulation* is a `matplotlib.tri.Triangulation` object, or

```
tripcolor(x, y, ...)
tripcolor(x, y, triangles, ...)
tripcolor(x, y, triangles=triangles, ...)
tripcolor(x, y, mask=mask, ...)
tripcolor(x, y, triangles, mask=mask, ...)
```

in which case a `Triangulation` object will be created. See *Triangulation* for a explanation of these possibilities.

The next argument must be `C`, the array of color values, either one per point in the triangulation if color values are defined at points, or one per triangle in the triangulation if color values are defined at triangles. If there are the same number of points and triangles in the triangulation it is assumed that color values are defined at points; to force the use of color values at triangles use the kwarg `facecolors=C` instead of just `C`.

`shading` may be 'flat' (the default) or 'gouraud'. If `shading` is 'flat' and `C` values are defined at points, the color values used for each triangle are from the mean `C` of the triangle's three points. If `shading` is 'gouraud' then color values must be defined at points.

The remaining kwargs are the same as for `pcolor()`.

#### Examples using `matplotlib.pyplot.tripcolor`

- `sphx_glr_gallery_images_contours_and_fields_tripcolor_demo.py`

#### `matplotlib.pyplot.triplot`

`matplotlib.pyplot.triplot(*args, **kwargs)`

Draw a unstructured triangular grid as lines and/or markers.

The triangulation to plot can be specified in one of two ways; either:

```
triplot(triangulation, ...)
```

where `triangulation` is a `matplotlib.tri.Triangulation` object, or

```
triplot(x, y, ...)
triplot(x, y, triangles, ...)
triplot(x, y, triangles=triangles, ...)
triplot(x, y, mask=mask, ...)
triplot(x, y, triangles, mask=mask, ...)
```

in which case a `Triangulation` object will be created. See *Triangulation* for a explanation of these possibilities.

The remaining args and kwargs are the same as for `plot()`.

Return a list of 2 *Line2D* containing respectively:

- the lines plotted for triangles edges
- the markers plotted for triangles nodes

#### Examples using `matplotlib.pyplot.triplot`

- `sphx_glr_gallery_images_contours_and_fields_tricontour_smooth_delaunay.py`
- `sphx_glr_gallery_images_contours_and_fields_trigradient_demo.py`
- `sphx_glr_gallery_images_contours_and_fields_triinterp_demo.py`

- sphx\_glr\_gallery\_images\_contours\_and\_fields\_triplet\_demo.py
- sphx\_glr\_gallery\_event\_handling\_trifinder\_event\_demo.py

### matplotlib.pyplot.twinx

`matplotlib.pyplot.twinx(ax=None)`

Make and return a second axes that shares the x-axis. The new axes will overlay *ax* (or the current axes if *ax* is *None*), and its ticks will be on the right.

#### Examples

`/gallery/subplots_axes_and_figures/two_scales`

### matplotlib.pyplot.twiny

`matplotlib.pyplot.twinx(ax=None)`

Make and return a second axes that shares the y-axis. The new axes will overlay *ax* (or the current axes if *ax* is *None*), and its ticks will be on the top.

#### Examples

`/gallery/subplots_axes_and_figures/two_scales`

### matplotlib.pyplot.uninstall\_repl\_displayhook

`matplotlib.pyplot.uninstall_repl_displayhook()`

Uninstall the matplotlib display hook.

### matplotlib.pyplot.violinplot

`matplotlib.pyplot.violinplot(dataset, positions=None, vert=True, widths=0.5, showmeans=False, showextrema=True, showmedians=False, points=100, bw_method=None, *, data=None)`

Make a violin plot.

Make a violin plot for each column of *dataset* or each vector in sequence *dataset*. Each filled area extends to represent the entire data range, with optional lines at the mean, the median, the minimum, and the maximum.

#### Parameters

**dataset** [Array or a sequence of vectors.] The input data.

**positions** [array-like, default = [1, 2, ..., n]] Sets the positions of the violins. The ticks and limits are automatically set to match the positions.

**vert** [bool, default = True.] If true, creates a vertical violin plot. Otherwise, creates a horizontal violin plot.

**widths** [array-like, default = 0.5] Either a scalar or a vector that sets the maximal width of each violin. The default is 0.5, which uses about half of the available horizontal space.

**showmeans** [bool, default = False] If `True`, will toggle rendering of the means.

**showextrema** [bool, default = True] If `True`, will toggle rendering of the extrema.

**showmedians** [bool, default = False] If `True`, will toggle rendering of the medians.

**points** [scalar, default = 100] Defines the number of points to evaluate each of the gaussian kernel density estimations at.

**bw\_method** [str, scalar or callable, optional] The method used to calculate the estimator bandwidth. This can be 'scott', 'silverman', a scalar constant or a callable. If a scalar, this will be used directly as kde. factor. If a callable, it should take a `GaussianKDE` instance as its only parameter and return a scalar. If `None` (default), 'scott' is used.

### Returns

**result** [dict] A dictionary mapping each component of the violinplot to a list of the corresponding collection instances created. The dictionary has the following keys:

- **bodies**: A list of the `matplotlib.collections.PolyCollection` instances containing the filled area of each violin.
- **cmeans**: A `matplotlib.collections.LineCollection` instance created to identify the mean values of each of the violin's distribution.
- **cmins**: A `matplotlib.collections.LineCollection` instance created to identify the bottom of each violin's distribution.
- **cmaxes**: A `matplotlib.collections.LineCollection` instance created to identify the top of each violin's distribution.
- **cbars**: A `matplotlib.collections.LineCollection` instance created to identify the centers of each violin's distribution.
- **cmedians**: A `matplotlib.collections.LineCollection` instance created to identify the median values of each of the violin's distribution.

### Notes

---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'dataset'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

**matplotlib.pyplot.viridis**

```
matplotlib.pyplot.viridis()
```

Set the colormap to "viridis".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

**matplotlib.pyplot.vlines**

```
matplotlib.pyplot.vlines(x, ymin, ymax, colors='k', linestyle='solid', label="", *,
                          data=None, **kwargs)
```

Plot vertical lines.

Plot vertical lines at each `x` from `ymin` to `ymax`.

**Parameters**

**x** [scalar or 1D array\_like] x-indexes where to plot the lines.

**ymin, ymax** [scalar or 1D array\_like] Respective beginning and end of each line. If scalars are provided, all lines will have same length.

**colors** [array\_like of colors, optional, default: 'k']

**linestyle** [{'solid', 'dashed', 'dashdot', 'dotted'}, optional]

**label** [string, optional, default: ""]

**Returns**

**lines** [*LineCollection*]

**Other Parameters**

**\*\*kwargs** [*LineCollection* properties.]

**See also:**

`hlines` horizontal lines

`axvline` vertical line across the axes

**Notes**


---

**Note:** In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'colors', 'x', 'ymax', 'ymin'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

**matplotlib.pyplot.waitforbuttonpress**`matplotlib.pyplot.waitforbuttonpress(*args, **kwargs)`

Blocking call to interact with the figure.

This will return True if a key was pressed, False if a mouse button was pressed and None if *timeout* was reached without either being pressed.

If *timeout* is negative, does not timeout.

**Examples using matplotlib.pyplot.waitforbuttonpress**

- sphx\_glr\_gallery\_event\_handling\_ginput\_manual\_clabel\_sgskip.py

**matplotlib.pyplot.winter**`matplotlib.pyplot.winter()`

Set the colormap to "winter".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

**matplotlib.pyplot.xcorr**`matplotlib.pyplot.xcorr(x, y, normed=True, detrend=<function detrend_none  
at 0x7f69881a1378>, usevlines=True, maxlags=10, *,  
data=None, **kwargs)`

Plot the cross correlation between *x* and *y*.

The correlation with lag *k* is defined as  $\sum_n x[n+k] \cdot y^*[n]$ , where *y\** is the complex conjugate of *y*.

**Parameters**

**x** [array-like of length *n*]

**y** [array-like of length *n*]

**detrend** [callable, optional, default: `mlab.detrend_none`] *x* and *y* are detrended by the *detrend* callable. This must be a function `x = detrend(x)` accepting and returning a `numpy.array`. Default is no normalization.

**normed** [bool, optional, default: `True`] If `True`, input vectors are normalised to unit length.

**usevlines** [bool, optional, default: `True`] Determines the plot style.

If `True`, vertical lines are plotted from 0 to the `xcorr` value using `Axes.vlines`. Additionally, a horizontal line is plotted at `y=0` using `Axes.axhline`.

If `False`, markers are plotted at the `xcorr` values using `Axes.plot`.

**maxlags** [int, optional, default: `10`] Number of lags to show. If `None`, will return all `2 * len(x) - 1` lags.

**Returns**

**lags** [array (length 2\*maxlags+1)] The lag vector.

**c** [array (length 2\*maxlags+1)] The auto correlation vector.

**line** [*LineCollection* or *Line2D*] *Artist* added to the axes of the correlation:

- *LineCollection* if *usevlines* is True.
- *Line2D* if *usevlines* is False.

**b** [*Line2D* or None] Horizontal line at 0 if *usevlines* is True None *usevlines* is False.

### Other Parameters

**linestyle** [*Line2D* property, optional] The linestyle for plotting the data points. Only used if *usevlines* is False.

**marker** [str, optional, default: 'o'] The marker for plotting the data points. Only used if *usevlines* is False.

### Notes

The cross correlation is performed with `numpy.correlate()` with `mode = "full"`.

---

**Note:** In addition to the above described arguments, this function can take a **data** key-word argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x', 'y'.

Objects passed as **data** must support item access (`data[<arg>]`) and membership test (`<arg> in data`).

---

### Examples using `matplotlib.pyplot.xcorr`

- `sphx_glr_gallery_lines_bars_and_markers_xcorr_acorr_demo.py`

### `matplotlib.pyplot.xkcd`

`matplotlib.pyplot.xkcd(scale=1, length=100, randomness=2)`

Turn on `xkcd` sketch-style drawing mode. This will only have effect on things drawn after this function is called.

For best results, the "Humor Sans" font should be installed: it is not included with `matplotlib`.

### Parameters

**scale** [float, optional] The amplitude of the wiggle perpendicular to the source line.

**length** [float, optional] The length of the wiggle along the line.

**randomness** [float, optional] The scale factor by which the length is shrunken or expanded.

## Notes

This function works by a number of rcParams, so it will probably override others you have set before.

If you want the effects of this function to be temporary, it can be used as a context manager, for example:

```
with plt.xkcd():
    # This figure will be in XKCD-style
    fig1 = plt.figure()
    # ...

# This figure will be in regular style
fig2 = plt.figure()
```

## Examples using `matplotlib.pyplot.xkcd`

- `sphinx_glr_gallery_showcase_xkcd.py`

## `matplotlib.pyplot.xlabel`

`matplotlib.pyplot.xlabel(xlabel, fontdict=None, labelpad=None, **kwargs)`

Set the label for the x-axis.

### Parameters

**xlabel** [str] The label text.

**labelpad** [scalar, optional, default: None] Spacing in points from the axes bounding box including ticks and tick labels.

### Other Parameters

**\*\*kwargs** [*Text* properties] *Text* properties control the appearance of the label.

### See also:

`text` for information on how override and the optional args work

## Examples using `matplotlib.pyplot.xlabel`

- `sphinx_glr_gallery_lines_bars_and_markers_nan_test.py`
- `sphinx_glr_gallery_lines_bars_and_markers_scatter_symbol.py`
- `sphinx_glr_gallery_subplots_axes_and_figures_axes_demo.py`
- `sphinx_glr_gallery_subplots_axes_and_figures_invert_axes.py`
- `sphinx_glr_gallery_subplots_axes_and_figures_subplot.py`
- `sphinx_glr_gallery_text_labels_and_annotations_multiline.py`
- `sphinx_glr_gallery_text_labels_and_annotations_text_fontdict.py`

- sphx\_glr\_gallery\_pyplots\_pyplot\_mathtext.py
- sphx\_glr\_gallery\_pyplots\_pyplot\_text.py
- sphx\_glr\_gallery\_style\_sheets\_plot\_solarizedlight2.py
- sphx\_glr\_gallery\_misc\_findobj\_demo.py
- sphx\_glr\_gallery\_misc\_plotfile\_demo.py
- sphx\_glr\_gallery\_scales\_custom\_scale.py
- sphx\_glr\_gallery\_userdemo\_pgf\_fonts.py
- sphx\_glr\_gallery\_userdemo\_pgf\_preamble\_sgskip.py
- sphx\_glr\_gallery\_userdemo\_pgf\_texsystem.py
- *Usage Guide*
- *Pyplot tutorial*

### matplotlib.pyplot.xlim

matplotlib.pyplot.xlim(\*args, \*\*kwargs)

Get or set the x limits of the current axes.

Call signatures:

```
left, right = xlim() # return the current xlim
xlim((left, right)) # set the xlim to left, right
xlim(left, right) # set the xlim to left, right
```

If you do not specify args, you can pass *left* or *right* as kwargs, i.e.:

```
xlim(right=3) # adjust the right leaving left unchanged
xlim(left=1) # adjust the left leaving right unchanged
```

Setting limits turns autoscaling off for the x-axis.

#### Returns

**left, right** A tuple of the new x-axis limits.

#### Notes

Calling this function with no arguments (e.g. `xlim()`) is the pyplot equivalent of calling `get_xlim` on the current axes. Calling this function with arguments is the pyplot equivalent of calling `set_xlim` on the current axes. All arguments are passed though.

#### Examples using matplotlib.pyplot.xlim

- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_axes\_demo.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_invert\_axes.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_shared\_axis\_demo.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_arrow\_demo.py

- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_text\_rotation\_relative\_to\_line.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_usetex\_fonteffects.py
- sphx\_glr\_gallery\_pyplots\_pyplot\_text.py
- sphx\_glr\_gallery\_shapes\_and\_collections\_ellipse\_demo.py
- *Frame grabbing*
- sphx\_glr\_gallery\_event\_handling\_ginput\_manual\_clabel\_sgskip.py

### matplotlib.pyplot.xscale

matplotlib.pyplot.xscale(*value*, **\*\*kwargs**)  
Set the x-axis scale.

#### Parameters

**value** [{"linear", "log", "symlog", "logit", ...}] The axis scale type to apply.  
**\*\*kwargs** Different keyword arguments are accepted, depending on the scale. See the respective class keyword arguments:

- *matplotlib.scale.LinearScale*
- *matplotlib.scale.LogScale*
- *matplotlib.scale.SymmetricalLogScale*
- *matplotlib.scale.LogitScale*

#### Notes

By default, Matplotlib supports the above mentioned scales. Additionally, custom scales may be registered using *matplotlib.scale.register\_scale*. These scales can then also be used here.

### Examples using matplotlib.pyplot.xscale

- sphx\_glr\_gallery\_scales\_symlog\_demo.py

### matplotlib.pyplot.xticks

matplotlib.pyplot.xticks(*ticks=None*, *labels=None*, **\*\*kwargs**)  
Get or set the current tick locations and labels of the x-axis.

Call signatures:

```
locs, labels = xticks()           # Get locations and labels
xticks(ticks, [labels], **kwargs) # Set locations and labels
```

#### Parameters

**ticks** [array\_like] A list of positions at which ticks should be placed. You can pass an empty list to disable xticks.

**labels** [array\_like, optional] A list of explicit labels to place at the given *locs*.

**\*\*kwargs** *Text* properties can be used to control the appearance of the labels.

### Returns

**locs** An array of label locations.

**labels** A list of *Text* objects.

### Notes

Calling this function with no arguments (e.g. `xticks()`) is the pyplot equivalent of calling `get_xticks` and `get_xticklabels` on the current axes. Calling this function with arguments is the pyplot equivalent of calling `set_xticks` and `set_xticklabels` on the current axes.

### Examples

Get the current locations and labels:

```
>>> locs, labels = xticks()
```

Set label locations:

```
>>> xticks(np.arange(0, 1, step=0.2))
```

Set text labels:

```
>>> xticks(np.arange(5), ('Tom', 'Dick', 'Harry', 'Sally', 'Sue'))
```

Set text labels and properties:

```
>>> xticks(np.arange(12), calendar.month_name[1:13], rotation=20)
```

Disable xticks:

```
>>> xticks([])
```

### Examples using `matplotlib.pyplot.xticks`

- `sphx_glr_gallery_lines_bars_and_markers_bar_stacked.py`
- `sphx_glr_gallery_subplots_axes_and_figures_axes_demo.py`
- `sphx_glr_gallery_subplots_axes_and_figures_secondary_axis.py`
- `sphx_glr_gallery_text_labels_and_annotations_arrow_demo.py`
- `sphx_glr_gallery_text_labels_and_annotations_multiline.py`
- `sphx_glr_gallery_text_labels_and_annotations_usetex_demo.py`
- `sphx_glr_gallery_axes_grid1_demo_colorbar_of_inset_axes.py`
- `sphx_glr_gallery_misc_table_demo.py`

- sphx\_glr\_gallery\_ticks\_and\_spines\_custom\_ticker1.py
- sphx\_glr\_gallery\_ticks\_and\_spines\_ticklabels\_rotation.py

### matplotlib.pyplot.ylabel

`matplotlib.pyplot.ylabel(ylabel, fontdict=None, labelpad=None, **kwargs)`  
Set the label for the y-axis.

#### Parameters

**ylabel** [str] The label text.

**labelpad** [scalar, optional, default: None] Spacing in points from the axes bounding box including ticks and tick labels.

#### Other Parameters

**\*\*kwargs** [*Text* properties] *Text* properties control the appearance of the label.

#### See also:

`text` for information on how override and the optional args work

### Examples using matplotlib.pyplot.ylabel

- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_bar\_stacked.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_nan\_test.py
- sphx\_glr\_gallery\_lines\_bars\_and\_markers\_scatter\_symbol.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_axes\_demo.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_invert\_axes.py
- sphx\_glr\_gallery\_subplots\_axes\_and\_figures\_subplot.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_multiline.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_text\_fontdict.py
- sphx\_glr\_gallery\_text\_labels\_and\_annotations\_usetex\_demo.py
- sphx\_glr\_gallery\_pyplots\_pyplot\_mathtext.py
- sphx\_glr\_gallery\_pyplots\_pyplot\_simple.py
- sphx\_glr\_gallery\_pyplots\_pyplot\_text.py
- sphx\_glr\_gallery\_style\_sheets\_plot\_solarizedlight2.py
- sphx\_glr\_gallery\_misc\_findobj\_demo.py
- sphx\_glr\_gallery\_misc\_plotfile\_demo.py
- sphx\_glr\_gallery\_misc\_table\_demo.py
- sphx\_glr\_gallery\_scales\_custom\_scale.py
- sphx\_glr\_gallery\_scales\_symlog\_demo.py
- sphx\_glr\_gallery\_userdemo\_pgf\_preamble\_sgskip.py

- *Usage Guide*
- *Pyplot tutorial*

### matplotlib.pyplot.ylim

`matplotlib.pyplot.ylim(*args, **kwargs)`  
 Get or set the y-limits of the current axes.

Call signatures:

```
bottom, top = ylim() # return the current ylim
ylim((bottom, top)) # set the ylim to bottom, top
ylim(bottom, top)   # set the ylim to bottom, top
```

If you do not specify args, you can alternatively pass *bottom* or *top* as kwargs, i.e.:

```
ylim(top=3) # adjust the top leaving bottom unchanged
ylim(bottom=1) # adjust the bottom leaving top unchanged
```

Setting limits turns autoscaling off for the y-axis.

#### Returns

**bottom, top** A tuple of the new y-axis limits.

#### Notes

Calling this function with no arguments (e.g. `ylim()`) is the pyplot equivalent of calling `get_ylim` on the current axes. Calling this function with arguments is the pyplot equivalent of calling `set_ylim` on the current axes. All arguments are passed though.

#### Examples using `matplotlib.pyplot.ylim`

- `sphinx_glr_gallery_subplots_axes_and_figures_axes_demo.py`
- `sphinx_glr_gallery_text_labels_and_annotations_arrow_demo.py`
- `sphinx_glr_gallery_text_labels_and_annotations_usetex_fonteffects.py`
- `sphinx_glr_gallery_pyplots_pyplot_text.py`
- `sphinx_glr_gallery_shapes_and_collections_ellipse_demo.py`
- *Frame grabbing*
- `sphinx_glr_gallery_event_handling_ginput_manual_clabel_sgskip.py`
- `sphinx_glr_gallery_misc_findobj_demo.py`
- *Pyplot tutorial*

### matplotlib.pyplot.yscale

`matplotlib.pyplot.yscale(value, **kwargs)`  
Set the y-axis scale.

#### Parameters

**value** [{"linear", "log", "symlog", "logit", ...}] The axis scale type to apply.

**\*\*kwargs** Different keyword arguments are accepted, depending on the scale. See the respective class keyword arguments:

- `matplotlib.scale.LinearScale`
- `matplotlib.scale.LogScale`
- `matplotlib.scale.SymmetricalLogScale`
- `matplotlib.scale.LogitScale`

#### Notes

By default, Matplotlib supports the above mentioned scales. Additionally, custom scales may be registered using `matplotlib.scale.register_scale`. These scales can then also be used here.

#### Examples using matplotlib.pyplot.yscale

- `sphinx_glr_gallery_pyplots_pyplot_scales.py`
- `sphinx_glr_gallery_scales_symlog_demo.py`
- *Pyplot tutorial*

### matplotlib.pyplot.yticks

`matplotlib.pyplot.yticks(ticks=None, labels=None, **kwargs)`  
Get or set the current tick locations and labels of the y-axis.

Call signatures:

```
locs, labels = yticks()           # Get locations and labels
yticks(ticks, [labels], **kwargs) # Set locations and labels
```

#### Parameters

**ticks** [array\_like] A list of positions at which ticks should be placed. You can pass an empty list to disable yticks.

**labels** [array\_like, optional] A list of explicit labels to place at the given *locs*.

**\*\*kwargs** *Text* properties can be used to control the appearance of the labels.

#### Returns

**locs** An array of label locations.

**labels** A list of *Text* objects.

### Notes

Calling this function with no arguments (e.g. `yticks()`) is the pyplot equivalent of calling `get_yticks` and `get_yticklabels` on the current axes. Calling this function with arguments is the pyplot equivalent of calling `set_yticks` and `set_yticklabels` on the current axes.

### Examples

Get the current locations and labels:

```
>>> locs, labels = yticks()
```

Set label locations:

```
>>> yticks(np.arange(0, 1, step=0.2))
```

Set text labels:

```
>>> yticks(np.arange(5), ('Tom', 'Dick', 'Harry', 'Sally', 'Sue'))
```

Set text labels and properties:

```
>>> yticks(np.arange(12), calendar.month_name[1:13], rotation=45)
```

Disable yticks:

```
>>> yticks([])
```

### Examples using `matplotlib.pyplot.yticks`

- `sphx_glr_gallery_lines_bars_and_markers_bar_stacked.py`
- `sphx_glr_gallery_subplots_axes_and_figures_axes_demo.py`
- `sphx_glr_gallery_text_labels_and_annotations_arrow_demo.py`
- `sphx_glr_gallery_text_labels_and_annotations_usetex_demo.py`
- `sphx_glr_gallery_axes_grid1_demo_colorbar_of_inset_axes.py`
- `sphx_glr_gallery_misc_table_demo.py`

`matplotlib.pyplot.plotting()`

	Function	Description
<code>acorr</code>		Plot the autocorrelation of $x$ .
<code>angle_spectrum</code>		Plot the angle spectrum.
<code>annotate</code>		Annotate the point $xy$ with text <i>text</i> .

Continued on next page

Table 194 – continued from previous page

	Function	Description
<i>arrow</i>		Add an arrow to the axes.
<i>autoscale</i>		Autoscale the axis view to the data (toggle).
<i>axes</i>		Add an axes to the current figure and make it the current axes.
<i>axhline</i>		Add a horizontal line across the axis.
<i>axhspan</i>		Add a horizontal span (rectangle) across the axis.
<i>axis</i>		Convenience method to get or set some axis properties.
<i>axvline</i>		Add a vertical line across the axes.
<i>axvspan</i>		Add a vertical span (rectangle) across the axes.
<i>bar</i>		Make a bar plot.
<i>barbs</i>		Plot a 2D field of barbs.
<i>barh</i>		Make a horizontal bar plot.
<i>box</i>		Turn the axes box on or off on the current axes.
<i>boxplot</i>		Make a box and whisker plot.
<i>broken_barh</i>		Plot a horizontal sequence of rectangles.
<i>cla</i>		Clear the current axes.
<i>clabel</i>		Label a contour plot.
<i>clf</i>		Clear the current figure.
<i>clim</i>		Set the color limits of the current image.
<i>close</i>		Close a figure window.
<i>cohere</i>		Plot the coherence between x and y.
<i>colorbar</i>		Add a colorbar to a plot.
<i>contour</i>		Plot contours.
<i>contourf</i>		Plot contours.
<i>csd</i>		Plot the cross-spectral density.
<i>delaxes</i>		Remove the Axes <i>ax</i> (defaulting to the current axes) from its figure.
<i>draw</i>		Redraw the current figure.
<i>errorbar</i>		Plot y versus x as lines and/or markers with attached errorbars.
<i>eventplot</i>		Plot identical parallel lines at the given positions.
<i>figimage</i>		Add a non-resampled image to the figure.
<i>figlegend</i>		Place a legend on the figure.
<i>fignum_exists</i>		Return whether the figure with the given id exists.
<i>figtext</i>		Add text to figure.
<i>figure</i>		Create a new figure.
<i>fill</i>		Plot filled polygons.
<i>fill_between</i>		Fill the area between two horizontal curves.
<i>fill_betweenx</i>		Fill the area between two vertical curves.
<i>findobj</i>		Find artist objects.
<i>gca</i>		Get the current <i>Axes</i> instance on the current figure matching the given keyword.
<i>gcf</i>		Get the current figure.
<i>gci</i>		Get the current colorable artist.
<i>get_figlabels</i>		Return a list of existing figure labels.
<i>get_fignums</i>		Return a list of existing figure numbers.
<i>grid</i>		Configure the grid lines.
<i>hexbin</i>		Make a hexagonal binning plot.
<i>hist</i>		Plot a histogram.
<i>hist2d</i>		Make a 2D histogram plot.
<i>hlines</i>		Plot horizontal lines at each y from <i>xmin</i> to <i>xmax</i> .
<i>imread</i>		Read an image from a file into an array.
<i>imsave</i>		Save an array as an image file.

Continued on next page

Table 194 – continued from previous page

	Function	Description
<i>imshow</i>		Display an image, i.e.
<i>install_repl_displayhook</i>		Install a repl display hook so that any stale figure are automatically redrawn v
<i>ioff</i>		Turn the interactive mode off.
<i>ion</i>		Turn the interactive mode on.
<i>isinteractive</i>		Return the status of interactive mode.
<i>legend</i>		Place a legend on the axes.
<i>locator_params</i>		Control behavior of major tick locators.
<i>loglog</i>		Make a plot with log scaling on both the x and y axis.
<i>magnitude_spectrum</i>		Plot the magnitude spectrum.
<i>margins</i>		Set or retrieve autoscaling margins.
<i>matshow</i>		Display an array as a matrix in a new figure window.
<i>minorticks_off</i>		Remove minor ticks from the axes.
<i>minorticks_on</i>		Display minor ticks on the axes.
<i>pause</i>		Pause for <i>interval</i> seconds.
<i>pcolor</i>		Create a pseudocolor plot with a non-regular rectangular grid.
<i>pcolormesh</i>		Create a pseudocolor plot with a non-regular rectangular grid.
<i>phase_spectrum</i>		Plot the phase spectrum.
<i>pie</i>		Plot a pie chart.
<i>plot</i>		Plot y versus x as lines and/or markers.
<i>plot_date</i>		Plot data that contains dates.
<i>plotfile</i>		Plot the data in a file.
<i>polar</i>		Make a polar plot.
<i>psd</i>		Plot the power spectral density.
<i>quiver</i>		Plot a 2D field of arrows.
<i>quiverkey</i>		Add a key to a quiver plot.
<i>rc</i>		Set the current rc params.
<i>rc_context</i>		Return a context manager for managing rc settings.
<i>rcdefaults</i>		Restore the rc params from Matplotlib's internal default style.
<i>rgrids</i>		Get or set the radial gridlines on the current polar plot.
<i>savefig</i>		Save the current figure.
<i>sca</i>		Set the current Axes instance to <i>ax</i> .
<i>scatter</i>		A scatter plot of y vs x with varying marker size and/or color.
<i>sci</i>		Set the current image.
<i>semilogx</i>		Make a plot with log scaling on the x axis.
<i>semilogy</i>		Make a plot with log scaling on the y axis.
<i>set_cmap</i>		Set the default colormap.
<i>setp</i>		Set a property on an artist object.
<i>show</i>		Display a figure.
<i>specgram</i>		Plot a spectrogram.
<i>spy</i>		Plot the sparsity pattern of a 2D array.
<i>stackplot</i>		Draw a stacked area plot.
<i>stem</i>		Create a stem plot.
<i>step</i>		Make a step plot.
<i>streamplot</i>		Draw streamlines of a vector flow.
<i>subplot</i>		Add a subplot to the current figure.
<i>subplot2grid</i>		Create an axis at specific location inside a regular grid.
<i>subplot_tool</i>		Launch a subplot tool window for a figure.
<i>subplots</i>		Create a figure and a set of subplots.
<i>subplots_adjust</i>		Tune the subplot layout.

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Table 194 – continued from previous page

	Function	Description
<code>suptitle</code>		Add a centered title to the figure.
<code>switch_backend</code>		Close all open figures and set the Matplotlib backend.
<code>table</code>		Add a table to an <i>Axes</i> .
<code>text</code>		Add text to the axes.
<code>thetagrids</code>		Get or set the theta gridlines on the current polar plot.
<code>tick_params</code>		Change the appearance of ticks, tick labels, and gridlines.
<code>ticklabel_format</code>		Change the <i>ScalarFormatter</i> used by default for linear axes.
<code>tight_layout</code>		Automatically adjust subplot parameters to give specified padding.
<code>title</code>		Set a title for the axes.
<code>tricontour</code>		Draw contours on an unstructured triangular grid.
<code>tricontourf</code>		Draw contours on an unstructured triangular grid.
<code>tripcolor</code>		Create a pseudocolor plot of an unstructured triangular grid.
<code>triplot</code>		Draw a unstructured triangular grid as lines and/or markers.
<code>twinx</code>		Make and return a second axes that shares the x-axis.
<code>twiny</code>		Make and return a second axes that shares the y-axis.
<code>uninstall_repl_displayhook</code>		Uninstall the matplotlib display hook.
<code>violinplot</code>		Make a violin plot.
<code>vlines</code>		Plot vertical lines.
<code>xcorr</code>		Plot the cross correlation between x and y.
<code>xkcd</code>		Turn on <code>xkcd</code> sketch-style drawing mode.
<code>xlabel</code>		Set the label for the x-axis.
<code>xlim</code>		Get or set the x limits of the current axes.
<code>xscale</code>		Set the x-axis scale.
<code>xticks</code>		Get or set the current tick locations and labels of the x-axis.
<code>ylabel</code>		Set the label for the y-axis.
<code>ylim</code>		Get or set the y-limits of the current axes.
<code>yscale</code>		Set the y-axis scale.
<code>yticks</code>		Get or set the current tick locations and labels of the y-axis.

## 17.37.2 Colors in Matplotlib

There are many colormaps you can use to map data onto color values. Below we list several ways in which color can be utilized in Matplotlib.

For a more in-depth look at colormaps, see the *Choosing Colormaps in Matplotlib* tutorial.

`matplotlib.pyplot.colormaps()`

Matplotlib provides a number of colormaps, and others can be added using `register_cmap()`. This function documents the built-in colormaps, and will also return a list of all registered colormaps if called.

You can set the colormap for an image, `pcolor`, `scatter`, etc, using a keyword argument:

```
imshow(X, cmap=cm.hot)
```

or using the `set_cmap()` function:

```
imshow(X)
pyplot.set_cmap('hot')
pyplot.set_cmap('jet')
```

In interactive mode, `set_cmap()` will update the colormap post-hoc, allowing you to see which one works best for your data.

All built-in colormaps can be reversed by appending `_r`: For instance, `gray_r` is the reverse of `gray`.

There are several common color schemes used in visualization:

**Sequential schemes** for unipolar data that progresses from low to high

**Diverging schemes** for bipolar data that emphasizes positive or negative deviations from a central value

**Cyclic schemes** for plotting values that wrap around at the endpoints, such as phase angle, wind direction, or time of day

**Qualitative schemes** for nominal data that has no inherent ordering, where color is used only to distinguish categories

Matplotlib ships with 4 perceptually uniform color maps which are the recommended color maps for sequential data:

Colormap	Description
<code>inferno</code>	perceptually uniform shades of black-red-yellow
<code>magma</code>	perceptually uniform shades of black-red-white
<code>plasma</code>	perceptually uniform shades of blue-red-yellow
<code>viridis</code>	perceptually uniform shades of blue-green-yellow

The following colormaps are based on the [ColorBrewer](#) color specifications and designs developed by Cynthia Brewer:

ColorBrewer Diverging (luminance is highest at the midpoint, and decreases towards differently-colored endpoints):

Colormap	Description
<code>BrBG</code>	brown, white, blue-green
<code>PiYG</code>	pink, white, yellow-green
<code>PRGn</code>	purple, white, green
<code>PuOr</code>	orange, white, purple
<code>RdBu</code>	red, white, blue
<code>RdGy</code>	red, white, gray
<code>RdYlBu</code>	red, yellow, blue
<code>RdYlGn</code>	red, yellow, green
<code>Spectral</code>	red, orange, yellow, green, blue

ColorBrewer Sequential (luminance decreases monotonically):

Colormap	Description
Blues	white to dark blue
BuGn	white, light blue, dark green
BuPu	white, light blue, dark purple
GnBu	white, light green, dark blue
Greens	white to dark green
Greys	white to black (not linear)
Oranges	white, orange, dark brown
OrRd	white, orange, dark red
PuBu	white, light purple, dark blue
PuBuGn	white, light purple, dark green
PuRd	white, light purple, dark red
Purples	white to dark purple
RdPu	white, pink, dark purple
Reds	white to dark red
YlGn	light yellow, dark green
YlGnBu	light yellow, light green, dark blue
YlOrBr	light yellow, orange, dark brown
YlOrRd	light yellow, orange, dark red

#### ColorBrewer Qualitative:

(For plotting nominal data, `ListedColormap` is used, not `LinearSegmentedColormap`. Different sets of colors are recommended for different numbers of categories.)

- Accent
- Dark2
- Paired
- Pastel1
- Pastel2
- Set1
- Set2
- Set3

A set of colormaps derived from those of the same name provided with Matlab are also included:

Colormap	Description
autumn	sequential linearly-increasing shades of red-orange-yellow
bone	sequential increasing black-white color map with a tinge of blue, to emulate X-ray film
cool	linearly-decreasing shades of cyan-magenta
copper	sequential increasing shades of black-copper
flag	repetitive red-white-blue-black pattern (not cyclic at endpoints)
gray	sequential linearly-increasing black-to-white grayscale
hot	sequential black-red-yellow-white, to emulate blackbody radiation from an object at increasing temperatures
jet	a spectral map with dark endpoints, blue-cyan-yellow-red; based on a fluid-jet simulation by NCSA <sup>1</sup>
pink	sequential increasing pastel black-pink-white, meant for sepia tone colorization of photographs
prism	repetitive red-yellow-green-blue-purple-...-green pattern (not cyclic at endpoints)
spring	linearly-increasing shades of magenta-yellow
summer	sequential linearly-increasing shades of green-yellow
winter	linearly-increasing shades of blue-green

A set of palettes from the [Yorick scientific visualisation package](#), an evolution of the GIST package, both by David H. Munro are included:

Colormap	Description
gist_earth	mapmaker's colors from dark blue deep ocean to green lowlands to brown highlands to white mountains
gist_heat	sequential increasing black-red-orange-white, to emulate blackbody radiation from an iron bar as it grows hotter
gist_ncar	pseudo-spectral black-blue-green-yellow-red-purple-white colormap from National Center for Atmospheric Research <sup>2</sup>
gist_rainbow	travels through the colors in spectral order from red to violet at full saturation (like <i>hsv</i> but not cyclic)
gist_stern	"Stern special" color table from Interactive Data Language software

A set of cyclic color maps:

<sup>1</sup> Rainbow colormaps, *jet* in particular, are considered a poor choice for scientific visualization by many researchers: [Rainbow Color Map \(Still\) Considered Harmful](#)

<sup>2</sup> Resembles "BkBlAqGrYeOrReViWh200" from NCAR Command Language. See [Color Table Gallery](#)

Colormap	Description
hsv	red-yellow-green-cyan-blue-magenta-red, formed by changing the hue component in the HSV color space
twilight	perceptually uniform shades of white-blue-black-red-white
twilight_shifted	perceptually uniform shades of black-blue-white-red-black

Other miscellaneous schemes:

Colormap	Description
afmhot	sequential black-orange-yellow-white blackbody spectrum, commonly used in atomic force microscopy
brg	blue-red-green
bwr	diverging blue-white-red
coolwarm	diverging blue-gray-red, meant to avoid issues with 3D shading, color blindness, and ordering of colors <sup>3</sup>
CMRmap	"Default colormaps on color images often reproduce to confusing grayscale images. The proposed colormap maintains an aesthetically pleasing color image that automatically reproduces to a monotonic grayscale with discrete, quantifiable saturation levels." <sup>4</sup>
cubehelix	Unlike most other color schemes cubehelix was designed by D.A. Green to be monotonically increasing in terms of perceived brightness. Also, when printed on a black and white postscript printer, the scheme results in a greyscale with monotonically increasing brightness. This color scheme is named cubehelix because the r,g,b values produced can be visualised as a squashed helix around the diagonal in the r,g,b color cube.
gnuplot	gnuplot's traditional pm3d scheme (black-blue-red-yellow)
gnuplot2	sequential color printable as gray (black-blue-violet-yellow-white)
ocean	green-blue-white
rainbow	spectral purple-blue-green-yellow-orange-red colormap with diverging luminance
seismic	diverging blue-white-red
nipy_spectral	spectral purple-blue-green-yellow-red-white spectrum, originally from the Neuroimaging in Python project
terrain	mapmaker's colors, blue-green-yellow-brown-white, originally from IGOR Pro

The following colormaps are redundant and may be removed in future versions. It's recommended to use the names in the descriptions instead, which produce identical output:

Colormap	Description
gist_gray	identical to <i>gray</i>
gist_yarg	identical to <i>gray_r</i>
binary	identical to <i>gray_r</i>

<sup>3</sup> See [Diverging Color Maps for Scientific Visualization](#) by Kenneth Moreland.

<sup>4</sup> See [A Color Map for Effective Black-and-White Rendering of Color-Scale Images](#) by Carey Rappaport

## 17.38 matplotlib.projections

```
class matplotlib.projections.ProjectionRegistry
    Bases: object

    Manages the set of projections available to the system.

    get_projection_class(self, name)
        Get a projection class from its name.

    get_projection_names(self)
        Get a list of the names of all projections currently registered.

    register(self, *projections)
        Register a new set of projections.

matplotlib.projections.get_projection_class(projection=None)
    Get a projection class from its name.

    If projection is None, a standard rectilinear projection is returned.

matplotlib.projections.get_projection_names()
    Get a list of acceptable projection names.

matplotlib.projections.process_projection_requirements(figure, *args, **kwargs)
    [Deprecated]
```

### Notes

Deprecated since version 3.1:

```
matplotlib.projections.register_projection(cls)
```

## 17.39 matplotlib.projections.polar

```
class matplotlib.projections.polar.InvertedPolarTransform(axis=None,
                                                         use_rmin=True, _ap-
                                                         ply_theta_transforms=True)

    Bases: matplotlib.transforms.Transform
```

The inverse of the polar transform, mapping Cartesian coordinate space *x* and *y* back to *theta* and *r*.

```
input_dims = 2
```

```
inverted(self)
```

Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to *self* does not cause a corresponding update to its inverted copy.

```
x == self.inverted().transform(self.transform(x))
```

```
is_separable = False
```

```
output_dims = 2
```

`transform_non_affine(self, xy)`

Performs only the non-affine part of the transformation.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.

In non-affine transformations, this is generally equivalent to `transform(values)`. In affine transformations, this is always a no-op.

Accepts a numpy array of shape  $(N \times \text{input\_dims})$  and returns a numpy array of shape  $(N \times \text{output\_dims})$ .

Alternatively, accepts a numpy array of length `input_dims` and returns a numpy array of length `output_dims`.

`class matplotlib.projections.polar.PolarAffine(scale_transform, limits)`

Bases: `matplotlib.transforms.Affine2DBase`

The affine part of the polar projection. Scales the output so that maximum radius rests on the edge of the axes circle.

`limits` is the view limit of the data. The only part of its bounds that is used is the y limits (for the radius limits). The theta range is handled by the non-affine transform.

`get_matrix(self)`

Get the Affine transformation array for the affine part of this transform.

`class matplotlib.projections.polar.PolarAxes(*args, theta_offset=0, theta_direction=1, rlabel_position=22.5, **kwargs)`

Bases: `matplotlib.axes._axes.Axes`

A polar graph projection, where the input dimensions are `theta`, `r`.

Theta starts pointing east and goes anti-clockwise.

`class InvertedPolarTransform(axis=None, use_rmin=True, _ap-  
ply_theta_transforms=True)`

Bases: `matplotlib.transforms.Transform`

The inverse of the polar transform, mapping Cartesian coordinate space `x` and `y` back to `theta` and `r`.

`input_dims = 2`

`inverted(self)`

Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to `self` does not cause a corresponding update to its inverted copy.

`x == self.inverted().transform(self.transform(x))`

`is_separable = False`

`output_dims = 2`

`transform_non_affine(self, xy)`

Performs only the non-affine part of the transformation.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.

In non-affine transformations, this is generally equivalent to `transform(values)`. In affine transformations, this is always a no-op.

Accepts a numpy array of shape  $(N \times \text{input\_dims})$  and returns a numpy array of shape  $(N \times \text{output\_dims})$ .

Alternatively, accepts a numpy array of length *input\_dims* and returns a numpy array of length *output\_dims*.

```
class PolarAffine(scale_transform, limits)
```

Bases: *matplotlib.transforms.Affine2DBase*

The affine part of the polar projection. Scales the output so that maximum radius rests on the edge of the axes circle.

*limits* is the view limit of the data. The only part of its bounds that is used is the y limits (for the radius limits). The theta range is handled by the non-affine transform.

```
get_matrix(self)
```

Get the Affine transformation array for the affine part of this transform.

```
class PolarTransform(axis=None, use_rmin=True, _apply_theta_transforms=True)
```

Bases: *matplotlib.transforms.Transform*

The base polar transform. This handles projection *theta* and *r* into Cartesian coordinate space *x* and *y*, but does not perform the ultimate affine transformation into the correct position.

```
input_dims = 2
```

```
inverted(self)
```

Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to *self* does not cause a corresponding update to its inverted copy.

```
x == self.inverted().transform(self.transform(x))
```

```
is_separable = False
```

```
output_dims = 2
```

```
transform_non_affine(self, tr)
```

Performs only the non-affine part of the transformation.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.

In non-affine transformations, this is generally equivalent to `transform(values)`. In affine transformations, this is always a no-op.

Accepts a numpy array of shape (N x *input\_dims*) and returns a numpy array of shape (N x *output\_dims*).

Alternatively, accepts a numpy array of length *input\_dims* and returns a numpy array of length *output\_dims*.

```
transform_path_non_affine(self, path)
```

Returns a path, transformed only by the non-affine part of this transform.

*path*: a *Path* instance.

`transform_path(path)` is equivalent to `transform_path_affine(transform_path_non_affine(values))`.

```
class RadialLocator(base, axes=None)
```

Bases: *matplotlib.ticker.Locator*

Used to locate radius ticks.

Ensures that all ticks are strictly positive. For all other tasks, it delegates to the base *Locator* (which may be different depending on the scale of the *r*-axis).

`autoscale(self)`  
autoscale the view limits

`pan(self, numsteps)`  
Pan numticks (can be positive or negative)

`refresh(self)`  
refresh internal information based on current lim

`view_limits(self, vmin, vmax)`  
Select a scale for the range from vmin to vmax.  
Subclasses should override this method to change locator behaviour.

`zoom(self, direction)`  
Zoom in/out on axis; if direction is >0 zoom in, else zoom out

`class ThetaFormatter`  
Bases: `matplotlib.ticker.Formatter`  
Used to format the *theta* tick labels. Converts the native unit of radians into degrees and adds a degree symbol.

`class ThetaLocator(base)`  
Bases: `matplotlib.ticker.Locator`  
Used to locate theta ticks.  
This will work the same as the base locator except in the case that the view spans the entire circle. In such cases, the previously used default locations of every 45 degrees are returned.

`autoscale(self)`  
autoscale the view limits

`pan(self, numsteps)`  
Pan numticks (can be positive or negative)

`refresh(self)`  
refresh internal information based on current lim

`set_axis(self, axis)`

`view_limits(self, vmin, vmax)`  
Select a scale for the range from vmin to vmax.  
Subclasses should override this method to change locator behaviour.

`zoom(self, direction)`  
Zoom in/out on axis; if direction is >0 zoom in, else zoom out

`can_pan(self)`  
Return *True* if this axes supports the pan/zoom button functionality.  
For polar axes, this is slightly misleading. Both panning and zooming are performed by the same button. Panning is performed in azimuth while zooming is done along the radial.

`can_zoom(self)`  
Return *True* if this axes supports the zoom box button functionality.  
Polar axes do not support zoom boxes.

`cla(self)`  
Clear the current axes.

`drag_pan(self, button, key, x, y)`  
 Called when the mouse moves during a pan operation.

`button` is the mouse button number:

- 1: LEFT
- 2: MIDDLE
- 3: RIGHT

`key` is a "shift" key

`x, y` are the mouse coordinates in display coords.

---

**Note:** Intended to be overridden by new projection types.

---

`draw(self, *args, **kwargs)`  
 Draw everything (plot lines, axes, labels)

`end_pan(self)`  
 Called when a pan operation completes (when the mouse button is up.)

---

**Note:** Intended to be overridden by new projection types.

---

`format_coord(self, theta, r)`  
 Return a format string formatting the coordinate using Unicode characters.

`get_data_ratio(self)`  
 Return the aspect ratio of the data itself. For a polar plot, this should always be 1.0

`get_rlabel_position(self)`

**Returns**

**float** The theta position of the radius labels in degrees.

`get_rmax(self)`

**Returns**

**float** Outer radial limit.

`get_rmin(self)`

**Returns**

**float** The inner radial limit.

`get_rorigin(self)`

**Returns**

**float**

`get_rsign(self)`

`get_theta_direction(self)`  
 Get the direction in which theta increases.

**-1:** Theta increases in the clockwise direction

**1:** Theta increases in the counterclockwise direction

`get_theta_offset(self)`

Get the offset for the location of 0 in radians.

`get_thetamax(self)`

`get_thetamin(self)`

`get_xaxis_text1_transform(self, pad)`

### Returns

**transform** [Transform] The transform used for drawing x-axis labels, which will add *pad\_points* of padding (in points) between the axes and the label. The x-direction is in data coordinates and the y-direction is in axis coordinates

**valign** [{'center', 'top', 'bottom', 'baseline', 'center\_baseline'}] The text vertical alignment.

**halign** [{'center', 'left', 'right'}] The text horizontal alignment.

### Notes

This transformation is primarily used by the *Axis* class, and is meant to be overridden by new kinds of projections that may need to place axis elements in different locations.

`get_xaxis_text2_transform(self, pad)`

### Returns

**transform** [Transform] The transform used for drawing secondary x-axis labels, which will add *pad\_points* of padding (in points) between the axes and the label. The x-direction is in data coordinates and the y-direction is in axis coordinates

**valign** [{'center', 'top', 'bottom', 'baseline', 'center\_baseline'}] The text vertical alignment.

**halign** [{'center', 'left', 'right'}] The text horizontal alignment.

### Notes

This transformation is primarily used by the *Axis* class, and is meant to be overridden by new kinds of projections that may need to place axis elements in different locations.

`get_xaxis_transform(self, which='grid')`

Get the transformation used for drawing x-axis labels, ticks and gridlines. The x-direction is in data coordinates and the y-direction is in axis coordinates.

---

**Note:** This transformation is primarily used by the *Axis* class, and is meant to be overridden by new kinds of projections that may need to place axis elements in different locations.

---

`get_yaxis_text1_transform(self, pad)`

### Returns

**transform** [Transform] The transform used for drawing y-axis labels, which will add *pad\_points* of padding (in points) between the axes and the label. The x-direction is in axis coordinates and the y-direction is in data coordinates

**valign** [{'center', 'top', 'bottom', 'baseline', 'center\_baseline'}] The text vertical alignment.

**halign** [{'center', 'left', 'right'}] The text horizontal alignment.

#### Notes

This transformation is primarily used by the *Axis* class, and is meant to be overridden by new kinds of projections that may need to place axis elements in different locations.

`get_yaxis_text2_transform(self, pad)`

#### Returns

**transform** [Transform] The transform used for drawing secondart y-axis labels, which will add *pad\_points* of padding (in points) between the axes and the label. The x-direction is in axis coordinates and the y-direction is in data coordinates

**valign** [{'center', 'top', 'bottom', 'baseline', 'center\_baseline'}] The text vertical alignment.

**halign** [{'center', 'left', 'right'}] The text horizontal alignment.

#### Notes

This transformation is primarily used by the *Axis* class, and is meant to be overridden by new kinds of projections that may need to place axis elements in different locations.

`get_yaxis_transform(self, which='grid')`

Get the transformation used for drawing y-axis labels, ticks and gridlines. The x-direction is in axis coordinates and the y-direction is in data coordinates.

---

**Note:** This transformation is primarily used by the *Axis* class, and is meant to be overridden by new kinds of projections that may need to place axis elements in different locations.

---

`name = 'polar'`

`set_rgrids(self, radii, labels=None, angle=None, fmt=None, **kwargs)`

Set the radial gridlines on a polar plot.

#### Parameters

**radii** [tuple with floats] The radii for the radial gridlines

**labels** [tuple with strings or None] The labels to use at each radial gridline. The *matplotlib.ticker.ScalarFormatter* will be used if None.

**angle** [float] The angular position of the radius labels in degrees.

**fmt** [str or None] Format string used in `matplotlib.ticker.FormatStrFormatter`. For example `'%f'`.

### Returns

**lines, labels** [list of `lines.Line2D`, list of `text.Text`] *lines* are the radial gridlines and *labels* are the tick labels.

### Other Parameters

**\*\*kwargs** *kwargs* are optional `Text` properties for the labels.

### See also:

`PolarAxes.set_thetagrids`

`Axis.get_gridlines`

`Axis.get_ticklabels`

`set_rlabel_position(self, value)`

Updates the theta position of the radius labels.

### Parameters

**value** [number] The angular position of the radius labels in degrees.

`set_rlim(self, bottom=None, top=None, emit=True, auto=False, **kwargs)`

See `set_ylim`.

`set_rmax(self, rmax)`

Set the outer radial limit.

### Parameters

**rmax** [float]

`set_rmin(self, rmin)`

Set the inner radial limit.

### Parameters

**rmin** [float]

`set_rorigin(self, rorigin)`

Update the radial origin.

### Parameters

**rorigin** [float]

`set_rscale(self, *args, **kwargs)`

`set_rticks(self, *args, **kwargs)`

`set_theta_direction(self, direction)`

Set the direction in which theta increases.

**clockwise, -1:** Theta increases in the clockwise direction

**counterclockwise, anticlockwise, 1:** Theta increases in the counterclockwise direction

`set_theta_offset(self, offset)`

Set the offset for the location of 0 in radians.

`set_theta_zero_location(self, loc, offset=0.0)`  
 Sets the location of theta's zero. (Calls `set_theta_offset` with the correct value in radians under the hood.)

**loc** [str] May be one of "N", "NW", "W", "SW", "S", "SE", "E", or "NE".

**offset** [float, optional] An offset in degrees to apply from the specified `loc`. **Note:** this offset is *always* applied counter-clockwise regardless of the direction setting.

`set_theta grids(self, angles, labels=None, fmt=None, **kwargs)`  
 Set the theta gridlines in a polar plot.

#### Parameters

**angles** [tuple with floats, degrees] The angles of the theta gridlines.

**labels** [tuple with strings or None] The labels to use at each theta gridline. The `projections.polar.ThetaFormatter` will be used if None.

**fmt** [str or None] Format string used in `matplotlib.ticker.FormatStrFormatter`. For example '%f'. Note that the angle that is used is in radians.

#### Returns

**lines, labels** [list of `lines.Line2D`, list of `text.Text`] `lines` are the theta gridlines and `labels` are the tick labels.

#### Other Parameters

**\*\*kwargs** `kwargs` are optional `Text` properties for the labels.

#### See also:

`PolarAxes.set_rgrids`

`Axis.get_gridlines`

`Axis.get_ticklabels`

`set_theta lim(self, *args, **kwargs)`  
 Set the minimum and maximum theta values.

#### Parameters

**thetamin** [float] Minimum value in degrees.

**thetamax** [float] Maximum value in degrees.

`set_thetamax(self, thetamax)`

`set_thetamin(self, thetamin)`

`set_xscale(self, scale, *args, **kwargs)`  
 Set the x-axis scale.

#### Parameters

**value** [{"linear", "log", "symlog", "logit", ...}] The axis scale type to apply.

**\*\*kwargs** Different keyword arguments are accepted, depending on the scale. See the respective class keyword arguments:

- `matplotlib.scale.LinearScale`

- `matplotlib.scale.LogScale`
- `matplotlib.scale.SymmetricalLogScale`
- `matplotlib.scale.LogitScale`

## Notes

By default, Matplotlib supports the above mentioned scales. Additionally, custom scales may be registered using `matplotlib.scale.register_scale`. These scales can then also be used here.

`set_ylim(self, bottom=None, top=None, emit=True, auto=False, *, ymin=None, ymax=None)`

Set the data limits for the radial axis.

### Parameters

**bottom** [scalar, optional] The bottom limit (default: `None`, which leaves the bottom limit unchanged). The bottom and top ylims may be passed as the tuple `(bottom, top)` as the first positional argument (or as the `bottom` keyword argument).

**top** [scalar, optional] The top limit (default: `None`, which leaves the top limit unchanged).

**emit** [bool, optional] Whether to notify observers of limit change (default: `True`).

**auto** [bool or `None`, optional] Whether to turn on autoscaling of the y-axis. `True` turns on, `False` turns off (default action), `None` leaves unchanged.

**ymin, ymax** [scalar, optional] These arguments are deprecated and will be removed in a future version. They are equivalent to `bottom` and `top` respectively, and it is an error to pass both `ymin` and `bottom` or `ymax` and `top`.

### Returns

**bottom, top** [(float, float)] The new y-axis limits in data coordinates.

`set_yscale(self, *args, **kwargs)`

Set the y-axis scale.

### Parameters

**value** [{"linear", "log", "symlog", "logit", ...}] The axis scale type to apply.

**\*\*kwargs** Different keyword arguments are accepted, depending on the scale. See the respective class keyword arguments:

- `matplotlib.scale.LinearScale`
- `matplotlib.scale.LogScale`
- `matplotlib.scale.SymmetricalLogScale`
- `matplotlib.scale.LogitScale`

## Notes

By default, Matplotlib supports the above mentioned scales. Additionally, custom scales may be registered using `matplotlib.scale.register_scale`. These scales can then also be used here.

`start_pan(self, x, y, button)`

Called when a pan operation has started.

`x`, `y` are the mouse coordinates in display coords. `button` is the mouse button number:

- 1: LEFT
- 2: MIDDLE
- 3: RIGHT

---

**Note:** Intended to be overridden by new projection types.

---

```
class matplotlib.projections.polar.PolarTransform(axis=None, use_rmin=True, _apply_theta_transforms=True)
```

Bases: `matplotlib.transforms.Transform`

The base polar transform. This handles projection *theta* and *r* into Cartesian coordinate space *x* and *y*, but does not perform the ultimate affine transformation into the correct position.

`input_dims = 2`

`inverted(self)`

Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to *self* does not cause a corresponding update to its inverted copy.

```
x == self.inverted().transform(self.transform(x))
```

`is_separable = False`

`output_dims = 2`

`transform_non_affine(self, tr)`

Performs only the non-affine part of the transformation.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.

In non-affine transformations, this is generally equivalent to `transform(values)`. In affine transformations, this is always a no-op.

Accepts a numpy array of shape  $(N \times \text{input\_dims})$  and returns a numpy array of shape  $(N \times \text{output\_dims})$ .

Alternatively, accepts a numpy array of length *input\_dims* and returns a numpy array of length *output\_dims*.

`transform_path_non_affine(self, path)`

Returns a path, transformed only by the non-affine part of this transform.

*path*: a *Path* instance.

`transform_path(path)` is equivalent to `transform_path_affine(transform_path_non_affine(values))`.

```
class matplotlib.projections.polar.RadialAxis(*args, **kwargs)
```

Bases: *matplotlib.axis.YAxis*

A radial Axis.

This overrides certain properties of a *YAxis* to provide special-casing for a radial axis.

```
axis_name = 'radius'
```

```
cla(self)
```

clear the current axis

```
class matplotlib.projections.polar.RadialLocator(base, axes=None)
```

Bases: *matplotlib.ticker.Locator*

Used to locate radius ticks.

Ensures that all ticks are strictly positive. For all other tasks, it delegates to the base *Locator* (which may be different depending on the scale of the *r*-axis).

```
autoscale(self)
```

autoscale the view limits

```
pan(self, numsteps)
```

Pan numticks (can be positive or negative)

```
refresh(self)
```

refresh internal information based on current lim

```
view_limits(self, vmin, vmax)
```

Select a scale for the range from *vmin* to *vmax*.

Subclasses should override this method to change locator behaviour.

```
zoom(self, direction)
```

Zoom in/out on axis; if *direction* is >0 zoom in, else zoom out

```
class matplotlib.projections.polar.RadialTick(axes, loc, label, size=None,
width=None, color=None, tick-
dir=None, pad=None, label-
size=None, labelcolor=None,
zorder=None, gridOn=None,
tick1On=True, tick2On=True, la-
bel1On=True, label2On=False,
major=True, labelrotation=0,
grid_color=None, grid_linestyle=None,
grid_linewidth=None,
grid_alpha=None, **kw)
```

Bases: *matplotlib.axis.YTick*

A radial-axis tick.

This subclass of *YTick* provides radial ticks with some small modification to their re-positioning such that ticks are rotated based on axes limits. This results in ticks that are correctly perpendicular to the spine. Labels are also rotated to be perpendicular to the spine, when 'auto' rotation is enabled.

*bbox* is the *Bound2D* bounding box in display coords of the Axes *loc* is the tick location in data coords *size* is the tick size in points

```
update_position(self, loc)
```

Set the location of tick in data coords with scalar *loc*.

```
class matplotlib.projections.polar.ThetaAxis(axes, pickradius=15)
```

Bases: *matplotlib.axis.XAxis*

A theta Axis.

This overrides certain properties of an XAxis to provide special-casing for an angular axis.

### Parameters

**axes** [*matplotlib.axes.Axes*] The *Axes* to which the created Axis belongs.

**pickradius** [float] The acceptance radius for containment tests. See also *Axis.contains*.

```
axis_name = 'theta'
```

```
cla(self)
```

clear the current axis

```
class matplotlib.projections.polar.ThetaFormatter
```

Bases: *matplotlib.ticker.Formatter*

Used to format the *theta* tick labels. Converts the native unit of radians into degrees and adds a degree symbol.

```
class matplotlib.projections.polar.ThetaLocator(base)
```

Bases: *matplotlib.ticker.Locator*

Used to locate theta ticks.

This will work the same as the base locator except in the case that the view spans the entire circle. In such cases, the previously used default locations of every 45 degrees are returned.

```
autoscale(self)
```

autoscale the view limits

```
pan(self, numsteps)
```

Pan numticks (can be positive or negative)

```
refresh(self)
```

refresh internal information based on current lim

```
set_axis(self, axis)
```

```
view_limits(self, vmin, vmax)
```

Select a scale for the range from *vmin* to *vmax*.

Subclasses should override this method to change locator behaviour.

```
zoom(self, direction)
```

Zoom in/out on axis; if *direction* is >0 zoom in, else zoom out

```
class matplotlib.projections.polar.ThetaTick(axes, *args, **kwargs)
```

Bases: *matplotlib.axis.XTick*

A theta-axis tick.

This subclass of XTick provides angular ticks with some small modification to their re-positioning such that ticks are rotated based on tick location. This results in ticks that are correctly perpendicular to the arc spine.

When 'auto' rotation is enabled, labels are also rotated to be parallel to the spine. The label padding is also applied here since it's not possible to use a generic axes transform to produce tick-specific padding.

```
update_position(self, loc)
```

Set the location of tick in data coords with scalar *loc*.

## 17.40 matplotlib.rcsetup

The rcsetup module contains the default values and the validation code for customization using matplotlib's rc settings.

Each rc setting is assigned a default value and a function used to validate any attempted changes to that setting. The default values and validation functions are defined in the rcsetup module, and are used to construct the rcParams global object which stores the settings and is referenced throughout matplotlib.

These default values should be consistent with the default matplotlibrc file that actually reflects the values given here. Any additions or deletions to the parameter set listed here should also be visited to the matplotlibrc.template in matplotlib's root source directory.

```
class matplotlib.rcsetup.ValidateInStrings(key, valid, ignorecase=False)
```

Bases: `object`

*valid* is a list of legal strings

```
class matplotlib.rcsetup.ValidateInterval(vmin, vmax, closedmin=True, closedmax=True)
```

Bases: `object`

Value must be in interval

```
matplotlib.rcsetup.cycler(*args, **kwargs)
```

Creates a `Cycler` object much like `cycler.cycler()`, but includes input validation.

Call signatures:

```
cycler(cycler)
cycler(label=values[], label2=values2[], ...])
cycler(label, values)
```

Form 1 copies a given `Cycler` object.

Form 2 creates a `Cycler` which cycles over one or more properties simultaneously. If multiple properties are given, their value lists must have the same length.

Form 3 creates a `Cycler` for a single property. This form exists for compatibility with the original `cycler`. Its use is discouraged in favor of the kwarg form, i.e. `cycler(label=values)`.

### Parameters

**cycler** [`Cycler`] Copy constructor for `Cycler`.

**label** [`str`] The property key. Must be a valid *Artist* property. For example, 'color' or 'linestyle'. Aliases are allowed, such as 'c' for 'color' and 'lw' for 'linewidth'.

**values** [`iterable`] Finite-length iterable of the property values. These values are validated and will raise a `ValueError` if invalid.

**Returns**

**cycler** [Cycler] A new `Cycler` for the given properties.

**Examples**

Creating a cycler for a single property:

```
>>> c = cycler(color=['red', 'green', 'blue'])
```

Creating a cycler for simultaneously cycling over multiple properties (e.g. red circle, green plus, blue cross):

```
>>> c = cycler(color=['red', 'green', 'blue'],
...            marker=['o', '+', 'x'])
```

```
matplotlib.rcsetup.update_savefig_format(value)
matplotlib.rcsetup.validate_animation_writer_path(p)
matplotlib.rcsetup.validate_any(s)
matplotlib.rcsetup.validate_anymethod(s)
matplotlib.rcsetup.validate_aspect(s)
matplotlib.rcsetup.validate_axisbelow(s)
matplotlib.rcsetup.validate_backend(s)
matplotlib.rcsetup.validate_bbox(s)
matplotlib.rcsetup.validate_bool(b)
    Convert b to a boolean or raise
matplotlib.rcsetup.validate_bool_maybe_none(b)
    Convert b to a boolean or raise.
matplotlib.rcsetup.validate_capstylelist(s)
matplotlib.rcsetup.validate_color(s)
    Return a valid color arg.
matplotlib.rcsetup.validate_color_for_prop_cycle(s)
matplotlib.rcsetup.validate_color_or_auto(s)
matplotlib.rcsetup.validate_color_or_inherit(s)
    Return a valid color arg.
matplotlib.rcsetup.validate_colorlist(s)
    return a list of colorspecs
matplotlib.rcsetup.validate_cycler(s)
    Return a Cycler object from a string repr or the object itself.
matplotlib.rcsetup.validate_dashlist(s)
matplotlib.rcsetup.validate_dpi(s)
    Confirm s is string 'figure' or convert s to float or raise.
matplotlib.rcsetup.validate_fillstylelist(s)
```

`matplotlib.rcsetup.validate_float(s)`

Convert `s` to float or raise.

`matplotlib.rcsetup.validate_float_or_None(s)`

Convert `s` to float, None or raise.

`matplotlib.rcsetup.validate_floatlist(s)`

Convert `s` to float or raise.

`matplotlib.rcsetup.validate_font_properties(s)`

`matplotlib.rcsetup.validate_fontsize(s)`

`matplotlib.rcsetup.validate_fontsize_None(s)`

`matplotlib.rcsetup.validate_fontsizelist(s)`

`matplotlib.rcsetup.validate_fonttype(s)`

Confirm that this is a Postscript or PDF font type that we know how to convert to.

`matplotlib.rcsetup.validate_hatch(s)`

Validate a hatch pattern. A hatch pattern string can have any sequence of the following characters: `\ / | - + * . x o 0`.

`matplotlib.rcsetup.validate_hatchlist(s)`

Validate a hatch pattern. A hatch pattern string can have any sequence of the following characters: `\ / | - + * . x o 0`.

`matplotlib.rcsetup.validate_hinting(s)`

`matplotlib.rcsetup.validate_hist_bins(s)`

`matplotlib.rcsetup.validate_int(s)`

Convert `s` to int or raise.

`matplotlib.rcsetup.validate_int_or_None(s)`

Return None if `s` is None or return `int(s)`, otherwise raise.

`matplotlib.rcsetup.validate_joinstylelist(s)`

`matplotlib.rcsetup.validate_markevery(s)`

Validate the markevery property of a Line2D object.

**Parameters**

`s` [None, int, float, slice, length-2 tuple of ints,] length-2 tuple of floats, list of ints

**Returns**

`s` [None, int, float, slice, length-2 tuple of ints,] length-2 tuple of floats, list of ints

`matplotlib.rcsetup.validate_markeverylist(s)`

Validate the markevery property of a Line2D object.

**Parameters**

`s` [None, int, float, slice, length-2 tuple of ints,] length-2 tuple of floats, list of ints

**Returns**

`s` [None, int, float, slice, length-2 tuple of ints,] length-2 tuple of floats, list of ints

```

matplotlib.rcsetup.validate_mathtext_default(s)
class matplotlib.rcsetup.validate_nseq_float(n=None, allow_none=False)
    Bases: object
class matplotlib.rcsetup.validate_nseq_int(n=None)
    Bases: object
matplotlib.rcsetup.validate_path_exists(s)
    If s is a path, return s, else False
matplotlib.rcsetup.validate_ps_distiller(s)
matplotlib.rcsetup.validate_qt4(s)
    [Deprecated]

```

**Notes**

Deprecated since version 3.1:

```

matplotlib.rcsetup.validate_qt5(s)
    [Deprecated]

```

**Notes**

Deprecated since version 3.1:

```

matplotlib.rcsetup.validate_sketch(s)
matplotlib.rcsetup.validate_string(s)
matplotlib.rcsetup.validate_string_or_None(s)
    Convert s to string or raise.
matplotlib.rcsetup.validate_stringlist(s)
    return a list
matplotlib.rcsetup.validate_svg_fonttype(s)
matplotlib.rcsetup.validate_toolbar(s)
matplotlib.rcsetup.validate_verbose(s)
    [Deprecated]

```

**Notes**

Deprecated since version 3.1:

```

matplotlib.rcsetup.validate_webagg_address(s)
matplotlib.rcsetup.validate_whiskers(s)

```

## 17.41 matplotlib.sankey

Module for creating Sankey diagrams using Matplotlib.

```
class matplotlib.sankey.Sankey(ax=None, scale=1.0, unit="", format='%G',
                               gap=0.25, radius=0.1, shoulder=0.03, offset=0.15,
                               head_angle=100, margin=0.4, tolerance=1e-06,
                               **kwargs)
```

Bases: `object`

Sankey diagram.

Sankey diagrams are a specific type of flow diagram, in which the width of the arrows is shown proportionally to the flow quantity. They are typically used to visualize energy or material or cost transfers between processes. [Wikipedia \(6/1/2011\)](#)

Create a new Sankey instance.

Optional keyword arguments:

Field	Description
<i>ax</i>	axes onto which the data should be plotted If <i>ax</i> isn't provided, new axes will be created.
<i>scale</i>	scaling factor for the flows <i>scale</i> sizes the width of the paths in order to maintain proper layout. The same scale is applied to all subdiagrams. The value should be chosen such that the product of the scale and the sum of the inputs is approximately 1.0 (and the product of the scale and the sum of the outputs is approximately -1.0).
<i>unit</i>	string representing the physical unit associated with the flow quantities If <i>unit</i> is None, then none of the quantities are labeled.
<i>format</i>	a Python number formatting string to be used in labeling the flow as a quantity (i.e., a number times a unit, where the unit is given)
<i>gap</i>	space between paths that break in/break away to/from the top or bottom
<i>radius</i>	inner radius of the vertical paths
<i>shoulder</i>	size of the shoulders of output arrows
<i>offset</i>	text offset (from the dip or tip of the arrow)
<i>head_angle</i>	angle of the arrow heads (and negative of the angle of the tails) [deg]
<i>margin</i>	minimum space between Sankey outlines and the edge of the plot area
<i>tolerance</i>	acceptable maximum of the magnitude of the sum of flows The magnitude of the sum of connected flows cannot be greater than <i>tolerance</i> .

The optional arguments listed above are applied to all subdiagrams so that there is consistent alignment and formatting.

If *Sankey* is instantiated with any keyword arguments other than those explicitly listed above (**kwargs**), they will be passed to *add()*, which will create the first subdiagram.

In order to draw a complex Sankey diagram, create an instance of *Sankey* by calling it without any **kwargs**:

```
sankey = Sankey()
```

Then add simple Sankey sub-diagrams:

```
sankey.add() # 1
sankey.add() # 2
#...
sankey.add() # n
```

Finally, create the full diagram:

```
sankey.finish()
```

Or, instead, simply daisy-chain those calls:

```
Sankey().add().add... .add().finish()
```

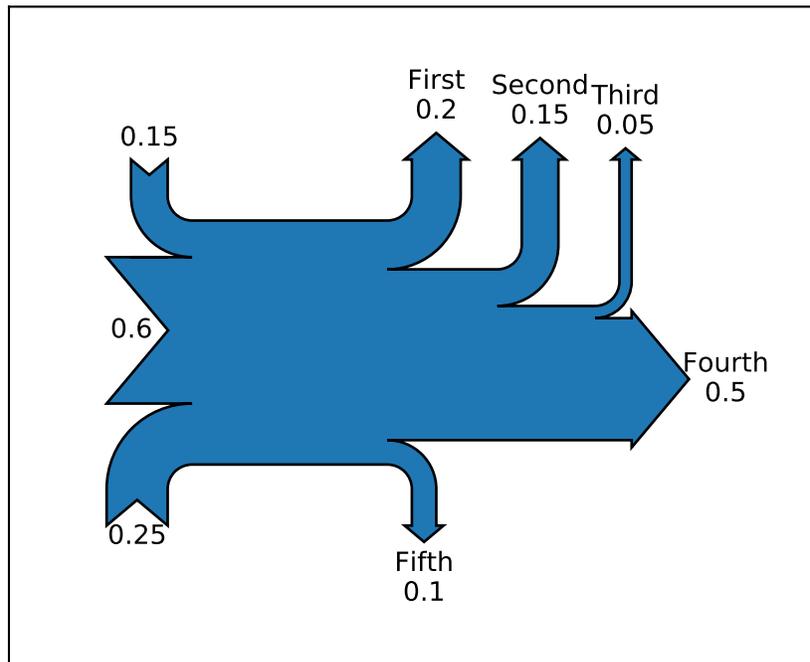
### See also:

*Sankey.add*

*Sankey.finish*

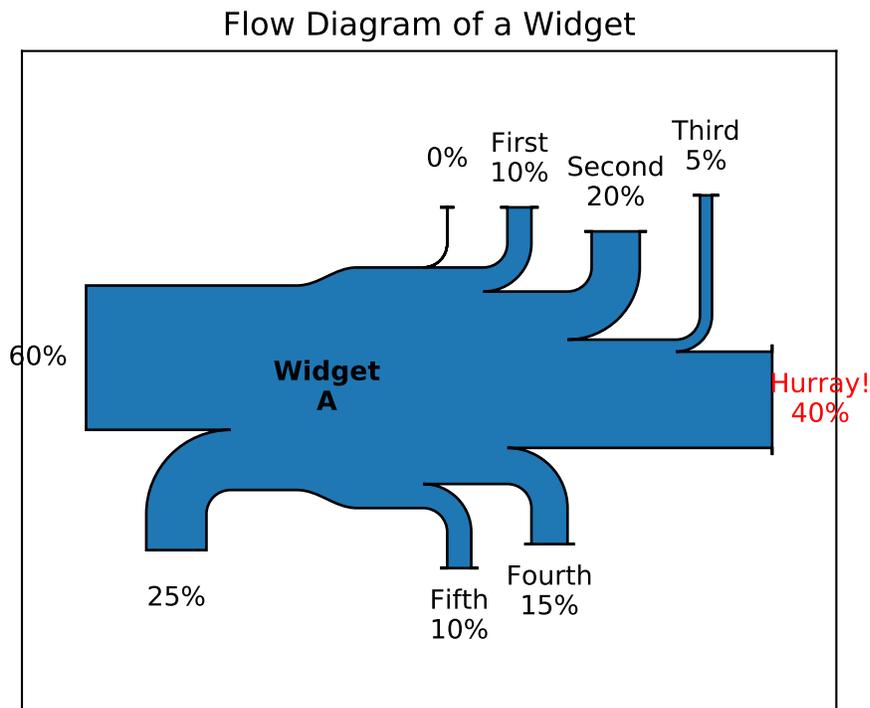
### Examples

The default settings produce a diagram like this.



```
add(self, patchlabel="", flows=None, orientations=None, labels="", trunk-
length=1.0, pathlengths=0.25, prior=None, connect=(0, 0), rotation=0,
**kwargs)
```

Add a simple Sankey diagram with flows at the same hierarchical level.



### Parameters

**patchlabel** [str] Label to be placed at the center of the diagram. Note that *label* (not *patchlabel*) can be passed as keyword argument to create an entry in the legend.

**flows** [list of float] Array of flow values. By convention, inputs are positive and outputs are negative.

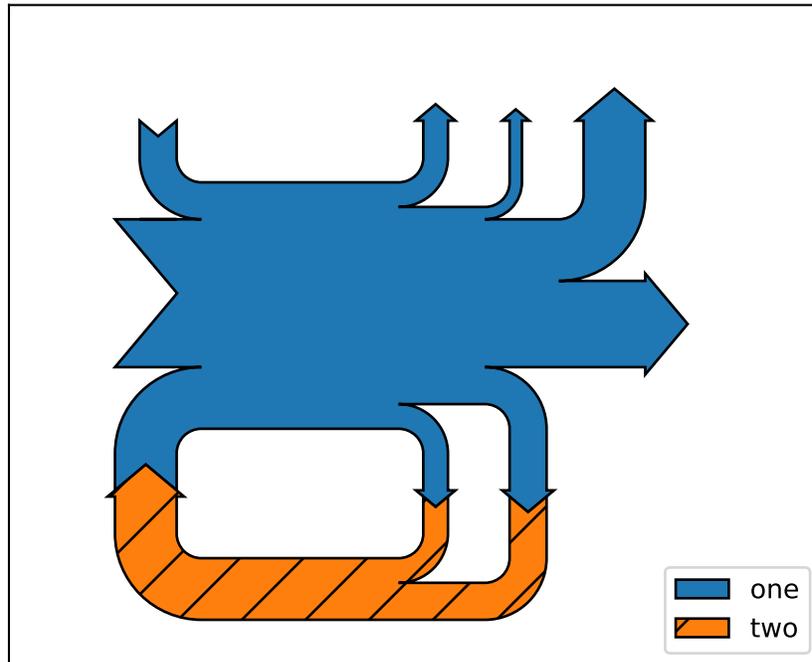
Flows are placed along the top of the diagram from the inside out in order of their index within *flows*. They are placed along the sides of the diagram from the top down and along the bottom from the outside in.

If the sum of the inputs and outputs is nonzero, the discrepancy will appear as a cubic Bezier curve along the top and bottom edges of the trunk.

**orientations** [list of {-1, 0, 1}] List of orientations of the flows (or a single orientation to be used for all flows). Valid values are 0 (inputs from the left, outputs to the right), 1 (from and to the top) or -1 (from and to the bottom).

**labels** [list of (str or None)] List of labels for the flows (or a single label to be used for all flows). Each label may be *None* (no label), or a labeling string. If an entry is a (possibly empty) string, then the quantity for the corresponding flow will be shown below the string. However, if the *unit* of the main diagram is *None*, then quantities

Two Systems



are never shown, regardless of the value of this argument.

**trunklength** [float] Length between the bases of the input and output groups (in data-space units).

**pathlengths** [list of float] List of lengths of the vertical arrows before break-in or after break-away. If a single value is given, then it will be applied to the first (inside) paths on the top and bottom, and the length of all other arrows will be justified accordingly. The *pathlengths* are not applied to the horizontal inputs and outputs.

**prior** [int] Index of the prior diagram to which this diagram should be connected.

**connect** [(int, int)] A (prior, this) tuple indexing the flow of the prior diagram and the flow of this diagram which should be connected. If this is the first diagram or *prior* is *None*, *connect* will be ignored.

**rotation** [float] Angle of rotation of the diagram in degrees. The interpretation of the *orientations* argument will be rotated accordingly (e.g., if *rotation* == 90, an *orientations* entry of 1 means to/from the left). *rotation* is ignored if this diagram is connected to an existing one (using *prior* and *connect*).

### Returns

**Sankey** The current *Sankey* instance.

### Other Parameters

**\*\*kwargs** Additional keyword arguments set `matplotlib.patches.PathPatch` properties, listed below. For example, one may want to use `fill=False` or `label="A legend entry"`.

	Property	Description
<code>agg_filter</code>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m,
<code>alpha</code>		float or None
<code>animated</code>		bool
<code>antialiased</code> or <code>aa</code>		unknown
<code>capstyle</code>		{'butt', 'round', 'projecting'}
<code>clip_box</code>		<i>Bbox</i>
<code>clip_on</code>		bool
<code>clip_path</code>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<code>color</code>		color
<code>contains</code>		callable
<code>edgecolor</code> or <code>ec</code>		color or None or 'auto'
<code>facecolor</code> or <code>fc</code>		color or None
<code>figure</code>		<i>Figure</i>
<code>fill</code>		bool
<code>gid</code>		str
<code>hatch</code>		{'/', '\', ' ', '-.', '+', 'x', 'o', 'O', '.', '*'}
<code>in_layout</code>		bool
<code>joinstyle</code>		{'miter', 'round', 'bevel'}
<code>label</code>		object
<code>linestyle</code> or <code>ls</code>		{'-', '-', '-.', ':', "", (offset, on-off-seq), ...}
<code>linewidth</code> or <code>lw</code>		float or None
<code>path_effects</code>		<i>AbstractPathEffect</i>
<code>picker</code>		None or bool or float or callable
<code>rasterized</code>		bool or None
<code>sketch_params</code>		(scale: float, length: float, randomness: float)
<code>snap</code>		bool or None
<code>transform</code>		<i>Transform</i>
<code>url</code>		str
<code>visible</code>		bool
<code>zorder</code>		float

**See also:**

`Sankey.finish`

`finish(self)`

Adjust the axes and return a list of information about the Sankey subdiagram(s).

Return value is a list of subdiagrams represented with the following fields:

Field	Description
<i>patch</i>	Sankey outline (an instance of <i>PathPatch</i> )
<i>flows</i>	values of the flows (positive for input, negative for output)
<i>angles</i>	list of angles of the arrows [deg/90] For example, if the diagram has not been rotated, an input to the top side will have an angle of 3 (DOWN), and an output from the top side will have an angle of 1 (UP). If a flow has been skipped (because its magnitude is less than <i>tolerance</i> ), then its angle will be <i>None</i> .
<i>tips</i>	array in which each row is an [x, y] pair indicating the positions of the tips (or "dips") of the flow paths If the magnitude of a flow is less the <i>tolerance</i> for the instance of <i>Sankey</i> , the flow is skipped and its tip will be at the center of the diagram.
<i>text</i>	<i>Text</i> instance for the label of the diagram
<i>texts</i>	list of <i>Text</i> instances for the labels of flows

**See also:***Sankey.add*

## 17.42 matplotlib.scale

```
class matplotlib.scale.FuncScale(axis, functions)
```

Bases: *matplotlib.scale.ScaleBase*

Provide an arbitrary scale with user-supplied function for the axis.

**Parameters**

**axis: the axis for the scale**

**functions** [(callable, callable)] two-tuple of the forward and inverse functions for the scale. The forward function must be monotonic.

Both functions must have the signature:

```
def forward(values: array-like) -> array-like
```

```
get_transform(self)
```

The transform for arbitrary scaling

```
name = 'function'
```

```
set_default_locators_and_formatters(self, axis)
```

Set the locators and formatters to the same defaults as the linear scale.

```
class matplotlib.scale.FuncScaleLog(axis, functions, base=10)
```

Bases: *matplotlib.scale.LogScale*

Provide an arbitrary scale with user-supplied function for the axis and then put on a logarithmic axes.

**Parameters**

**axis: the axis for the scale**

**functions** [(callable, callable)] two-tuple of the forward and inverse functions for the scale. The forward function must be monotonic.

Both functions must have the signature:

```
def forward(values: array-like) -> array-like
```

**base** [float] logarithmic base of the scale (default = 10)

base

get\_transform(*self*)

The transform for arbitrary scaling

name = 'functionlog'

class matplotlib.scale.FuncTransform(*forward*, *inverse*)

Bases: *matplotlib.transforms.Transform*

A simple transform that takes an arbitrary function for the forward and inverse transform.

### Parameters

**forward** [callable] The forward function for the transform. This function must have an inverse and, for best behavior, be monotonic. It must have the signature:

```
def forward(values: array-like) -> array-like
```

**inverse** [callable] The inverse of the forward function. Signature as forward.

has\_inverse = True

input\_dims = 1

inverted(*self*)

Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to *self* does not cause a corresponding update to its inverted copy.

```
x == self.inverted().transform(self.transform(x))
```

is\_separable = True

output\_dims = 1

transform\_non\_affine(*self*, *values*)

Performs only the non-affine part of the transformation.

transform(*values*) is always equivalent to transform\_affine(transform\_non\_affine(*values*)).

In non-affine transformations, this is generally equivalent to transform(*values*). In affine transformations, this is always a no-op.

Accepts a numpy array of shape (N x *input\_dims*) and returns a numpy array of shape (N x *output\_dims*).

Alternatively, accepts a numpy array of length *input\_dims* and returns a numpy array of length *output\_dims*.

```
class matplotlib.scale.InvertedLog10Transform(**kwargs)
    Bases: matplotlib.scale.InvertedLogTransformBase
    [Deprecated]
```

### Notes

Deprecated since version 3.1:

`base = 10.0`

`inverted(self)`

Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to *self* does not cause a corresponding update to its inverted copy.

`x == self.inverted().transform(self.transform(x))`

```
class matplotlib.scale.InvertedLog2Transform(**kwargs)
    Bases: matplotlib.scale.InvertedLogTransformBase
    [Deprecated]
```

### Notes

Deprecated since version 3.1:

`base = 2.0`

`inverted(self)`

Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to *self* does not cause a corresponding update to its inverted copy.

`x == self.inverted().transform(self.transform(x))`

```
class matplotlib.scale.InvertedLogTransform(base)
    Bases: matplotlib.scale.InvertedLogTransformBase
```

`has_inverse = True`

`input_dims = 1`

`inverted(self)`

Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to *self* does not cause a corresponding update to its inverted copy.

`x == self.inverted().transform(self.transform(x))`

`is_separable = True`

`output_dims = 1`

`transform_non_affine(self, a)`

Performs only the non-affine part of the transformation.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.

In non-affine transformations, this is generally equivalent to `transform(values)`. In affine transformations, this is always a no-op.

Accepts a numpy array of shape  $(N \times \text{input\_dims})$  and returns a numpy array of shape  $(N \times \text{output\_dims})$ .

Alternatively, accepts a numpy array of length `input_dims` and returns a numpy array of length `output_dims`.

```
class matplotlib.scale.InvertedLogTransformBase(**kwargs)
    Bases: matplotlib.transforms.Transform
    [Deprecated]
```

### Notes

Deprecated since version 3.1:

```
has_inverse = True
```

```
input_dims = 1
```

```
is_separable = True
```

```
output_dims = 1
```

```
transform_non_affine(self, a)
```

Performs only the non-affine part of the transformation.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.

In non-affine transformations, this is generally equivalent to `transform(values)`. In affine transformations, this is always a no-op.

Accepts a numpy array of shape  $(N \times \text{input\_dims})$  and returns a numpy array of shape  $(N \times \text{output\_dims})$ .

Alternatively, accepts a numpy array of length `input_dims` and returns a numpy array of length `output_dims`.

```
class matplotlib.scale.InvertedNaturalLogTransform(**kwargs)
    Bases: matplotlib.scale.InvertedLogTransformBase
    [Deprecated]
```

### Notes

Deprecated since version 3.1:

```
base = 2.718281828459045
```

```
inverted(self)
```

Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to `self` does not cause a corresponding update to its inverted copy.

```
x == self.inverted().transform(self.transform(x))
```

```
class matplotlib.scale.InvertedSymmetricalLogTransform(base, linthresh, linscale)
    Bases: matplotlib.transforms.Transform
```

```

has_inverse = True
input_dims = 1
inverted(self)
    Return the corresponding inverse transformation.

    The return value of this method should be treated as temporary. An update to self
    does not cause a corresponding update to its inverted copy.

    x == self.inverted().transform(self.transform(x))

is_separable = True
output_dims = 1
transform_non_affine(self, a)
    Performs only the non-affine part of the transformation.

    transform(values) is always equivalent to transform_affine(transform_non_affine(values)).

    In non-affine transformations, this is generally equivalent to transform(values). In
    affine transformations, this is always a no-op.

    Accepts a numpy array of shape (N x input_dims) and returns a numpy array of shape
    (N x output_dims).

    Alternatively, accepts a numpy array of length input_dims and returns a numpy array
    of length output_dims.

```

```
class matplotlib.scale.LinearScale(axis, **kwargs)
```

```
    Bases: matplotlib.scale.ScaleBase
```

```
    The default linear scale.
```

```
    get_transform(self)
```

```
        The transform for linear scaling is just the IdentityTransform.
```

```
    name = 'linear'
```

```
    set_default_locators_and_formatters(self, axis)
```

```
        Set the locators and formatters to reasonable defaults for linear scaling.
```

```
class matplotlib.scale.Log10Transform(**kwargs)
```

```
    Bases: matplotlib.scale.LogTransformBase
```

```
    [Deprecated]
```

## Notes

Deprecated since version 3.1:

```
base = 10.0
```

```
inverted(self)
```

```
    Return the corresponding inverse transformation.
```

```
    The return value of this method should be treated as temporary. An update to self
    does not cause a corresponding update to its inverted copy.
```

```
    x == self.inverted().transform(self.transform(x))
```

```
class matplotlib.scale.Log2Transform(**kwargs)
    Bases: matplotlib.scale.LogTransformBase
    [Deprecated]
```

### Notes

Deprecated since version 3.1:

`base = 2.0`

`inverted(self)`

Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to *self* does not cause a corresponding update to its inverted copy.

```
x == self.inverted().transform(self.transform(x))
```

```
class matplotlib.scale.LogScale(axis, **kwargs)
    Bases: matplotlib.scale.ScaleBase
```

A standard logarithmic scale. Care is taken to only plot positive values.

**basex/basey:** The base of the logarithm

**nonposx/nonposy: {'mask', 'clip'}** non-positive values in x or y can be masked as invalid, or clipped to a very small positive number

**subsx/subsy:** Where to place the subticks between each major tick. Should be a sequence of integers. For example, in a log10 scale: [2, 3, 4, 5, 6, 7, 8, 9]

will place 8 logarithmically spaced minor ticks between each major tick.

```
class InvertedLog10Transform(**kwargs)
    Bases: matplotlib.scale.InvertedLogTransformBase
    [Deprecated]
```

### Notes

Deprecated since version 3.1:

`base = 10.0`

`inverted(self)`

Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to *self* does not cause a corresponding update to its inverted copy.

```
x == self.inverted().transform(self.transform(x))
```

```
class InvertedLog2Transform(**kwargs)
    Bases: matplotlib.scale.InvertedLogTransformBase
    [Deprecated]
```

## Notes

Deprecated since version 3.1:

`base = 2.0`

`inverted(self)`

Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to *self* does not cause a corresponding update to its inverted copy.

`x == self.inverted().transform(self.transform(x))`

```
class InvertedLogTransform(base)
```

Bases: `matplotlib.scale.InvertedLogTransformBase`

`has_inverse = True`

`input_dims = 1`

`inverted(self)`

Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to *self* does not cause a corresponding update to its inverted copy.

`x == self.inverted().transform(self.transform(x))`

`is_separable = True`

`output_dims = 1`

`transform_non_affine(self, a)`

Performs only the non-affine part of the transformation.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.

In non-affine transformations, this is generally equivalent to `transform(values)`.

In affine transformations, this is always a no-op.

Accepts a numpy array of shape (N x *input\_dims*) and returns a numpy array of shape (N x *output\_dims*).

Alternatively, accepts a numpy array of length *input\_dims* and returns a numpy array of length *output\_dims*.

```
class InvertedNaturalLogTransform(**kwargs)
```

Bases: `matplotlib.scale.InvertedLogTransformBase`

[*Deprecated*]

## Notes

Deprecated since version 3.1:

`base = 2.718281828459045`

`inverted(self)`

Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to *self* does not cause a corresponding update to its inverted copy.

```
x == self.inverted().transform(self.transform(x))  
class Log10Transform(**kwargs)  
    Bases: matplotlib.scale.LogTransformBase  
    [Deprecated]
```

#### Notes

Deprecated since version 3.1:

```
base = 10.0
```

```
inverted(self)
```

Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to *self* does not cause a corresponding update to its inverted copy.

```
x == self.inverted().transform(self.transform(x))
```

```
class Log2Transform(**kwargs)  
    Bases: matplotlib.scale.LogTransformBase  
    [Deprecated]
```

#### Notes

Deprecated since version 3.1:

```
base = 2.0
```

```
inverted(self)
```

Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to *self* does not cause a corresponding update to its inverted copy.

```
x == self.inverted().transform(self.transform(x))
```

```
class LogTransform(base, nonpos='clip')  
    Bases: matplotlib.transforms.Transform
```

```
has_inverse = True
```

```
input_dims = 1
```

```
inverted(self)
```

Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to *self* does not cause a corresponding update to its inverted copy.

```
x == self.inverted().transform(self.transform(x))
```

```
is_separable = True
```

```
output_dims = 1
```

```
transform_non_affine(self, a)
```

Performs only the non-affine part of the transformation.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.

In non-affine transformations, this is generally equivalent to `transform(values)`. In affine transformations, this is always a no-op.

Accepts a numpy array of shape  $(N \times \text{input\_dims})$  and returns a numpy array of shape  $(N \times \text{output\_dims})$ .

Alternatively, accepts a numpy array of length `input_dims` and returns a numpy array of length `output_dims`.

```
class LogTransformBase(**kwargs)
    Bases: matplotlib.transforms.Transform
    [Deprecated]
```

### Notes

Deprecated since version 3.1:

```
has_inverse = True
```

```
input_dims = 1
```

```
is_separable = True
```

```
output_dims = 1
```

```
transform_non_affine(self, a)
```

Performs only the non-affine part of the transformation.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.

In non-affine transformations, this is generally equivalent to `transform(values)`.

In affine transformations, this is always a no-op.

Accepts a numpy array of shape  $(N \times \text{input\_dims})$  and returns a numpy array of shape  $(N \times \text{output\_dims})$ .

Alternatively, accepts a numpy array of length `input_dims` and returns a numpy array of length `output_dims`.

```
class NaturalLogTransform(**kwargs)
    Bases: matplotlib.scale.LogTransformBase
    [Deprecated]
```

### Notes

Deprecated since version 3.1:

```
base = 2.718281828459045
```

```
inverted(self)
```

Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to `self` does not cause a corresponding update to its inverted copy.

```
x === self.inverted().transform(self.transform(x))
```

```
base
```

```
get_transform(self)
    Return a Transform instance appropriate for the given logarithm base.

limit_range_for_scale(self, vmin, vmax, minpos)
    Limit the domain to positive values.

name = 'log'

set_default_locators_and_formatters(self, axis)
    Set the locators and formatters to specialized versions for log scaling.

class matplotlib.scale.LogTransform(base, nonpos='clip')
    Bases: matplotlib.transforms.Transform

    has_inverse = True

    input_dims = 1

    inverted(self)
        Return the corresponding inverse transformation.

        The return value of this method should be treated as temporary. An update to self
        does not cause a corresponding update to its inverted copy.

        x == self.inverted().transform(self.transform(x))

    is_separable = True

    output_dims = 1

    transform_non_affine(self, a)
        Performs only the non-affine part of the transformation.

        transform(values) is always equivalent to transform_affine(transform_non_affine(values)).

        In non-affine transformations, this is generally equivalent to transform(values). In
        affine transformations, this is always a no-op.

        Accepts a numpy array of shape (N x input_dims) and returns a numpy array of shape
        (N x output_dims).

        Alternatively, accepts a numpy array of length input_dims and returns a numpy array
        of length output_dims.

class matplotlib.scale.LogTransformBase(**kwargs)
    Bases: matplotlib.transforms.Transform

    [Deprecated]
```

### Notes

Deprecated since version 3.1:

```
has_inverse = True

input_dims = 1

is_separable = True

output_dims = 1

transform_non_affine(self, a)
    Performs only the non-affine part of the transformation.

    transform(values) is always equivalent to transform_affine(transform_non_affine(values)).
```

In non-affine transformations, this is generally equivalent to `transform(values)`. In affine transformations, this is always a no-op.

Accepts a numpy array of shape  $(N \times \text{input\_dims})$  and returns a numpy array of shape  $(N \times \text{output\_dims})$ .

Alternatively, accepts a numpy array of length `input_dims` and returns a numpy array of length `output_dims`.

```
class matplotlib.scale.LogisticTransform(nonpos='mask')
    Bases: matplotlib.transforms.Transform
    has_inverse = True
    input_dims = 1
    inverted(self)
        Return the corresponding inverse transformation.
        The return value of this method should be treated as temporary. An update to self
        does not cause a corresponding update to its inverted copy.
        x == self.inverted().transform(self.transform(x))
    is_separable = True
    output_dims = 1
    transform_non_affine(self, a)
        logistic transform (base 10)
class matplotlib.scale.LogitScale(axis, nonpos='mask')
    Bases: matplotlib.scale.ScaleBase
    Logit scale for data between zero and one, both excluded.
    This scale is similar to a log scale close to zero and to one, and almost linear around 0.5.
    It maps the interval ]0, 1[ onto ]-infty, +infty[.
    nonpos: {'mask', 'clip'} values beyond ]0, 1[ can be masked as invalid, or clipped to
    a number very close to 0 or 1
    get_transform(self)
        Return a LogitTransform instance.
    limit_range_for_scale(self, vmin, vmax, minpos)
        Limit the domain to values between 0 and 1 (excluded).
    name = 'logit'
    set_default_locators_and_formatters(self, axis)
        Set the Locator and Formatter objects on the given axis to match this scale.
class matplotlib.scale.LogitTransform(nonpos='mask')
    Bases: matplotlib.transforms.Transform
    has_inverse = True
    input_dims = 1
    inverted(self)
        Return the corresponding inverse transformation.
        The return value of this method should be treated as temporary. An update to self
        does not cause a corresponding update to its inverted copy.
```

```
x == self.inverted().transform(self.transform(x))
is_separable = True
output_dims = 1
transform_non_affine(self, a)
    logit transform (base 10), masked or clipped
class matplotlib.scale.NaturalLogTransform(**kwargs)
    Bases: matplotlib.scale.LogTransformBase
    [Deprecated]
```

### Notes

Deprecated since version 3.1:

base = 2.718281828459045

`inverted(self)`  
Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to *self* does not cause a corresponding update to its inverted copy.

```
x == self.inverted().transform(self.transform(x))
```

```
class matplotlib.scale.ScaleBase(axis, **kwargs)
    Bases: object
```

The base class for all scales.

Scales are separable transformations, working on a single dimension.

Any subclasses will want to override:

- `name`
- `get_transform()`
- `set_default_locators_and_formatters()`

### And optionally:

- `limit_range_for_scale()`

Construct a new scale.

### Notes

The following note is for scale implementors.

For back-compatibility reasons, scales take an *Axis* object as first argument. However, this argument should not be used: a single scale object should be usable by multiple *Axes* at the same time.

`get_transform(self)`  
Return the *Transform* object associated with this scale.

`limit_range_for_scale(self, vmin, vmax, minpos)`  
Returns the range *vmin*, *vmax*, possibly limited to the domain supported by this scale.

***minpos* should be the minimum positive value in the data.** This is used by log scales to determine a minimum value.

`set_default_locators_and_formatters(self, axis)`  
Set the *Locator* and *Formatter* objects on the given axis to match this scale.

`class matplotlib.scale.SymmetricalLogScale(axis, **kwargs)`  
Bases: `matplotlib.scale.ScaleBase`

The symmetrical logarithmic scale is logarithmic in both the positive and negative directions from the origin.

Since the values close to zero tend toward infinity, there is a need to have a range around zero that is linear. The parameter *linthresh* allows the user to specify the size of this range (*-linthresh*, *linthresh*).

### Parameters

**basex, basey** [float] The base of the logarithm. Defaults to 10.

**linthreshx, linthreshy** [float] Defines the range (*-x*, *x*), within which the plot is linear. This avoids having the plot go to infinity around zero. Defaults to 2.

**subsx, subsy** [sequence of int] Where to place the subticks between each major tick. For example, in a log10 scale: [2, 3, 4, 5, 6, 7, 8, 9] will place 8 logarithmically spaced minor ticks between each major tick.

**linscalex, linscaley** [float, optional] This allows the linear range (*-linthresh*, *linthresh*) to be stretched relative to the logarithmic range. Its value is the number of decades to use for each half of the linear range. For example, when *linscale* == 1.0 (the default), the space used for the positive and negative halves of the linear range will be equal to one decade in the logarithmic range.

`class InvertedSymmetricalLogTransform(base, linthresh, linscale)`  
Bases: `matplotlib.transforms.Transform`

`has_inverse = True`

`input_dims = 1`

`inverted(self)`

Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to *self* does not cause a corresponding update to its inverted copy.

`x == self.inverted().transform(self.transform(x))`

`is_separable = True`

`output_dims = 1`

`transform_non_affine(self, a)`

Performs only the non-affine part of the transformation.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.

In non-affine transformations, this is generally equivalent to `transform(values)`. In affine transformations, this is always a no-op.

Accepts a numpy array of shape  $(N \times \text{input\_dims})$  and returns a numpy array of shape  $(N \times \text{output\_dims})$ .

Alternatively, accepts a numpy array of length `input_dims` and returns a numpy array of length `output_dims`.

```
class SymmetricalLogTransform(base, linthresh, linscale)
```

```
    Bases: matplotlib.transforms.Transform
```

```
    has_inverse = True
```

```
    input_dims = 1
```

```
    inverted(self)
```

Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to `self` does not cause a corresponding update to its inverted copy.

```
    x == self.inverted().transform(self.transform(x))
```

```
    is_separable = True
```

```
    output_dims = 1
```

```
    transform_non_affine(self, a)
```

Performs only the non-affine part of the transformation.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.

In non-affine transformations, this is generally equivalent to `transform(values)`.

In affine transformations, this is always a no-op.

Accepts a numpy array of shape  $(N \times \text{input\_dims})$  and returns a numpy array of shape  $(N \times \text{output\_dims})$ .

Alternatively, accepts a numpy array of length `input_dims` and returns a numpy array of length `output_dims`.

```
    get_transform(self)
```

Return a *SymmetricalLogTransform* instance.

```
    name = 'symlog'
```

```
    set_default_locators_and_formatters(self, axis)
```

Set the locators and formatters to specialized versions for symmetrical log scaling.

```
class matplotlib.scale.SymmetricalLogTransform(base, linthresh, linscale)
```

```
    Bases: matplotlib.transforms.Transform
```

```
    has_inverse = True
```

```
    input_dims = 1
```

```
    inverted(self)
```

Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to `self` does not cause a corresponding update to its inverted copy.

```
    x == self.inverted().transform(self.transform(x))
```

```
    is_separable = True
```

```
output_dims = 1
```

```
transform_non_affine(self, a)
```

Performs only the non-affine part of the transformation.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.

In non-affine transformations, this is generally equivalent to `transform(values)`. In affine transformations, this is always a no-op.

Accepts a numpy array of shape  $(N \times \text{input\_dims})$  and returns a numpy array of shape  $(N \times \text{output\_dims})$ .

Alternatively, accepts a numpy array of length `input_dims` and returns a numpy array of length `output_dims`.

```
matplotlib.scale.get_scale_docs()
```

[*Deprecated*] Helper function for generating docstrings related to scales.

### Notes

Deprecated since version 3.1: `get_scale_docs()` is considered private API since 3.1 and will be removed from the public API in 3.3.

```
matplotlib.scale.get_scale_names()
```

```
matplotlib.scale.register_scale(scale_class)
```

Register a new kind of scale.

`scale_class` must be a subclass of `ScaleBase`.

```
matplotlib.scale.scale_factory(scale, axis, **kwargs)
```

Return a scale class by name.

### Parameters

**scale** [{function, functionlog, linear, log, logit, symlog}]

**axis** [Axis]

## 17.43 matplotlib.spines

```
class matplotlib.spines.Spine(axes, spine_type, path, **kwargs)
```

Bases: `matplotlib.patches.Patch`

an axis spine - the line noting the data area boundaries

Spines are the lines connecting the axis tick marks and noting the boundaries of the data area. They can be placed at arbitrary positions. See function:`set_position` for more information.

The default position is `('outward', 0)`.

Spines are subclasses of class:`Patch`, and inherit much of their behavior.

Spines draw a line, a circle, or an arc depending if function:`set_patch_line`, function:`set_patch_circle`, or function:`set_patch_arc` has been called. Line-like is the default.

- `axes` : the Axes instance containing the spine
- `spine_type` : a string specifying the spine type

- *path* : the path instance used to draw the spine

Valid kwargs are:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<i>alpha</i>		float or None
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i>		unknown
<i>capstyle</i>		{'butt', 'round', 'projecting'}
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>color</i>		color
<i>contains</i>		callable
<i>edgecolor</i> or <i>ec</i>		color or None or 'auto'
<i>facecolor</i> or <i>fc</i>		color or None
<i>figure</i>		<i>Figure</i>
<i>fill</i>		bool
<i>gid</i>		str
<i>hatch</i>		{'/', '\', ' ', '-.', '+', 'x', 'o', 'O', '.', '*'}
<i>in_layout</i>		bool
<i>joinstyle</i>		{'miter', 'round', 'bevel'}
<i>label</i>		object
<i>linestyle</i> or <i>ls</i>		{'-', '--', '-.', ':', '', (offset, on-off-seq), ...}
<i>linewidth</i> or <i>lw</i>		float or None
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		None or bool or float or callable
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>transform</i>		<i>Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>zorder</i>		float

`classmethod arc_spine(axes, spine_type, center, radius, theta1, theta2, **kwargs)`  
 (classmethod) Returns an arc *Spine*.

`classmethod circular_spine(axes, center, radius, **kwargs)`  
 (staticmethod) Returns a circular *Spine*.

`cla(self)`  
 Clear the current spine.

`draw(self, renderer)`  
 Draw the *Patch* to the given *renderer*.

`get_bounds(self)`  
 Get the bounds of the spine.

`get_patch_transform(self)`  
 Return the *Transform* instance which takes patch coordinates to data coordinates.

For example, one may define a patch of a circle which represents a radius of 5 by providing coordinates for a unit circle, and a transform which scales the coordinates (the patch coordinate) by 5.

`get_path(self)`

Return the path of this patch

`get_position(self)`

Return the spine position.

`get_smart_bounds(self)`

Return whether the spine has smart bounds.

`get_spine_transform(self)`

Return the spine transform.

`get_window_extent(self, renderer=None)`

Return the window extent of the spines in display space, including padding for ticks (but not their labels)

**See also:**

`matplotlib.axes.Axes.get_tightbbox`

`matplotlib.axes.Axes.get_window_extent`

`is_frame_like(self)`

[*Deprecated*] Return True if directly on axes frame.

This is useful for determining if a spine is the edge of an old style MPL plot. If so, this function will return True.

**Notes**

Deprecated since version 3.1.

`classmethod linear_spine(axes, spine_type, **kwargs)`  
(staticmethod) Returns a linear *Spine*.

`register_axis(self, axis)`

Register an axis.

An axis should be registered with its corresponding spine from the Axes instance. This allows the spine to clear any axis properties when needed.

`set_bounds(self, low, high)`

Set the bounds of the spine.

`set_color(self, c)`

Set the edgcolor.

**Parameters**

**c** [color]

**Notes**

This method does not modify the facecolor (which defaults to "none"), unlike the `Patch.set_color` method defined in the parent class. Use `Patch.set_facecolor` to set

the facecolor.

`set_patch_arc(self, center, radius, theta1, theta2)`  
Set the spine to be arc-like.

`set_patch_circle(self, center, radius)`  
Set the spine to be circular.

`set_patch_line(self)`  
Set the spine to be linear.

`set_position(self, position)`  
Set the position of the spine.

Spine position is specified by a 2 tuple of (position type, amount). The position types are:

- 'outward' : place the spine out from the data area by the specified number of points. (Negative values specify placing the spine inward.)
- 'axes' : place the spine at the specified Axes coordinate (from 0.0-1.0).
- 'data' : place the spine at the specified data coordinate.

Additionally, shorthand notations define a special positions:

- 'center' -> ('axes', 0.5)
- 'zero' -> ('data', 0.0)

`set_smart_bounds(self, value)`  
Set the spine and associated axis to have smart bounds.

## 17.44 matplotlib.style

`matplotlib.style.context(style, after_reset=False)`  
Context manager for using style settings temporarily.

### Parameters

**style** [str, dict, or list] A style specification. Valid options are:

str	The name of a style or a path/URL to a style file. For a list of available style names, see <code>style.available</code> .
dict	Dictionary with valid key/value pairs for <code>matplotlib.rcParams</code> .
list	A list of style specifiers (str or dict) applied from first to last in the list.

**after\_reset** [bool] If True, apply style after resetting settings to their defaults; otherwise, apply style on top of the current settings.

`matplotlib.style.reload_library()`  
Reload style library.

`matplotlib.style.use(style)`  
Use matplotlib style settings from a style specification.

The style name of 'default' is reserved for reverting back to the default style settings.

### Parameters

**style** [str, dict, or list] A style specification. Valid options are:

str	The name of a style or a path/URL to a style file. For a list of available style names, see <code>style.available</code> .
dict	Dictionary with valid key/value pairs for <code>matplotlib.rcParams</code> .
list	A list of style specifiers (str or dict) applied from first to last in the list.

`matplotlib.style.library`  
Dictionary of available styles

`matplotlib.style.available`  
List of available styles

## 17.45 `matplotlib.table`

This module provides functionality to add a table to a plot.

Use the factory function `table` to create a ready-made table from texts. If you need more control, use the `Table` class and its methods.

The table consists of a grid of cells, which are indexed by (row, column). The cell (0, 0) is positioned at the top left.

Thanks to John Gill for providing the class and table.

```
class matplotlib.table.Cell(xy, width, height, edgecolor='k', facecolor='w', fill=True,
                           text="", loc=None, fontproperties=None)
```

Bases: `matplotlib.patches.Rectangle`

A cell is a `Rectangle` with some associated `Text`.

### Parameters

**xy** [2-tuple] The position of the bottom left corner of the cell.

**width** [float] The cell width.

**height** [float] The cell height.

**edgecolor** [color spec] The color of the cell border.

**facecolor** [color spec] The cell facecolor.

**fill** [bool] Whether the cell background is filled.

**text** [str] The cell text.

**loc** [{'left', 'center', 'right'}, default: 'right'] The alignment of the text within the cell.

**fontproperties** [dict] A dict defining the font properties of the text. Supported keys and values are the keyword arguments accepted by `FontProperties`.

`PAD = 0.1`

Padding between text and rectangle.

```
auto_set_font_size(self, renderer)
```

Shrink font size until the text fits into the cell width.

`draw(self, renderer)`  
 Draw the Patch to the given *renderer*.

`get_fontsize(self)`  
 Return the cell fontsize.

`get_required_width(self, renderer)`  
 Return the minimal required width for the cell.

`get_text(self)`  
 Return the cell *Text* instance.

`get_text_bounds(self, renderer)`  
 Return the text bounds as (*x*, *y*, *width*, *height*) in table coordinates.

`set_figure(self, fig)`  
 Set the *Figure* instance the artist belongs to.

**Parameters**

**fig** [*Figure*]

`set_fontsize(self, size)`  
 Set the text fontsize.

`set_text_props(self, **kwargs)`  
 Update the text properties.

Valid kwargs are

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and
<i>alpha</i>	float	
<i>animated</i>	bool	
<i>backgroundcolor</i>	color	
<i>bbox</i>		dict with properties for <i>patches.FancyBboxPatch</i>
<i>clip_box</i>	<i>Bbox</i>	
<i>clip_on</i>	bool	
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>color</i> or <i>c</i>	color	
<i>contains</i>	callable	
<i>figure</i>		<i>Figure</i>
<i>fontfamily</i> or <i>family</i>		{'FONTNAME', 'serif', 'sans-serif', 'cursive', 'fantasy', 'monospace'}
<i>fontproperties</i> or <i>font_properties</i>		<i>font_manager.FontProperties</i>
<i>fontsize</i> or <i>size</i>		{size in points, 'xx-small', 'x-small', 'small', 'medium', 'large', 'x-large'}
<i>fontstretch</i> or <i>stretch</i>		{a numeric value in range 0-1000, 'ultra-condensed', 'extra-condensed'}
<i>fontstyle</i> or <i>style</i>		{'normal', 'italic', 'oblique'}
<i>fontvariant</i> or <i>variant</i>		{'normal', 'small-caps'}
<i>fontweight</i> or <i>weight</i>		{a numeric value in range 0-1000, 'ultralight', 'light', 'normal', 'regular'}
<i>gid</i>	str	
<i>horizontalalignment</i> or <i>ha</i>		{'center', 'right', 'left'}
<i>in_layout</i>	bool	
<i>label</i>	object	
<i>linespacing</i>		float (multiple of font size)
<i>multialignment</i> or <i>ma</i>		{'left', 'right', 'center'}
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		None or bool or float or callable

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	Property	Description
<i>position</i>	(float, float)	
<i>rasterized</i>	bool or None	
<i>rotation</i>	{angle in degrees, 'vertical', 'horizontal'}	
<i>rotation_mode</i>	{None, 'default', 'anchor'}	
<i>sketch_params</i>	(scale: float, length: float, randomness: float)	
<i>snap</i>	bool or None	
<i>text</i>	object	
<i>transform</i>	<i>Transform</i>	
<i>url</i>	str	
<i>usetex</i>	bool or None	
<i>verticalalignment</i> or <i>va</i>	{'center', 'top', 'bottom', 'baseline', 'center_baseline'}	
<i>visible</i>	bool	
<i>wrap</i>	bool	
<i>x</i>	float	
<i>y</i>	float	
<i>zorder</i>	float	

`set_transform(self, trans)`  
Set the artist transform.

### Parameters

**t** [*Transform*]

`class matplotlib.table.CustomCell(*args, visible_edges, **kwargs)`  
Bases: `matplotlib.table.Cell`

A *Cell* subclass with configurable edge visibility.

`get_path(self)`  
Return a *Path* for the *visible\_edges*.

`visible_edges`  
The cell edges to be drawn with a line.

Reading this property returns a substring of 'BRTL' (bottom, right, top, left').

When setting this property, you can use a substring of 'BRTL' or one of {'open', 'closed', 'horizontal', 'vertical'}.

`class matplotlib.table.Table(ax, loc=None, bbox=None, **kwargs)`  
Bases: `matplotlib.artist.Artist`

A table of cells.

The table consists of a grid of cells, which are indexed by (row, column).

For a simple table, you'll have a full grid of cells with indices from (0, 0) to (num\_rows-1, num\_cols-1), in which the cell (0, 0) is positioned at the top left. However, you can also add cells with negative indices. You don't have to add a cell to every grid position, so you can create tables that have holes.

*Note:* You'll usually not create an empty table from scratch. Instead use *table* to create a table from data.

### Parameters

**ax** [*matplotlib.axes.Axes*] The *Axes* to plot the table into.

**loc** [str] The position of the cell with respect to *ax*. This must be one of the *codes*.

**bbox** [*Bbox* or None] A bounding box to draw the table into. If this is not *None*, this overrides *loc*.

### Other Parameters

**\*\*kwargs** *Artist* properties.

AXESPAD = 0.02

The border between the Axes and the table edge in Axes units.

FONTSIZE = 10

`add_cell(self, row, col, *args, **kwargs)`

Create a cell and add it to the table.

### Parameters

**row** [int] Row index.

**col** [int] Column index.

**\*args, \*\*kwargs** All other parameters are passed on to *Cell*.

### Returns

**cell** [*CustomCell*] The created cell.

`auto_set_column_width(self, col)`

Automatically set the widths of given columns to optimal sizes.

### Parameters

**col** [int or sequence of ints] The indices of the columns to auto-scale.

`auto_set_font_size(self, value=True)`

Automatically set font size.

`codes = {'best': 0, 'bottom': 17, 'bottom left': 12, 'bottom right': 13, 'center': 9, 'center left': 11, 'center right': 14, 'left': 15, 'right': 16}`

Possible values where to place the table relative to the Axes.

`contains(self, mouseevent)`

Test whether the artist contains the mouse event.

### Parameters

**mouseevent** [*matplotlib.backend\_bases.MouseEvent*]

### Returns

**contains** [bool] Whether any values are within the radius.

**details** [dict] An artist-specific dictionary of details of the event context, such as which points are contained in the pick radius. See the individual Artist subclasses for details.

### See also:

`set_contains, get_contains`

`draw(self, renderer)`

Draw the Artist using the given renderer.

This method will be overridden in the Artist subclasses. Typically, it is implemented to not have any effect if the Artist is not visible (`Artist.get_visible` is `False`).

### Parameters

**renderer** [`RendererBase` subclass.]

`edges`

The default value of `visible_edges` for newly added cells using `add_cell`.

### Notes

This setting does currently only affect newly created cells using `add_cell`.

To change existing cells, you have to set their edges explicitly:

```
for c in tab.get_celld().values():
    c.visible_edges = 'horizontal'
```

`get_celld(self)`

Return a dict of cells in the table mapping (`row, column`) to `Cells`.

### Notes

You can also directly index into the Table object to access individual cells:

```
cell = table[row, col]
```

`get_child_artists(self)`

[*Deprecated*] Return the Artists contained by the table.

### Notes

Deprecated since version 3.0.

`get_children(self)`

Return the Artists contained by the table.

`get_window_extent(self, renderer)`

Return the bounding box of the table in window coords.

`scale(self, xscale, yscale)`

Scale column widths by `xscale` and row heights by `yscale`.

`set_fontsize(self, size)`

Set the font size, in points, of the cell text.

### Parameters

**size** [float]

## Notes

As long as auto font size has not been disabled, the value will be clipped such that the text fits horizontally into the cell.

You can disable this behavior using `auto_set_font_size`.

```
>>> the_table.auto_set_font_size(False)
>>> the_table.set_fontsize(20)
```

However, there is no automatic scaling of the row height so that the text may exceed the cell boundary.

```
matplotlib.table.table(ax, cellText=None, cellColours=None, cellLoc='right',
                       colWidths=None, rowLabels=None, rowColours=None,
                       rowLoc='left', colLabels=None, colColours=None, col-
                       Loc='center', loc='bottom', bbox=None, edges='closed',
                       **kwargs)
```

Add a table to an *Axes*.

At least one of `cellText` or `cellColours` must be specified. These parameters must be 2D lists, in which the outer lists define the rows and the inner list define the column values per row. Each row must have the same number of elements.

The table can optionally have row and column headers, which are configured using `rowLabels`, `rowColours`, `rowLoc` and `colLabels`, `colColours`, `colLoc` respectively.

For finer grained control over tables, use the `Table` class and add it to the axes with `Axes.add_table`.

## Parameters

**cellText** [2D list of str, optional] The texts to place into the table cells.

*Note:* Line breaks in the strings are currently not accounted for and will result in the text exceeding the cell boundaries.

**cellColours** [2D list of matplotlib color specs, optional] The background colors of the cells.

**cellLoc** [{'left', 'center', 'right'}], default: 'right'] The alignment of the text within the cells.

**colWidths** [list of float, optional] The column widths in units of the axes. If not given, all columns will have a width of  $1 / n_{cols}$ .

**rowLabels** [list of str, optional] The text of the row header cells.

**rowColours** [list of matplotlib color specs, optional] The colors of the row header cells.

**rowLoc** [{'left', 'center', 'right'}], optional, default: 'left'] The text alignment of the row header cells.

**colLabels** [list of str, optional] The text of the column header cells.

**colColours** [list of matplotlib color specs, optional] The colors of the column header cells.

**rowLoc** [{'left', 'center', 'right'}], optional, default: 'left'] The text alignment of the column header cells.

**loc** [str, optional] The position of the cell with respect to *ax*. This must be one of the *codes*.

**bbox** [*Bbox*, optional] A bounding box to draw the table into. If this is not *None*, this overrides *loc*.

**edges** [substring of 'BRTL' or {'open', 'closed', 'horizontal', 'vertical'}] The cell edges to be drawn with a line. See also *visible\_edges*.

### Returns

**table** [*Table*] The created table.

### Other Parameters

**\*\*kwargs** *Table* properties.

Property	Description
<i>agg_filter</i>	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
<i>alpha</i>	float
<i>animated</i>	bool
<i>clip_box</i>	<i>Bbox</i>
<i>clip_on</i>	bool
<i>clip_path</i>	[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   <i>None</i> ]
<i>contains</i>	callable
<i>figure</i>	<i>Figure</i>
<i>fontsize</i>	float
<i>gid</i>	str
<i>in_layout</i>	bool
<i>label</i>	object
<i>path_effects</i>	<i>AbstractPathEffect</i>
<i>picker</i>	<i>None</i> or bool or float or callable
<i>rasterized</i>	bool or <i>None</i>
<i>sketch_params</i>	( <i>scale</i> : float, <i>length</i> : float, <i>randomness</i> : float)
<i>snap</i>	bool or <i>None</i>
<i>transform</i>	<i>Transform</i>
<i>url</i>	str
<i>visible</i>	bool
<i>zorder</i>	float

## 17.46 matplotlib.testing

### 17.46.1 matplotlib.testing

Helper functions for testing.

`matplotlib.testing.is_called_from_pytest()`

Whether we are in a pytest run.

`matplotlib.testing.set_font_settings_for_testing()`

`matplotlib.testing.set_reproducibility_for_testing()`

`matplotlib.testing.setup()`

## 17.46.2 matplotlib.testing.compare

Provides a collection of utilities for comparing (image) results.

`matplotlib.testing.compare.compare_float(expected, actual, relTol=None, absTol=None)`

[*Deprecated*] Fail if the floating point values are not close enough, with the given message.

You can specify a relative tolerance, absolute tolerance, or both.

### Notes

Deprecated since version 3.0.

`matplotlib.testing.compare.compare_images(expected, actual, tol, in_decorator=False)`

Compare two "image" files checking differences within a tolerance.

The two given filenames may point to files which are convertible to PNG via the `converter` dictionary. The underlying RMS is calculated with the `calculate_rms` function.

### Parameters

**expected** [str] The filename of the expected image.

**actual** [str] The filename of the actual image.

**tol** [float] The tolerance (a color value difference, where 255 is the maximal difference). The test fails if the average pixel difference is greater than this value.

**in\_decorator** [bool] Determines the output format. If called from `image_comparison` decorator, this should be True. (default=False)

### Returns

**comparison\_result** [None or dict or str] Return *None* if the images are equal within the given tolerance.

If the images differ, the return value depends on `in_decorator`. If `in_decorator` is true, a dict with the following entries is returned:

- *rms*: The RMS of the image difference.
- *expected*: The filename of the expected image.
- *actual*: The filename of the actual image.
- *diff\_image*: The filename of the difference image.
- *tol*: The comparison tolerance.

Otherwise, a human-readable multi-line string representation of this information is returned.

### Examples

```
img1 = "./baseline/plot.png"
img2 = "./output/plot.png"
compare_images(img1, img2, 0.001)
```

```
matplotlib.testing.compare.comparable_formats()
```

Return the list of file formats that *compare\_images* can compare on this system.

### Returns

**supported\_formats** [list of str] E.g. ['png', 'pdf', 'svg', 'eps'].

## 17.46.3 matplotlib.testing.decorators

```
class matplotlib.testing.decorators.CleanupTest(**kwargs)
```

Bases: `object`

[*Deprecated*]

### Notes

Deprecated since version 3.0:

```
classmethod setup_class()
```

```
classmethod teardown_class()
```

```
test(self)
```

```
class matplotlib.testing.decorators.CleanupTestCase(methodName='runTest')
```

Bases: `unittest.case.TestCase`

A wrapper for `unittest.TestCase` that includes cleanup operations.

Create an instance of the class that will use the named test method when executed. Raises a `ValueError` if the instance does not have a method with the specified name.

```
classmethod setUpClass()
```

Hook method for setting up class fixture before running tests in the class.

```
classmethod tearDownClass()
```

Hook method for deconstructing the class fixture after running all tests in the class.

```
class matplotlib.testing.decorators.ImageComparisonTest(**kwargs)
```

Bases: `matplotlib.testing.decorators.CleanupTest`, `matplotlib.testing.decorators._ImageComparisonBase`

[*Deprecated*] Nose-based image comparison class

This class generates tests for a nose-based testing framework. Ideally, this class would not be public, and the only publicly visible API would be the *image\_comparison()* decorator. Unfortunately, there are existing downstream users of this class (e.g., `pytest-mpl`) so it cannot yet be removed.

### Notes

Deprecated since version 3.0.

```
nose_runner(self)
```

```
setup(self)
```

```
teardown(self)
```

```
matplotlib.testing.decorators.check_figures_equal(*, extensions=('png', 'pdf', 'svg'),
                                                tol=0)
```

Decorator for test cases that generate and compare two figures.

The decorated function must take two arguments, *fig\_test* and *fig\_ref*, and draw the test and reference images on them. After the function returns, the figures are saved and compared.

This decorator should be preferred over *image\_comparison* when possible in order to keep the size of the test suite from ballooning.

### Parameters

**extensions** [list, default: ["png", "pdf", "svg"]] The extensions to test.

**tol** [float] The RMS threshold above which the test is considered failed.

### Examples

Check that calling `Axes.plot` with a single argument plots it against `[0, 1, 2, ...]`:

```
@check_figures_equal()
def test_plot(fig_test, fig_ref):
    fig_test.subplots().plot([1, 3, 5])
    fig_ref.subplots().plot([0, 1, 2], [1, 3, 5])
```

```
matplotlib.testing.decorators.check_freetype_version(ver)
```

```
matplotlib.testing.decorators.cleanup(style=None)
```

A decorator to ensure that any global state is reset before running a test.

### Parameters

**style** [str, optional] The name of the style to apply.

```
matplotlib.testing.decorators.image_comparison(baseline_images, extensions=None,
                                              tol=0, freetype_version=None,
                                              remove_text=False, save_fig_kwarg=None,
                                              style='classic_test')
```

Compare images generated by the test with those specified in *baseline\_images*, which must correspond, else an `ImageComparisonFailure` exception will be raised.

### Parameters

**baseline\_images** [list or None] A list of strings specifying the names of the images generated by calls to `matplotlib.figure.savefig()`.

If *None*, the test function must use the *baseline\_images* fixture, either as a parameter or with `pytest.mark.usefixtures`. This value is only allowed when using `pytest`.

**extensions** [None or list of str] The list of extensions to test, e.g. ['png', 'pdf'].

If *None*, defaults to all supported extensions: png, pdf, and svg.

In order to keep the size of the test suite from ballooning, we only include the *svg* or *pdf* outputs if the test is explicitly exercising a feature dependent on that backend (see also the *check\_figures\_equal* decorator for that purpose).

**tol** [float, optional, default: 0] The RMS threshold above which the test is considered failed.

**freetype\_version** [str or tuple] The expected freetype version or range of versions for this test to pass.

**remove\_text** [bool] Remove the title and tick text from the figure before comparison. This is useful to make the baseline images independent of variations in text rendering between different versions of FreeType.

This does not remove other, more deliberate, text, such as legends and annotations.

**savefig\_kwarg** [dict] Optional arguments that are passed to the `savefig` method.

**style** [string] Optional name for the base style to apply to the image test. The test itself can also apply additional styles if desired. Defaults to the `'_classic_test'` style.

`matplotlib.testing.decorators.remove_ticks_and_titles(figure)`

`matplotlib.testing.decorators.skip_if_command_unavailable(cmd)`  
 [*Deprecated*] skips a test if a command is unavailable.

#### Parameters

**cmd** [list of str] must be a complete command which should not return a non zero exit code, something like `["latex", "-version"]`

#### Notes

Deprecated since version 3.0.

`matplotlib.testing.decorators.switch_backend(backend)`  
 [*Deprecated*]

#### Notes

Deprecated since version 3.1:

### 17.46.4 `matplotlib.testing.disable_internet`

`matplotlib.testing.disable_internet.check_internet_off(original_function)`

Wraps `original_function`, which in most cases is assumed to be a `socket.socket` method, to raise an `IOError` for any operations on non-local AF\_INET sockets.

`matplotlib.testing.disable_internet.no_internet(verbose=False)`

Context manager to temporarily disable internet access (if not already disabled). If it was already disabled before entering the context manager (i.e. `turn_off_internet` was called previously) then this is a no-op and leaves internet access disabled until a manual call to `turn_on_internet`.

`matplotlib.testing.disable_internet.turn_off_internet(verbose=False)`

Disable internet access via python by preventing connections from being created using the `socket` module. Presumably this could be worked around by using some other means

of accessing the internet, but all default python modules (urllib, requests, etc.) use socket [citation needed].

```
matplotlib.testing.disable_internet.turn_on_internet(verbose=False)
Restore internet access. Not used, but kept in case it is needed.
```

### 17.46.5 matplotlib.testing.exceptions

```
exception matplotlib.testing.exceptions.ImageComparisonFailure
Bases: AssertionError
```

Raise this exception to mark a test as a comparison between two images.

### 17.47 matplotlib.text

Classes for including text in a figure.

```
class matplotlib.text.Annotation(text, xy, xytext=None, xycoords='data',
                                textcoords=None, arrowprops=None, annotation_clip=None, **kwargs)
Bases: matplotlib.text.Text, matplotlib.text._AnnotationBase
```

An *Annotation* is a *Text* that can refer to a specific position *xy*. Optionally an arrow pointing from the text to *xy* can be drawn.

#### Attributes

**xy** The annotated position.

**xycoords** The coordinate system for *xy*.

**arrow\_patch** A *FancyArrowPatch* to point from *xytext* to *xy*.

Annotate the point *xy* with text *text*.

In the simplest form, the text is placed at *xy*.

Optionally, the text can be displayed in another position *xytext*. An arrow pointing from the text to the annotated point *xy* can then be added by defining *arrowprops*.

#### Parameters

**text** [str] The text of the annotation. *s* is a deprecated synonym for this parameter.

**xy** [(float, float)] The point (*x*,*y*) to annotate.

**xytext** [(float, float), optional] The position (*x*,*y*) to place the text at. If *None*, defaults to *xy*.

**xycoords** [str, *Artist*, *Transform*, callable or tuple, optional] The coordinate system that *xy* is given in. The following types of values are supported:

- One of the following strings:

Value	Description
'figure points'	Points from the lower left of the figure
'figure pixels'	Pixels from the lower left of the figure
'figure fraction'	Fraction of figure from lower left
'axes points'	Points from lower left corner of axes
'axes pixels'	Pixels from lower left corner of axes
'axes fraction'	Fraction of axes from lower left
'data'	Use the coordinate system of the object being annotated (default)
'polar'	$(\theta, r)$ if not native 'data' coordinates

- An *Artist*:  $xy$  is interpreted as a fraction of the artists *Bbox*. E.g.  $(0, 0)$  would be the lower left corner of the bounding box and  $(0.5, 1)$  would be the center top of the bounding box.
- A *Transform* to transform  $xy$  to screen coordinates.
- A function with one of the following signatures:

```
def transform(renderer) -> Bbox
def transform(renderer) -> Transform
```

where *renderer* is a *RendererBase* subclass.

The result of the function is interpreted like the *Artist* and *Transform* cases above.

- A tuple  $(xcoords, ycoords)$  specifying separate coordinate systems for  $x$  and  $y$ .  $xcoords$  and  $ycoords$  must each be of one of the above described types.

See *Advanced Annotation* for more details.

Defaults to 'data'.

**textcoords** [*str*, *Artist*, *Transform*, callable or tuple, optional] The coordinate system that  $xytext$  is given in.

All  $ycoords$  values are valid as well as the following strings:

Value	Description
'offset points'	Offset (in points) from the $xy$ value
'offset pixels'	Offset (in pixels) from the $xy$ value

Defaults to the value of  $ycoords$ , i.e. use the same coordinate system for annotation point and text position.

**arrowprops** [dict, optional] The properties used to draw a *FancyArrowPatch* arrow between the positions  $xy$  and  $xytext$ .

If *arrowprops* does not contain the key 'arrowstyle' the allowed keys are:

Key	Description
width	The width of the arrow in points
headwidth	The width of the base of the arrow head in points
headlength	The length of the arrow head in points
shrink	Fraction of total length to shrink from both ends
?	Any key to <i>matplotlib.patches.FancyArrowPatch</i>

If *arrowprops* contains the key 'arrowstyle' the above keys are forbidden. The allowed values of 'arrowstyle' are:

Name	Attrs
'-'	None
'->'	head_length=0.4,head_width=0.2
'-['	widthB=1.0,lengthB=0.2,angleB=None
' - '	widthA=1.0,widthB=1.0
'- >'	head_length=0.4,head_width=0.2
'<-'	head_length=0.4,head_width=0.2
'<->'	head_length=0.4,head_width=0.2
'< -'	head_length=0.4,head_width=0.2
'< ->'	head_length=0.4,head_width=0.2
'fancy'	head_length=0.4,head_width=0.4,tail_width=0.4
'simple'	head_length=0.5,head_width=0.5,tail_width=0.2
'wedge'	tail_width=0.3,shrink_factor=0.5

Valid keys for *FancyArrowPatch* are:

Key	Description
arrowstyle	the arrow style
connectionstyle	the connection style
relpos	default is (0.5, 0.5)
patchA	default is bounding box of the text
patchB	default is None
shrinkA	default is 2 points
shrinkB	default is 2 points
mutation_scale	default is text size (in points)
mutation_aspect	default is 1.
?	any key for <i>matplotlib.patches.PathPatch</i>

Defaults to None, i.e. no arrow is drawn.

**annotation\_clip** [bool or None, optional] Whether to draw the annotation when the annotation point *xy* is outside the axes area.

- If *True*, the annotation will only be drawn when *xy* is within the axes.
- If *False*, the annotation will always be drawn.
- If *None*, the annotation will only be drawn when *xy* is within the axes and *xycoords* is 'data'.

Defaults to *None*.

**\*\*kwargs** Additional kwargs are passed to *Text*.

**Returns****annotation** [*Annotation*]**See also:*****Advanced Annotation***

anncoords

The coordinate system to use for *Annotation.xyann*.

arrow

[*Deprecated*]**Notes**

Deprecated since version 3.0: arrow was deprecated in Matplotlib 3.0 and will be removed in 3.2. Use arrow\_patch instead.

contains(*self*, *event*)

Test whether the mouse event occurred in the patch.

In the case of text, a hit is true anywhere in the axis-aligned bounding-box containing the text.

**Returns****bool** [bool]draw(*self*, *renderer*)Draw the *Annotation* object to the given *renderer*.get\_anncoords(*self*)Return the coordinate system to use for *Annotation.xyann*.See also *xycoords* in *Annotation*.get\_window\_extent(*self*, *renderer=None*)

Return the Bbox bounding the text and arrow, in display units.

**Parameters**

**renderer** [Renderer, optional] A renderer is needed to compute the bounding box. If the artist has already been drawn, the renderer is cached; thus, it is only necessary to pass this argument when calling *get\_window\_extent* before the first *draw*. In practice, it is usually easier to trigger a draw first (e.g. by saving the figure).

set\_anncoords(*self*, *coords*)Set the coordinate system to use for *Annotation.xyann*.See also *xycoords* in *Annotation*.set\_figure(*self*, *fig*)Set the *Figure* instance the artist belongs to.**Parameters****fig** [*Figure*]update\_positions(*self*, *renderer*)

Update the pixel positions of the annotated point and the text.

`xyann`

The the text position.

See also `xytext` in *Annotation*.

`class matplotlib.text.OffsetFrom(artist, ref_coord, unit='points')`

Bases: `object`

Callable helper class for working with *Annotation*

**Parameters**

**artist** [Artist, BboxBase, or Transform] The object to compute the offset from.

**ref\_coord** [length 2 sequence] If `artist` is an Artist or BboxBase, this value is the location to of the offset origin in fractions of the artist bounding box.

If `artist` is a transform, the offset origin is the transform applied to this value.

**unit** [{'points', 'pixels'}] The screen units to use (pixels or points) for the offset input.

`get_unit(self)`

The unit for input to the transform used by `__call__`

`set_unit(self, unit)`

The unit for input to the transform used by `__call__`

**Parameters**

**unit** [{'points', 'pixels'}]

`class matplotlib.text.Text(x=0, y=0, text="", color=None, verticalalignment='baseline', horizontalalignment='left', multialignment=None, fontproperties=None, rotation=None, linespacing=None, rotation_mode=None, usetex=None, wrap=False, **kwargs)`

Bases: `matplotlib.artist.Artist`

Handle storing and drawing of text in window or data coordinates.

Create a *Text* instance at `x`, `y` with string `text`.

Valid kwargs are

	Property	Description
<code>agg_filter</code>		a filter function, which takes a (m, n, 3) float array and a dpi value, and
<code>alpha</code>	float	
<code>animated</code>	bool	
<code>backgroundcolor</code>	color	
<code>bbox</code>		dict with properties for <code>patches.FancyBboxPatch</code>
<code>clip_box</code>	<code>Bbox</code>	
<code>clip_on</code>	bool	
<code>clip_path</code>		[( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   <code>None</code> ]
<code>color OR C</code>	color	
<code>contains</code>	callable	
<code>figure</code>		<code>Figure</code>

Continued on next page

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	Property	Description
<i>fontfamily</i> or family		{'FONTNAME', 'serif', 'sans-serif', 'cursive', 'fantasy', 'monospace'}
<i>fontproperties</i> or font_properties		<i>font_manager.FontProperties</i>
<i>fontsize</i> or size		{size in points, 'xx-small', 'x-small', 'small', 'medium', 'large', 'x-large'}
<i>fontstretch</i> or stretch		{a numeric value in range 0-1000, 'ultra-condensed', 'extra-condensed'}
<i>fontstyle</i> or style		{'normal', 'italic', 'oblique'}
<i>fontvariant</i> or variant		{'normal', 'small-caps'}
<i>fontweight</i> or weight		{a numeric value in range 0-1000, 'ultralight', 'light', 'normal', 'regular'}
<i>gid</i>		str
<i>horizontalalignment</i> or ha		{'center', 'right', 'left'}
<i>in_layout</i>		bool
<i>label</i>		object
<i>linespacing</i>		float (multiple of font size)
<i>multialignment</i> or ma		{'left', 'right', 'center'}
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		None or bool or float or callable
<i>position</i>		(float, float)
<i>rasterized</i>		bool or None
<i>rotation</i>		{angle in degrees, 'vertical', 'horizontal'}
<i>rotation_mode</i>		{None, 'default', 'anchor'}
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>text</i>		object
<i>transform</i>		<i>Transform</i>
<i>url</i>		str
<i>usetex</i>		bool or None
<i>verticalalignment</i> or va		{'center', 'top', 'bottom', 'baseline', 'center_baseline'}
<i>visible</i>		bool
<i>wrap</i>		bool
<i>x</i>		float
<i>y</i>		float
<i>zorder</i>		float

`contains(self, mouseevent)`

Test whether the mouse event occurred in the patch.

In the case of text, a hit is true anywhere in the axis-aligned bounding-box containing the text.

### Returns

**bool** [bool]

`draw(self, renderer)`

Draws the *Text* object to the given *renderer*.

`get_bbox_patch(self)`

Return the bbox Patch, or None if the *patches.FancyBboxPatch* is not made.

`get_c(self)`

Alias for `get_color`.

`get_color(self)`

Return the color of the text

`get_family(self)`

Alias for `get_fontfamily`.

`get_font_properties(self)`

Alias for `get_fontproperties`.

`get_fontfamily(self)`

Return the list of font families used for font lookup

**See also:**

`font_manager.FontProperties.get_family`

`get_fontname(self)`

Return the font name as string

**See also:**

`font_manager.FontProperties.get_name`

`get_fontproperties(self)`

Return the `font_manager.FontProperties` object

`get_fontsize(self)`

Return the font size as integer

**See also:**

`font_manager.FontProperties.get_size_in_points`

`get_fontstyle(self)`

Return the font style as string

**See also:**

`font_manager.FontProperties.get_style`

`get_fontvariant(self)`

Return the font variant as a string

**See also:**

`font_manager.FontProperties.get_variant`

`get_fontweight(self)`

Get the font weight as string or number

**See also:**

`font_manager.FontProperties.get_weight`

`get_ha(self)`

Alias for `get_horizontalalignment`.

`get_horizontalalignment(self)`

Return the horizontal alignment as string. Will be one of 'left', 'center' or 'right'.

`get_name(self)`

Alias for `get_fontname`.

`get_position(self)`  
Return the position of the text as a tuple (x, y)

`get_prop_tup(self, renderer=None)`  
Return a hashable tuple of properties.  
  
Not intended to be human readable, but useful for backends who want to cache derived information about text (e.g., layouts) and need to know if the text has changed.

`get_rotation(self)`  
Return the text angle as float in degrees.

`get_rotation_mode(self)`  
Get the text rotation mode.

`get_size(self)`  
Alias for `get_fontsize`.

`get_stretch(self)`  
Get the font stretch as a string or number

**See also:**

`font_manager.FontProperties.get_stretch`

`get_style(self)`  
Alias for `get_fontstyle`.

`get_text(self)`  
Get the text as string

`get_unitless_position(self)`  
Return the unitless position of the text as a tuple (x, y)

`get_usetex(self)`  
Return whether this *Text* object uses TeX for rendering.

`get_va(self)`  
Alias for `get_verticalalignment`.

`get_variant(self)`  
Alias for `get_fontvariant`.

`get_verticalalignment(self)`  
Return the vertical alignment as string. Will be one of 'top', 'center', 'bottom' or 'baseline'.

`get_weight(self)`  
Alias for `get_fontweight`.

`get_window_extent(self, renderer=None, dpi=None)`  
Return the Bbox bounding the text, in display units.

In addition to being used internally, this is useful for specifying clickable regions in a png file on a web page.

### Parameters

**renderer** [Renderer, optional] A renderer is needed to compute the bounding box. If the artist has already been drawn, the renderer is cached; thus, it is only necessary to pass this argument when calling `get_window_extent` before the first *draw*. In practice, it is usually easier to trigger a draw first (e.g. by saving the figure).

**dpi** [float, optional] The dpi value for computing the bbox, defaults to `self.figure.dpi` (*not* the renderer dpi); should be set e.g. if to match regions with a figure saved with a custom dpi value.

`get_wrap(self)`

Return the wrapping state for the text.

`static is_math_text(s, usetex=None)`

[*Deprecated*] Returns a cleaned string and a boolean flag. The flag indicates if the given string `s` contains any mathtext, determined by counting unescaped dollar signs. If no mathtext is present, the cleaned string has its dollar signs unescaped. If `usetex` is on, the flag always has the value "TeX".

### Notes

Deprecated since version 3.1.

`set_backgroundcolor(self, color)`

Set the background color of the text by updating the bbox.

### Parameters

**color** [color]

### See also:

`set_bbox` To change the position of the bounding box

`set_bbox(self, rectprops)`

Draw a bounding box around self.

### Parameters

**rectprops** [dict with properties for `patches.FancyBboxPatch`] The default boxstyle is 'square'. The mutation scale of the `patches.FancyBboxPatch` is set to the fontsize.

### Examples

```
t.set_bbox(dict(facecolor='red', alpha=0.5))
```

`set_c(self, color)`

Alias for `set_color`.

`set_clip_box(self, clipbox)`

Set the artist's clip *Bbox*.

### Parameters

**clipbox** [*Bbox*]

`set_clip_on(self, b)`

Set whether the artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

### Parameters

**b** [bool]

`set_clip_path(self, path, transform=None)`

Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- *None*, to remove a previously set clipping path.

For efficiency, if the path happens to be an axis-aligned rectangle, this method will set the clipping box to the corresponding rectangle and set the clipping path to *None*.

ACCEPTS: [(*Path*, *Transform*) | *Patch* | *None*]

`set_color(self, color)`

Set the foreground color of the text

### Parameters

**color** [color]

`set_family(self, fontname)`

Alias for `set_fontfamily`.

`set_font_properties(self, fp)`

Alias for `set_fontproperties`.

`set_fontfamily(self, fontname)`

Set the font family. May be either a single string, or a list of strings in decreasing priority. Each string may be either a real font name or a generic font class name. If the latter, the specific font names will be looked up in the corresponding rcParams.

If a *Text* instance is constructed with `fontfamily=None`, then the font is set to `rcParams["font.family"]`, and the same is done when `set_fontfamily()` is called on an existing *Text* instance.

### Parameters

**fontname** [{FONTNAME, 'serif', 'sans-serif', 'cursive', 'fantasy', 'monospace'}]

### See also:

`font_manager.FontProperties.set_family`

`set_fontname(self, fontname)`

Alias for `set_family`.

One-way alias only: the getter differs.

### Parameters

**fontname** [{FONTNAME, 'serif', 'sans-serif', 'cursive', 'fantasy', 'monospace'}]

### See also:

`font_manager.FontProperties.set_family`

`set_fontproperties(self, fp)`

Set the font properties that control the text.

**Parameters**

**fp** [*font\_manager.FontProperties*]

`set_fontsize(self, fontsize)`

Set the font size. May be either a size string, relative to the default font size, or an absolute font size in points.

**Parameters**

**fontsize** [{size in points, 'xx-small', 'x-small', 'small', 'medium', 'large', 'x-large', 'xx-large'}]

**See also:**

*font\_manager.FontProperties.set\_size*

`set_fontstretch(self, stretch)`

Set the font stretch (horizontal condensation or expansion).

**Parameters**

**stretch** [{a numeric value in range 0-1000, 'ultra-condensed', 'extra-condensed', 'condensed', 'semi-condensed', 'normal', 'semi-expanded', 'expanded', 'extra-expanded', 'ultra-expanded'}]

**See also:**

*font\_manager.FontProperties.set\_stretch*

`set_fontstyle(self, fontstyle)`

Set the font style.

**Parameters**

**fontstyle** [{'normal', 'italic', 'oblique'}]

**See also:**

*font\_manager.FontProperties.set\_style*

`set_fontvariant(self, variant)`

Set the font variant, either 'normal' or 'small-caps'.

**Parameters**

**variant** [{'normal', 'small-caps'}]

**See also:**

*font\_manager.FontProperties.set\_variant*

`set_fontweight(self, weight)`

Set the font weight.

**Parameters**

**weight** [{a numeric value in range 0-1000, 'ultralight', 'light', 'normal', 'regular', 'book', 'medium', 'roman', 'semibold', 'demibold', 'demi', 'bold', 'heavy', 'extra bold', 'black'}]

**See also:**

`font_manager.FontProperties.set_weight`

`set_ha(self, align)`

Alias for `set_horizontalalignment`.

`set_horizontalalignment(self, align)`

Set the horizontal alignment to one of

#### Parameters

**align** [ {'center', 'right', 'left'} ]

`set_linespacing(self, spacing)`

Set the line spacing as a multiple of the font size. Default is 1.2.

#### Parameters

**spacing** [float (multiple of font size)]

`set_ma(self, align)`

Alias for `set_multialignment`.

`set_multialignment(self, align)`

Set the alignment for multiple lines layout. The layout of the bounding box of all the lines is determined by the `horizontalalignment` and `verticalalignment` properties, but the multiline text within that box can be

#### Parameters

**align** [ {'left', 'right', 'center'} ]

`set_name(self, fontname)`

Alias for `set_fontname`.

`set_position(self, xy)`

Set the (x, y) position of the text.

#### Parameters

**xy** [(float, float)]

`set_rotation(self, s)`

Set the rotation of the text.

#### Parameters

**s** [ {angle in degrees, 'vertical', 'horizontal'} ]

`set_rotation_mode(self, m)`

Set text rotation mode.

#### Parameters

**m** [ {None, 'default', 'anchor'} ] If None or "default", the text will be first rotated, then aligned according to their horizontal and vertical alignments. If "anchor", then alignment occurs before rotation.

`set_size(self, fontsize)`

Alias for `set_fontsize`.

`set_stretch(self, stretch)`

Alias for `set_fontstretch`.

`set_style(self, fontstyle)`

Alias for `set_fontstyle`.

`set_text(self, s)`

Set the text string *s*.

It may contain newlines (`\n`) or math in LaTeX syntax.

**Parameters**

**s** [object] Any object gets converted to its `str`, except `None` which becomes `''`.

`set_usetex(self, usetex)`

**Parameters**

**usetex** [bool or None] Whether to render using TeX, `None` means to use `rcParams["text.usetex"]`.

`set_va(self, align)`

Alias for `set_verticalalignment`.

`set_variant(self, variant)`

Alias for `set_fontvariant`.

`set_verticalalignment(self, align)`

Set the vertical alignment

**Parameters**

**align** [{'center', 'top', 'bottom', 'baseline', 'center\_baseline'}]

`set_weight(self, weight)`

Alias for `set_fontweight`.

`set_wrap(self, wrap)`

Set the wrapping state for the text.

**Parameters**

**wrap** [bool]

`set_x(self, x)`

Set the x position of the text.

**Parameters**

**x** [float]

`set_y(self, y)`

Set the y position of the text.

**Parameters**

**y** [float]

`update(self, kwargs)`

Update properties from a dictionary.

`update_bbox_position_size(self, renderer)`

Update the location and the size of the bbox.

This method should be used when the position and size of the bbox needs to be updated before actually drawing the bbox.

`update_from(self, other)`

Copy properties from *other* to *self*.

`zorder = 3`

```
class matplotlib.text.TextWithDash(**kwargs)
```

Bases: `matplotlib.text.Text`

[*Deprecated*] This is basically a `Text` with a dash (drawn with a `Line2D`) before/after it. It is intended to be a drop-in replacement for `Text`, and should behave identically to it when `dashlength = 0.0`.

The dash always comes between the point specified by `set_position()` and the text. When a dash exists, the text alignment arguments (`horizontalalignment`, `verticalalignment`) are ignored.

`dashlength` is the length of the dash in canvas units. (default = 0.0).

`dashdirection` is one of 0 or 1, where 0 draws the dash after the text and 1 before. (default = 0).

`dashrotation` specifies the rotation of the dash, and should generally stay `None`. In this case `get_dashrotation()` returns `get_rotation()`. (i.e., the dash takes its rotation from the text's rotation). Because the text center is projected onto the dash, major deviations in the rotation cause what may be considered visually unappealing results. (default = `None`)

`dashpad` is a padding length to add (or subtract) space between the text and the dash, in canvas units. (default = 3)

`dashpush` "pushes" the dash and text away from the point specified by `set_position()` by the amount in canvas units. (default = 0)

---

**Note:** The alignment of the two objects is based on the bounding box of the `Text`, as obtained by `get_window_extent()`. This, in turn, appears to depend on the font metrics as given by the rendering backend. Hence the quality of the "centering" of the label text with respect to the dash varies depending on the backend used.

---



---

**Note:** I'm not sure that I got the `get_window_extent()` right, or whether that's sufficient for providing the object bounding box.

---

## Notes

Deprecated since version 3.1.

`draw(self, renderer)`

Draw the `TextWithDash` object to the given `renderer`.

`get_dashdirection(self)`

Get the direction dash. 1 is before the text and 0 is after.

`get_dashlength(self)`

Get the length of the dash.

`get_dashpad(self)`

Get the extra spacing between the dash and the text, in canvas units.

`get_dashpush(self)`

Get the extra spacing between the dash and the specified text position, in canvas units.

`get_dashrotation(self)`

Get the rotation of the dash in degrees.

`get_figure(self)`

return the figure instance the artist belongs to

`get_position(self)`

Return the position of the text as a tuple (x, y)

`get_prop_tup(self, renderer=None)`

Return a hashable tuple of properties.

Not intended to be human readable, but useful for backends who want to cache derived information about text (e.g., layouts) and need to know if the text has changed.

`get_unitless_position(self)`

Return the unitless position of the text as a tuple (x, y)

`get_window_extent(self, renderer=None)`

Return a *Bbox* object bounding the text, in display units.

In addition to being used internally, this is useful for specifying clickable regions in a png file on a web page.

*renderer* defaults to the *\_renderer* attribute of the text object. This is not assigned until the first execution of *draw()*, so you must use this kwarg if you want to call *get\_window\_extent()* prior to the first *draw()*. For getting web page regions, it is simpler to call the method after saving the figure.

`set_dashdirection(self, dd)`

Set the direction of the dash following the text. 1 is before the text and 0 is after. The default is 0, which is what you'd want for the typical case of ticks below and on the left of the figure.

**Parameters**

**dd** [int (1 is before, 0 is after)]

`set_dashlength(self, dl)`

Set the length of the dash, in canvas units.

**Parameters**

**dl** [float]

`set_dashpad(self, dp)`

Set the "pad" of the TextWithDash, which is the extra spacing between the dash and the text, in canvas units.

**Parameters**

**dp** [float]

`set_dashpush(self, dp)`

Set the "push" of the TextWithDash, which is the extra spacing between the beginning of the dash and the specified position.

**Parameters**

**dp** [float]

`set_dashrotation(self, dr)`

Set the rotation of the dash, in degrees.

**Parameters**

**dr** [float]

`set_figure(self, fig)`  
Set the figure instance the artist belongs to.

**Parameters**

**fig** [matplotlib.figure.Figure]

`set_position(self, xy)`  
Set the (x, y) position of the *TextWithDash*.

**Parameters**

**xy** [(float, float)]

`set_transform(self, t)`  
Set the *matplotlib.transforms.Transform* instance used by this artist.

**Parameters**

**t** [matplotlib.transforms.Transform]

`set_x(self, x)`  
Set the x position of the *TextWithDash*.

**Parameters**

**x** [float]

`set_y(self, y)`  
Set the y position of the *TextWithDash*.

**Parameters**

**y** [float]

`update_coords(self, renderer)`  
Computes the actual x, y coordinates for text based on the input x, y and the *dash-length*. Since the rotation is with respect to the actual canvas's coordinates we need to map back and forth.

`matplotlib.text.get_rotation(rotation)`  
Return the text angle as float between 0 and 360 degrees.

*rotation* may be 'horizontal', 'vertical', or a numeric value in degrees.

## 17.48 matplotlib.textpath

`class matplotlib.textpath.TextPath(xy, s, size=None, prop=None, _interpolation_steps=1, usetex=False, *args, **kwargs)`

Bases: *matplotlib.path.Path*

Create a path from the text.

Create a path from the text. Note that it simply is a path, not an artist. You need to use the *PathPatch* (or other artists) to draw this path onto the canvas.

**Parameters**

**xy** [tuple or array of two float values] Position of the text. For no offset, use `xy=(0, 0)`.

- s** [str] The text to convert to a path.
- size** [float, optional] Font size in points. Defaults to the size specified via the font properties *prop*.
- prop** [*matplotlib.font\_manager.FontProperties*, optional] Font property. If not provided, will use a default *FontProperties* with parameters from the *rcParams*.
- \_interpolation\_steps** [integer, optional] (Currently ignored)
- usetex** [bool, optional] Whether to use tex rendering. Defaults to `False`.

### Examples

The following creates a path from the string "ABC" with Helvetica font face; and another path from the latex fraction 1/2:

```
from matplotlib.textpath import TextPath
from matplotlib.font_manager import FontProperties

fp = FontProperties(family="Helvetica", style="italic")
path1 = TextPath((12,12), "ABC", size=12, prop=fp)
path2 = TextPath((0,0), r"$\frac{1}{2}$", size=12, usetex=True)
```

Also see `/gallery/text_labels_and_annotations/demo_text_path`.

#### codes

Return the codes

#### `get_size(self)`

Get the text size.

#### `is_math_text(self, s)`

[*Deprecated*] Returns True if the given string *s* contains any mathtext.

### Notes

Deprecated since version 3.1.

#### `set_size(self, size)`

Set the text size.

#### `text_get_vertices_codes(self, prop, s, usetex)`

[*Deprecated*] Convert string *s* to a (vertices, codes) pair using font property *prop*.

### Notes

Deprecated since version 3.1.

#### vertices

Return the cached path after updating it if necessary.

`class matplotlib.textpath.TextToPath`

Bases: `object`

A class that converts strings to paths.

DPI = 72

FONT\_SCALE = 100.0

`get_glyphs_mathtext(self, prop, s, glyph_map=None, return_new_glyphs_only=False)`

Parse mathtext string *s* and convert it to a (vertices, codes) pair.

`get_glyphs_tex(self, prop, s, glyph_map=None, return_new_glyphs_only=False)`

Convert the string *s* to vertices and codes using usetex mode.

`get_glyphs_with_font(self, font, s, glyph_map=None, return_new_glyphs_only=False)`

Convert string *s* to vertices and codes using the provided ttf font.

`get_texmanager(self)`

Return the cached TexManager instance.

`get_text_path(self, prop, s, ismath=False, usetex=<deprecated parameter>)`

Convert text *s* to path (a tuple of vertices and codes for `matplotlib.path.Path`).

### Parameters

**prop** [`matplotlib.font_manager.FontProperties` instance] The font properties for the text.

**s** [str] The text to be converted.

**ismath** [{False, True, "TeX"}] If True, use mathtext parser. If "TeX", use tex for rendering.

**usetex** [bool, optional] If set, forces *ismath* to True. This parameter is deprecated.

### Returns

**verts, codes** [tuple of lists] *verts* is a list of numpy arrays containing the x and y coordinates of the vertices. *codes* is a list of path codes.

### Examples

Create a list of vertices and codes from a text, and create a Path from those:

```
from matplotlib.path import Path
from matplotlib.textpath import TextToPath
from matplotlib.font_manager import FontProperties

fp = FontProperties(family="Humor Sans", style="italic")
verts, codes = TextToPath().get_text_path(fp, "ABC")
path = Path(verts, codes, closed=False)
```

Also see `TextPath` for a more direct way to create a path from a text.

`get_text_width_height_descent(self, s, prop, ismath)`

`glyph_to_path(self, font, currx=0.0)`

[*Deprecated*] Convert the *font*'s current glyph to a (vertices, codes) pair.

### Notes

Deprecated since version 3.1.

`tex_font_map`  
[*Deprecated*]

### Notes

Deprecated since version 3.0:

## 17.49 matplotlib.ticker

### 17.49.1 Tick locating and formatting

This module contains classes to support completely configurable tick locating and formatting. Although the locators know nothing about major or minor ticks, they are used by the Axis class to support major and minor tick locating and formatting. Generic tick locators and formatters are provided, as well as domain specific custom ones.

#### Default Formatter

The default formatter identifies when the x-data being plotted is a small range on top of a large offset. To reduce the chances that the ticklabels overlap, the ticks are labeled as deltas from a fixed offset. For example:

```
ax.plot(np.arange(2000, 2010), range(10))
```

will have tick of 0-9 with an offset of +2e3. If this is not desired turn off the use of the offset on the default formatter:

```
ax.get_xaxis().get_major_formatter().set_useOffset(False)
```

set the rcParam `axes.formatter.useoffset=False` to turn it off globally, or set a different formatter.

#### Tick locating

The Locator class is the base class for all tick locators. The locators handle autoscaling of the view limits based on the data limits, and the choosing of tick locations. A useful semi-automatic tick locator is *MultipleLocator*. It is initialized with a base, e.g., 10, and it picks axis limits and ticks that are multiples of that base.

The Locator subclasses defined here are

*AutoLocator* *MaxNLocator* with simple defaults. This is the default tick locator for most plotting.

*MaxNLocator* Finds up to a max number of intervals with ticks at nice locations.

*LinearLocator* Space ticks evenly from min to max.

*LogLocator* Space ticks logarithmically from min to max.

*MultipleLocator* Ticks and range are a multiple of base; either integer or float.

*FixedLocator* Tick locations are fixed.

*IndexLocator* Locator for index plots (e.g., where  $x = \text{range}(\text{len}(y))$ ).

*NullLocator* No ticks.

*SymmetricalLogLocator* Locator for use with with the symlog norm; works like *LogLocator* for the part outside of the threshold and adds 0 if inside the limits.

*LogitLocator* Locator for logit scaling.

*OldAutoLocator* Choose a *MultipleLocator* and dynamically reassign it for intelligent ticking during navigation.

*AutoMinorLocator* Locator for minor ticks when the axis is linear and the major ticks are uniformly spaced. Subdivides the major tick interval into a specified number of minor intervals, defaulting to 4 or 5 depending on the major interval.

There are a number of locators specialized for date locations - see the `dates` module.

You can define your own locator by deriving from `Locator`. You must override the `__call__` method, which returns a sequence of locations, and you will probably want to override the `autoscale` method to set the view limits from the data limits.

If you want to override the default locator, use one of the above or a custom locator and pass it to the x or y axis instance. The relevant methods are:

```
ax.xaxis.set_major_locator(xmajor_locator)
ax.xaxis.set_minor_locator(xminor_locator)
ax.yaxis.set_major_locator(ymajor_locator)
ax.yaxis.set_minor_locator(yminor_locator)
```

The default minor locator is *NullLocator*, i.e., no minor ticks on by default.

## Tick formatting

Tick formatting is controlled by classes derived from `Formatter`. The formatter operates on a single tick value and returns a string to the axis.

*NullFormatter* No labels on the ticks.

*IndexFormatter* Set the strings from a list of labels.

*FixedFormatter* Set the strings manually for the labels.

*FuncFormatter* User defined function sets the labels.

*StrMethodFormatter* Use string `format` method.

*FormatStrFormatter* Use an old-style `sprintf` format string.

*ScalarFormatter* Default formatter for scalars: autopick the format string.

*LogFormatter* Formatter for log axes.

*LogFormatterExponent* Format values for log axis using `exponent = log_base(value)`.

*LogFormatterMathtext* Format values for log axis using `exponent = log_base(value)` using `Math` text.

*LogFormatterSciNotation* Format values for log axis using scientific notation.

*LogitFormatter* Probability formatter.

*EngFormatter* Format labels in engineering notation

*PercentFormatter* Format labels as a percentage

You can derive your own formatter from the `Formatter` base class by simply overriding the `__call__` method. The formatter class has access to the axis view and data limits.

To control the major and minor tick label formats, use one of the following methods:

```
ax.xaxis.set_major_formatter(xmajor_formatter)
ax.xaxis.set_minor_formatter(xminor_formatter)
ax.yaxis.set_major_formatter(ymajor_formatter)
ax.yaxis.set_minor_formatter(yminor_formatter)
```

See `/gallery/ticks_and_spines/major_minor_demo` for an example of setting major and minor ticks. See the `matplotlib.dates` module for more information and examples of using date locators and formatters.

```
class matplotlib.ticker.TickHelper
```

```
    Bases: object
```

```
    axis = None
```

```
    create_dummy_axis(self, **kwargs)
```

```
    set_axis(self, axis)
```

```
    set_bounds(self, vmin, vmax)
```

```
    set_data_interval(self, vmin, vmax)
```

```
    set_view_interval(self, vmin, vmax)
```

```
class matplotlib.ticker.Formatter
```

```
    Bases: matplotlib.ticker.TickHelper
```

Create a string based on a tick value and location.

```
    fix_minus(self, s)
```

Some classes may want to replace a hyphen for minus with the proper unicode symbol (U+2212) for typographical correctness. The default is to not replace it.

Note, if you use this method, e.g., in `format_data()` or call, you probably don't want to use it for `format_data_short()` since the toolbar uses this for interactive coord reporting and I doubt we can expect GUIs across platforms will handle the unicode correctly. So for now the classes that override `fix_minus()` should have an explicit `format_data_short()` method

```
    format_data(self, value)
```

Returns the full string representation of the value with the position unspecified.

```
    format_data_short(self, value)
```

Return a short string version of the tick value.

Defaults to the position-independent long value.

```
    format_ticks(self, values)
```

Return the tick labels for all the ticks at once.

```
    get_offset(self)
```

```
    locs = []
```

```
set_locs(self, locs)
```

```
class matplotlib.ticker.FixedFormatter(seq)
```

Bases: *matplotlib.ticker.Formatter*

Return fixed strings for tick labels based only on position, not value.

Set the sequence of strings that will be used for labels.

```
get_offset(self)
```

```
set_offset_string(self, ofs)
```

```
class matplotlib.ticker.NullFormatter
```

Bases: *matplotlib.ticker.Formatter*

Always return the empty string.

```
class matplotlib.ticker.FuncFormatter(func)
```

Bases: *matplotlib.ticker.Formatter*

Use a user-defined function for formatting.

The function should take in two inputs (a tick value *x* and a position *pos*), and return a string containing the corresponding tick label.

```
class matplotlib.ticker.FormatStrFormatter(fmt)
```

Bases: *matplotlib.ticker.Formatter*

Use an old-style ('%' operator) format string to format the tick.

The format string should have a single variable format (%) in it. It will be applied to the value (not the position) of the tick.

```
class matplotlib.ticker.StrMethodFormatter(fmt)
```

Bases: *matplotlib.ticker.Formatter*

Use a new-style format string (as used by `str.format()`) to format the tick.

The field used for the value must be labeled *x* and the field used for the position must be labeled *pos*.

```
class matplotlib.ticker.ScalarFormatter(useOffset=None, useMathText=None, useLocale=None)
```

Bases: *matplotlib.ticker.Formatter*

Format tick values as a number.

Tick value is interpreted as a plain old number. If `useOffset==True` and the data range is much smaller than the data average, then an offset will be determined such that the tick labels are meaningful. Scientific notation is used for data  $< 10^{-n}$  or data  $\geq 10^m$ , where *n* and *m* are the power limits set using `set_powerlimits((n,m))`. The defaults for these are controlled by the `axes.formatter.limits` rc parameter.

```
fix_minus(self, s)
```

Replace hyphens with a unicode minus.

```
format_data(self, value)
```

Return a formatted string representation of a number.

```
format_data_short(self, value)
```

Return a short formatted string representation of a number.

```
get_offset(self)
```

Return scientific notation, plus offset.

```
get_useLocale(self)
get_useMathText(self)
get_useOffset(self)
pprint_val(self, x)
    [Deprecated]
```

### Notes

Deprecated since version 3.1:

```
set_locs(self, locs)
    Set the locations of the ticks.

set_powerlimits(self, lims)
    Sets size thresholds for scientific notation.
```

### Parameters

**lims** [(min\_exp, max\_exp)] A tuple containing the powers of 10 that determine the switchover threshold. Numbers below  $10^{\text{min\_exp}}$  and above  $10^{\text{max\_exp}}$  will be displayed in scientific notation.

For example, `formatter.set_powerlimits((-3, 4))` sets the pre-2007 default in which scientific notation is used for numbers less than  $1e^{-3}$  or greater than  $1e^4$ .

### See also:

*ScalarFormatter.set\_scientific*

```
set_scientific(self, b)
    Turn scientific notation on or off.
```

### See also:

*ScalarFormatter.set\_powerlimits*

```
set_useLocale(self, val)
set_useMathText(self, val)
set_useOffset(self, val)
useLocale
useMathText
useOffset
```

```
class matplotlib.ticker.LogFormatter(base=10.0, labelOnlyBase=False, mi-
                                     nor_thresholds=None, linthresh=None)
    Bases: matplotlib.ticker.Formatter
```

Base class for formatting ticks on a log or symlog scale.

It may be instantiated directly, or subclassed.

### Parameters

**base** [float, optional, default: 10.] Base of the logarithm used in all calculations.

**labelOnlyBase** [bool, optional, default: False] If True, label ticks only at integer powers of base. This is normally True for major ticks and False for minor ticks.

**minor\_thresholds** [(subset, all), optional, default: (1, 0.4)] If labelOnlyBase is False, these two numbers control the labeling of ticks that are not at integer powers of base; normally these are the minor ticks. The controlling parameter is the log of the axis data range. In the typical case where base is 10 it is the number of decades spanned by the axis, so we can call it 'numdec'. If  $\text{numdec} \leq \text{all}$ , all minor ticks will be labeled. If  $\text{all} < \text{numdec} \leq \text{subset}$ , then only a subset of minor ticks will be labeled, so as to avoid crowding. If  $\text{numdec} > \text{subset}$  then no minor ticks will be labeled.

**linthresh** [None or float, optional, default: None] If a symmetric log scale is in use, its `linthresh` parameter must be supplied here.

## Notes

The `set_locs` method must be called to enable the subsetting logic controlled by the `minor_thresholds` parameter.

In some cases such as the colorbar, there is no distinction between major and minor ticks; the tick locations might be set manually, or by a locator that puts ticks at integer powers of base and at intermediate locations. For this situation, disable the `minor_thresholds` logic by using `minor_thresholds=(np.inf, np.inf)`, so that all ticks will be labeled.

To disable labeling of minor ticks when 'labelOnlyBase' is False, use `minor_thresholds=(0, 0)`. This is the default for the "classic" style.

## Examples

To label a subset of minor ticks when the view limits span up to 2 decades, and all of the ticks when zoomed in to 0.5 decades or less, use `minor_thresholds=(2, 0.5)`.

To label all minor ticks when the view limits span up to 1.5 decades, use `minor_thresholds=(1.5, 1.5)`.

`base(self, base)`  
Change the *base* for labeling.

**Warning:** Should always match the base used for *LogLocator*

`format_data(self, value)`  
Returns the full string representation of the value with the position unspecified.

`format_data_short(self, value)`  
Return a short formatted string representation of a number.

`label_minor(self, labelOnlyBase)`  
Switch minor tick labeling on or off.

### Parameters

**labelOnlyBase** [bool] If True, label ticks only at integer powers of base.

```
pprint_val(self, *args, **kwargs)
    [Deprecated]
```

### Notes

Deprecated since version 3.1:

```
set_locs(self, locs=None)
    Use axis view limits to control which ticks are labeled.
```

The *locs* parameter is ignored in the present algorithm.

```
class matplotlib.ticker.LogFormatterExponent(base=10.0, labelOnlyBase=False, minor_thresholds=None, linthresh=None)
```

Bases: *matplotlib.ticker.LogFormatter*

Format values for log axis using `exponent = log_base(value)`.

```
class matplotlib.ticker.LogFormatterMathtext(base=10.0, labelOnlyBase=False, minor_thresholds=None, linthresh=None)
```

Bases: *matplotlib.ticker.LogFormatter*

Format values for log axis using `exponent = log_base(value)`.

```
class matplotlib.ticker.IndexFormatter(labels)
```

Bases: *matplotlib.ticker.Formatter*

Format the position *x* to the nearest *i*-th label where  $i = \text{int}(x + 0.5)$ . Positions where  $i < 0$  or  $i > \text{len}(\text{list})$  have no tick labels.

### Parameters

**labels** [list] List of labels.

```
class matplotlib.ticker.LogFormatterSciNotation(base=10.0, labelOnlyBase=False, minor_thresholds=None, linthresh=None)
```

Bases: *matplotlib.ticker.LogFormatterMathtext*

Format values following scientific notation in a logarithmic axis.

```
class matplotlib.ticker.LogitFormatter
    Bases: matplotlib.ticker.Formatter
```

Probability formatter (using Math text).

```
format_data_short(self, value)
    return a short formatted string representation of a number
```

```
class matplotlib.ticker.EngFormatter(unit="", places=None, sep=' ', *, usetex=None, useMathText=None)
```

Bases: *matplotlib.ticker.Formatter*

Formats axis values using engineering prefixes to represent powers of 1000, plus a specified unit, e.g., 10 MHz instead of  $1e7$ .

### Parameters

**unit** [str (default: "")] Unit symbol to use, suitable for use with single-letter representations of powers of 1000. For example, 'Hz' or 'm'.

**places** [int (default: None)] Precision with which to display the number, specified in digits after the decimal point (there will be between one and three digits before the decimal point). If it is None, the formatting falls back to the floating point format '%g', which displays up to 6 *significant* digits, i.e. the equivalent value for *places* varies between 0 and 5 (inclusive).

**sep** [str (default: " ")] Separator used between the value and the prefix/unit. For example, one get '3.14 mV' if *sep* is " " (default) and '3.14mV' if *sep* is "". Besides the default behavior, some other useful options may be:

- `sep=""` to append directly the prefix/unit to the value;
- `sep="\N{THIN SPACE}"` (U+2009);
- `sep="\N{NARROW NO-BREAK SPACE}"` (U+202F);
- `sep="\N{NO-BREAK SPACE}"` (U+00A0).

**usetex** [bool (default: None)] To enable/disable the use of TeX's math mode for rendering the numbers in the formatter.

**useMathText** [bool (default: None)] To enable/disable the use `mathtext` for rendering the numbers in the formatter.

`ENG_PREFIXES = {-24: 'y', -21: 'z', -18: 'a', -15: 'f', -12: 'p', -9: 'n', -6: 'μ', -3: 'm', 0:`

`fix_minus(self, s)`

Replace hyphens with a unicode minus.

`format_eng(self, num)`

Formats a number in engineering notation, appending a letter representing the power of 1000 of the original number. Some examples:

```
>>> format_eng(0)           # for self.places = 0
'0'
```

```
>>> format_eng(1000000) # for self.places = 1
'1.0 M'
```

```
>>> format_eng("-1e-6") # for self.places = 2
'-1.00 μ'
```

`get_useMathText(self)`

`get_usetex(self)`

`set_useMathText(self, val)`

`set_usetex(self, val)`

`useMathText`

`usetex`

`class matplotlib.ticker.PercentFormatter(xmax=100, decimals=None, symbol='%', is_latex=False)`

Bases: `matplotlib.ticker.Formatter`

Format numbers as a percentage.

**Parameters**

**xmax** [float] Determines how the number is converted into a percentage. *xmax* is the data value that corresponds to 100%. Percentages are computed as  $x / xmax * 100$ . So if the data is already scaled to be percentages, *xmax* will be 100. Another common situation is where *xmax* is 1.0.

**decimals** [None or int] The number of decimal places to place after the point. If *None* (the default), the number will be computed automatically.

**symbol** [string or None] A string that will be appended to the label. It may be *None* or empty to indicate that no symbol should be used. LaTeX special characters are escaped in *symbol* whenever latex mode is enabled, unless *is\_latex* is *True*.

**is\_latex** [bool] If *False*, reserved LaTeX characters in *symbol* will be escaped.

`convert_to_pct(self, x)`

`format_pct(self, x, display_range)`

Formats the number as a percentage number with the correct number of decimals and adds the percent symbol, if any.

If `self.decimals` is *None*, the number of digits after the decimal point is set based on the `display_range` of the axis as follows:

display_range	decimals	sample
>50	0	x = 34.5 => 35%
>5	1	x = 34.5 => 34.5%
>0.5	2	x = 34.5 => 34.50%
...	...	...

This method will not be very good for tiny axis ranges or extremely large ones. It assumes that the values on the chart are percentages displayed on a reasonable scale.

`symbol`

The configured percent symbol as a string.

If LaTeX is enabled via `rcParams["text.usetex"]`, the special characters `{'#, '$', '%', '&', '~', '_', '^', '\\', '{', '}'}` are automatically escaped in the string.

`class matplotlib.ticker.Locator`

Bases: `matplotlib.ticker.TickHelper`

Determine the tick locations;

Note that the same locator should not be used across multiple *Axis* because the locator stores references to the *Axis* data and view limits.

`MAXTICKS = 1000`

`autoscale(self)`

autoscale the view limits

`nonsingular(self, v0, v1)`

Expand a range as needed to avoid singularities.

`pan(self, numsteps)`

Pan numticks (can be positive or negative)

`raise_if_exceeds(self, locs)`

raise a RuntimeError if Locator attempts to create more than MAXTICKS locs

`refresh(self)`

refresh internal information based on current lim

`set_params(self, **kwargs)`

Do nothing, and raise a warning. Any locator class not supporting the `set_params()` function will call this.

`tick_values(self, vmin, vmax)`

Return the values of the located ticks given **vmin** and **vmax**.

---

**Note:** To get tick locations with the `vmin` and `vmax` values defined automatically for the associated axis simply call the Locator instance:

```
>>> print(type(loc))
<type 'Locator'>
>>> print(loc())
[1, 2, 3, 4]
```

`view_limits(self, vmin, vmax)`

Select a scale for the range from `vmin` to `vmax`.

Subclasses should override this method to change locator behaviour.

`zoom(self, direction)`

Zoom in/out on axis; if `direction` is `>0` zoom in, else zoom out

`class matplotlib.ticker.IndexLocator(base, offset)`

Bases: `matplotlib.ticker.Locator`

Place a tick on every multiple of some base number of points plotted, e.g., on every 5th point. It is assumed that you are doing index plotting; i.e., the axis is `0, len(data)`. This is mainly useful for x ticks.

place ticks on the `i`-th data points where  $(i - \text{offset}) \% \text{base} == 0$

`set_params(self, base=None, offset=None)`

Set parameters within this locator

`tick_values(self, vmin, vmax)`

Return the values of the located ticks given **vmin** and **vmax**.

---

**Note:** To get tick locations with the `vmin` and `vmax` values defined automatically for the associated axis simply call the Locator instance:

```
>>> print(type(loc))
<type 'Locator'>
>>> print(loc())
[1, 2, 3, 4]
```

```
class matplotlib.ticker.FixedLocator(locs, nbins=None)
```

```
    Bases: matplotlib.ticker.Locator
```

Tick locations are fixed. If *nbins* is not *None*, the array of possible positions will be subsampled to keep the number of ticks  $\leq$  *nbins* + 1. The subsampling will be done so as to include the smallest absolute value; for example, if zero is included in the array of possibilities, then it is guaranteed to be one of the chosen ticks.

```
    set_params(self, nbins=None)
```

```
        Set parameters within this locator.
```

```
    tick_values(self, vmin, vmax)
```

```
        " Return the locations of the ticks.
```

---

**Note:** Because the values are fixed, *vmin* and *vmax* are not used in this method.

---

```
class matplotlib.ticker.NullLocator
```

```
    Bases: matplotlib.ticker.Locator
```

```
    No ticks
```

```
    tick_values(self, vmin, vmax)
```

```
        " Return the locations of the ticks.
```

---

**Note:** Because the values are *Null*, *vmin* and *vmax* are not used in this method.

---

```
class matplotlib.ticker.LinearLocator(numticks=None, presets=None)
```

```
    Bases: matplotlib.ticker.Locator
```

```
    Determine the tick locations
```

The first time this function is called it will try to set the number of ticks to make a nice tick partitioning. Thereafter the number of ticks will be fixed so that interactive navigation will be nice

Use *presets* to set *locs* based on *lom*. A dict mapping *vmin, vmax*->*locs*

```
    set_params(self, numticks=None, presets=None)
```

```
        Set parameters within this locator.
```

```
    tick_values(self, vmin, vmax)
```

```
        Return the values of the located ticks given vmin and vmax.
```

---

**Note:** To get tick locations with the *vmin* and *vmax* values defined automatically for the associated axis simply call the *Locator* instance:

```
>>> print(type(loc))
<type 'Locator'>
>>> print(loc())
[1, 2, 3, 4]
```

```
    view_limits(self, vmin, vmax)
```

```
        Try to choose the view limits intelligently
```

```
class matplotlib.ticker.LogLocator(base=10.0, subs=(1.0, ), numdecs=4,
                                  numticks=None)
```

Bases: *matplotlib.ticker.Locator*

Determine the tick locations for log axes

Place ticks on the locations :  $\text{subs}[j] * \text{base}^{*i}$

### Parameters

**subs** [None, string, or sequence of float, optional, default (1.0,)] Gives the multiples of integer powers of the base at which to place ticks. The default places ticks only at integer powers of the base. The permitted string values are 'auto' and 'all', both of which use an algorithm based on the axis view limits to determine whether and how to put ticks between integer powers of the base. With 'auto', ticks are placed only between integer powers; with 'all', the integer powers are included. A value of None is equivalent to 'auto'.

**base**(*self*, *base*)

set the base of the log scaling (major tick every  $\text{base}^{*i}$ , *i* integer)

**nonsingular**(*self*, *vmin*, *vmax*)

Expand a range as needed to avoid singularities.

**set\_params**(*self*, *base*=None, *subs*=None, *numdecs*=None, *numticks*=None)

Set parameters within this locator.

**subs**(*self*, *subs*)

set the minor ticks for the log scaling every  $\text{base}^{*i} * \text{subs}[j]$

**tick\_values**(*self*, *vmin*, *vmax*)

Return the values of the located ticks given **vmin** and **vmax**.

---

**Note:** To get tick locations with the *vmin* and *vmax* values defined automatically for the associated axis simply call the Locator instance:

```
>>> print(type(loc))
<type 'Locator'>
>>> print(loc())
[1, 2, 3, 4]
```

**view\_limits**(*self*, *vmin*, *vmax*)

Try to choose the view limits intelligently

```
class matplotlib.ticker.AutoLocator
```

Bases: *matplotlib.ticker.MaxNLocator*

Dynamically find major tick positions. This is actually a subclass of *MaxNLocator*, with parameters *nbins* = 'auto' and *steps* = [1, 2, 2.5, 5, 10].

To know the values of the non-public parameters, please have a look to the defaults of *MaxNLocator*.

```
class matplotlib.ticker.MultipleLocator(base=1.0)
```

Bases: *matplotlib.ticker.Locator*

Set a tick on each integer multiple of a base within the view interval.

`set_params(self, base)`  
Set parameters within this locator.

`tick_values(self, vmin, vmax)`  
Return the values of the located ticks given **vmin** and **vmax**.

---

**Note:** To get tick locations with the `vmin` and `vmax` values defined automatically for the associated axis simply call the Locator instance:

```
>>> print(type(loc))
<type 'Locator'>
>>> print(loc())
[1, 2, 3, 4]
```

---

`view_limits(self, dmin, dmax)`  
Set the view limits to the nearest multiples of base that contain the data.

`class matplotlib.ticker.MaxNLocator(*args, **kwargs)`  
Bases: `matplotlib.ticker.Locator`

Select no more than N intervals at nice locations.

### Parameters

**nbins** [int or 'auto', optional, default: 10] Maximum number of intervals; one less than max number of ticks. If the string 'auto', the number of bins will be automatically determined based on the length of the axis.

**steps** [array-like, optional] Sequence of nice numbers starting with 1 and ending with 10; e.g., [1, 2, 4, 5, 10], where the values are acceptable tick multiples. i.e. for the example, 20, 40, 60 would be an acceptable set of ticks, as would 0.4, 0.6, 0.8, because they are multiples of 2. However, 30, 60, 90 would not be allowed because 3 does not appear in the list of steps.

**integer** [bool, optional, default: False] If True, ticks will take only integer values, provided at least `min_n_ticks` integers are found within the view limits.

**symmetric** [bool, optional, default: False] If True, autoscaling will result in a range symmetric about zero.

**prune** [{'lower', 'upper', 'both', None}, optional, default: None] Remove edge ticks - useful for stacked or ganged plots where the upper tick of one axes overlaps with the lower tick of the axes above it, primarily when `rcParams["axes.autolimit_mode"]` is 'round\_numbers'. If `prune=='lower'`, the smallest tick will be removed. If `prune == 'upper'`, the largest tick will be removed. If `prune == 'both'`, the largest and smallest ticks will be removed. If `prune == None`, no ticks will be removed.

**min\_n\_ticks** [int, optional, default: 2] Relax `nbins` and `integer` constraints if necessary to obtain this minimum number of ticks.

`default_params = {'integer': False, 'min_n_ticks': 2, 'nbins': 10, 'prune': None, 'steps': None,`

`set_params(self, **kwargs)`  
Set parameters for this locator.

**Parameters****nbins** [int or 'auto', optional] see *MaxNLocator***steps** [array-like, optional] see *MaxNLocator***integer** [bool, optional] see *MaxNLocator***symmetric** [bool, optional] see *MaxNLocator***prune** [{'lower', 'upper', 'both', None}, optional] see *MaxNLocator***min\_n\_ticks** [int, optional] see *MaxNLocator*`tick_values(self, vmin, vmax)`Return the values of the located ticks given **vmin** and **vmax**.**Note:** To get tick locations with the `vmin` and `vmax` values defined automatically for the associated axis simply call the Locator instance:

```
>>> print(type(loc))
<type 'Locator'>
>>> print(loc())
[1, 2, 3, 4]
```

`view_limits(self, dmin, dmax)`Select a scale for the range from `vmin` to `vmax`.

Subclasses should override this method to change locator behaviour.

`class matplotlib.ticker.AutoMinorLocator(n=None)`Bases: *matplotlib.ticker.Locator*

Dynamically find minor tick positions based on the positions of major ticks. The scale must be linear with major ticks evenly spaced.

`n` is the number of subdivisions of the interval between major ticks; e.g., `n=2` will place a single minor tick midway between major ticks.If `n` is omitted or `None`, it will be set to 5 or 4.`tick_values(self, vmin, vmax)`Return the values of the located ticks given **vmin** and **vmax**.**Note:** To get tick locations with the `vmin` and `vmax` values defined automatically for the associated axis simply call the Locator instance:

```
>>> print(type(loc))
<type 'Locator'>
>>> print(loc())
[1, 2, 3, 4]
```

`class matplotlib.ticker.SymmetricalLogLocator(transform=None, subs=None, linthresh=None, base=None)`Bases: *matplotlib.ticker.Locator*

Determine the tick locations for symmetric log axes

place ticks on the location= `base**i*subs[j]`

`set_params(self, subs=None, numticks=None)`

Set parameters within this locator.

`tick_values(self, vmin, vmax)`

Return the values of the located ticks given **vmin** and **vmax**.

---

**Note:** To get tick locations with the `vmin` and `vmax` values defined automatically for the associated axis simply call the Locator instance:

```
>>> print(type(loc))
<type 'Locator'>
>>> print(loc())
[1, 2, 3, 4]
```

---

`view_limits(self, vmin, vmax)`

Try to choose the view limits intelligently

`class matplotlib.ticker.LogitLocator(minor=False)`

Bases: `matplotlib.ticker.Locator`

Determine the tick locations for logit axes

place ticks on the logit locations

`nonsingular(self, vmin, vmax)`

Expand a range as needed to avoid singularities.

`set_params(self, minor=None)`

Set parameters within this locator.

`tick_values(self, vmin, vmax)`

Return the values of the located ticks given **vmin** and **vmax**.

---

**Note:** To get tick locations with the `vmin` and `vmax` values defined automatically for the associated axis simply call the Locator instance:

```
>>> print(type(loc))
<type 'Locator'>
>>> print(loc())
[1, 2, 3, 4]
```

---

## 17.50 matplotlib.tight\_layout

This module provides routines to adjust subplot params so that subplots are nicely fit in the figure. In doing so, only axis labels, tick labels, axes titles and offsetboxes that are anchored to axes are currently considered.

Internally, it assumes that the margins (`left_margin`, etc.) which are differences between `ax.get_tightbbox` and `ax.bbox` are independent of axes position. This may fail if `Axes.adjustable` is `datalim`. Also, This will fail for some cases (for example, left or right margin is affected by `xlabel`).

```
matplotlib.tight_layout.auto_adjust_subplotpars(fig, renderer, nrows_ncols,
                                                num1num2_list, subplot_list,
                                                ax_bbox_list=None, pad=1.08,
                                                h_pad=None, w_pad=None,
                                                rect=None)
```

Return a dict of subplot parameters to adjust spacing between subplots or `None` if resulting axes would have zero height or width.

Note that this function ignores geometry information of subplot itself, but uses what is given by the `nrows_ncols` and `num1num2_list` parameters. Also, the results could be incorrect if some subplots have `adjustable=datalim`.

### Parameters

**nrows\_ncols** [Tuple[int, int]] Number of rows and number of columns of the grid.

**num1num2\_list** [List[int]] List of numbers specifying the area occupied by the subplot

**subplot\_list** [list of subplots] List of subplots that will be used to calculate optimal subplot\_params.

**pad** [float] Padding between the figure edge and the edges of subplots, as a fraction of the font size.

**h\_pad, w\_pad** [float] Padding (height/width) between edges of adjacent subplots, as a fraction of the font size. Defaults to `pad`.

**rect** [Tuple[float, float, float, float]] [left, bottom, right, top] in normalized (0, 1) figure coordinates.

```
matplotlib.tight_layout.get_renderer(fig)
```

```
matplotlib.tight_layout.get_subplotspec_list(axes_list, grid_spec=None)
```

Return a list of subplotspec from the given list of axes.

For an instance of axes that does not support subplotspec, `None` is inserted in the list.

If `grid_spec` is given, `None` is inserted for those not from the given `grid_spec`.

```
matplotlib.tight_layout.get_tight_layout_figure(fig, axes_list, subplotspec_list,
                                                renderer, pad=1.08, h_pad=None,
                                                w_pad=None, rect=None)
```

Return subplot parameters for tight-laid-out-figure with specified padding.

### Parameters

**fig** [Figure]

**axes\_list** [list of Axes]

**subplotspec\_list** [list of *SubplotSpec*] The subplotspecs of each axes.

**renderer** [renderer]

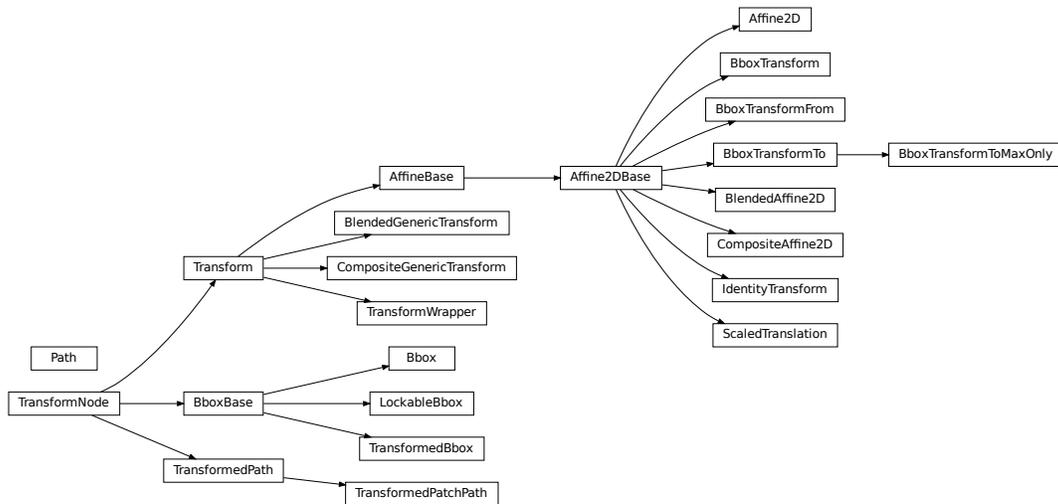
**pad** [float] Padding between the figure edge and the edges of subplots, as a fraction of the font size.

**h\_pad, w\_pad** [float] Padding (height/width) between edges of adjacent subplots. Defaults to `pad`.

**rect** [Tuple[float, float, float, float], optional] (left, bottom, right, top) rectangle in normalized figure coordinates that the whole subplots area (including labels) will fit into. Defaults to using the entire figure.

**Returns**

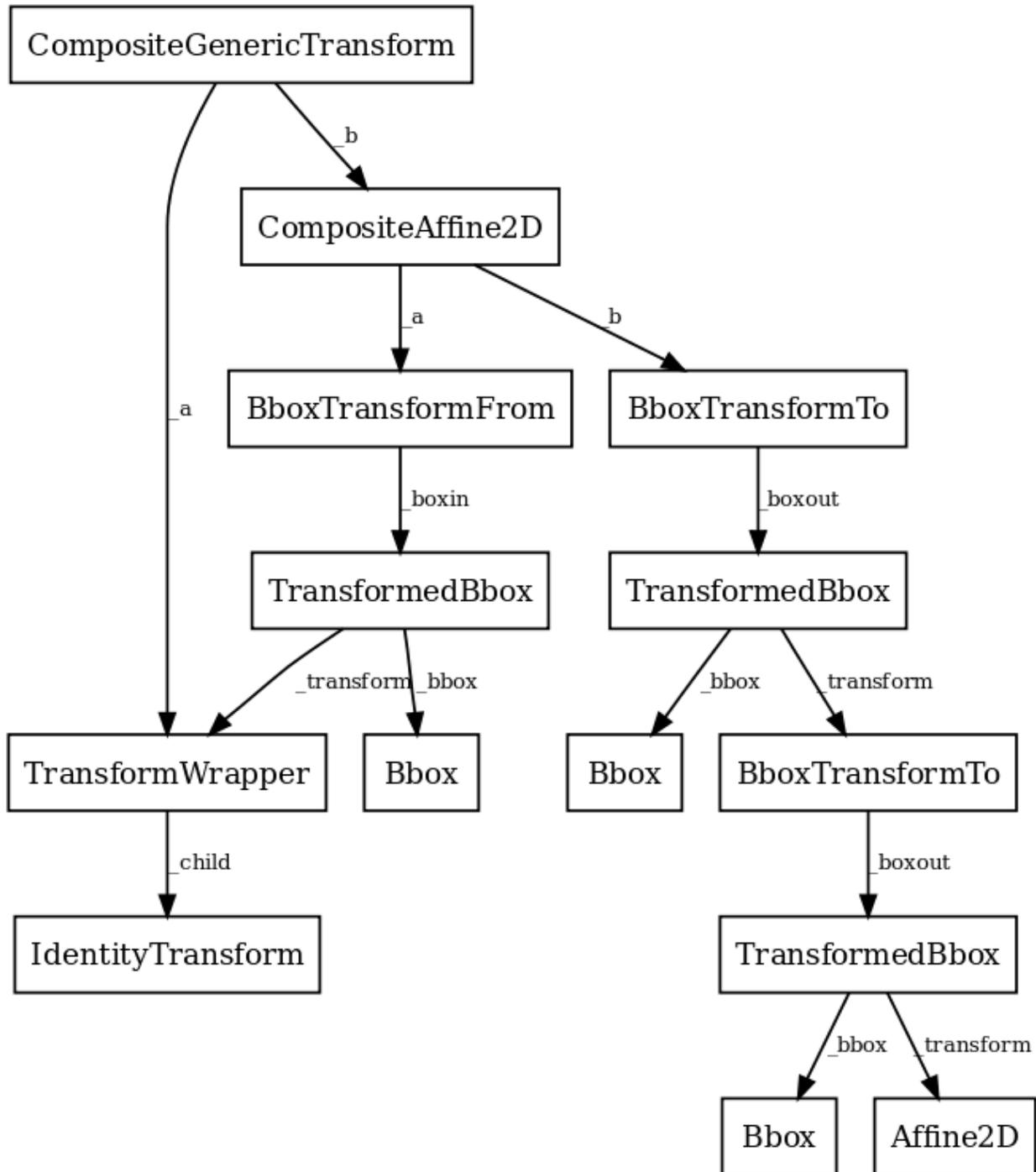
**subplotspec or None** subplotspec kwargs to be passed to *Figure*.  
*subplots\_adjust* or None if *tight\_layout* could not be accomplished.

**17.51 matplotlib.transforms**

matplotlib includes a framework for arbitrary geometric transformations that is used determine the final position of all elements drawn on the canvas.

Transforms are composed into trees of *TransformNode* objects whose actual value depends on their children. When the contents of children change, their parents are automatically invalidated. The next time an invalidated transform is accessed, it is recomputed to reflect those changes. This invalidation/caching approach prevents unnecessary recomputations of transforms, and contributes to better interactive performance.

For example, here is a graph of the transform tree used to plot data to the graph:



The framework can be used for both affine and non-affine transformations. However, for speed, we want use the backend renderers to perform affine transformations whenever possible. Therefore, it is possible to perform just the affine or non-affine part of a transformation on a set of data. The affine is always assumed to occur after the non-affine. For any transform:

```
full transform == non-affine part + affine part
```

The backends are not expected to handle non-affine transformations themselves.

```
class matplotlib.transforms.Affine2D(matrix=None, **kwargs)
    Bases: matplotlib.transforms.Affine2DBase
```

A mutable 2D affine transformation.

Initialize an Affine transform from a 3x3 numpy float array:

```
a c e
b d f
0 0 1
```

If *matrix* is None, initialize with the identity transform.

```
clear(self)
```

Reset the underlying matrix to the identity transform.

```
static from_values(a, b, c, d, e, f)
```

(staticmethod) Create a new Affine2D instance from the given values:

```
a c e
b d f
0 0 1
```

```
get_matrix(self)
```

Get the underlying transformation matrix as a 3x3 numpy array:

```
a c e
b d f
0 0 1
```

```
static identity()
```

(staticmethod) Return a new *Affine2D* object that is the identity transform.

Unless this transform will be mutated later on, consider using the faster *IdentityTransform* class instead.

```
rotate(self, theta)
```

Add a rotation (in radians) to this transform in place.

Returns *self*, so this method can easily be chained with more calls to *rotate()*, *rotate\_deg()*, *translate()* and *scale()*.

```
rotate_around(self, x, y, theta)
```

Add a rotation (in radians) around the point (x, y) in place.

Returns *self*, so this method can easily be chained with more calls to *rotate()*, *rotate\_deg()*, *translate()* and *scale()*.

```
rotate_deg(self, degrees)
```

Add a rotation (in degrees) to this transform in place.

Returns *self*, so this method can easily be chained with more calls to *rotate()*, *rotate\_deg()*, *translate()* and *scale()*.

```
rotate_deg_around(self, x, y, degrees)
```

Add a rotation (in degrees) around the point (x, y) in place.

Returns *self*, so this method can easily be chained with more calls to *rotate()*, *rotate\_deg()*, *translate()* and *scale()*.

`scale(self, sx, sy=None)`  
Adds a scale in place.

If *sy* is *None*, the same scale is applied in both the *x*- and *y*-directions.

Returns *self*, so this method can easily be chained with more calls to *rotate()*, *rotate\_deg()*, *translate()* and *scale()*.

`set(self, other)`  
Set this transformation from the frozen copy of another *Affine2DBase* object.

`set_matrix(self, mtx)`  
Set the underlying transformation matrix from a 3x3 numpy array:

```
a c e
b d f
0 0 1
```

.

`skew(self, xShear, yShear)`  
Adds a skew in place.

*xShear* and *yShear* are the shear angles along the *x*- and *y*-axes, respectively, in radians.

Returns *self*, so this method can easily be chained with more calls to *rotate()*, *rotate\_deg()*, *translate()* and *scale()*.

`skew_deg(self, xShear, yShear)`  
Adds a skew in place.

*xShear* and *yShear* are the shear angles along the *x*- and *y*-axes, respectively, in degrees.

Returns *self*, so this method can easily be chained with more calls to *rotate()*, *rotate\_deg()*, *translate()* and *scale()*.

`translate(self, tx, ty)`  
Adds a translation in place.

Returns *self*, so this method can easily be chained with more calls to *rotate()*, *rotate\_deg()*, *translate()* and *scale()*.

`class matplotlib.transforms.Affine2DBase(*args, **kwargs)`

Bases: *matplotlib.transforms.AffineBase*

The base class of all 2D affine transformations.

2D affine transformations are performed using a 3x3 numpy array:

```
a c e
b d f
0 0 1
```

This class provides the read-only interface. For a mutable 2D affine transformation, use *Affine2D*.

Subclasses of this class will generally only need to override a constructor and *get\_matrix()* that generates a custom 3x3 matrix.

`frozen(self)`

Returns a frozen copy of this transform node. The frozen copy will not update when its children change. Useful for storing a previously known state of a transform where `copy.deepcopy()` might normally be used.

`has_inverse = True`

`input_dims = 2`

`inverted(self)`

Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to `self` does not cause a corresponding update to its inverted copy.

```
x == self.inverted().transform(self.transform(x))
```

`is_separable`

`bool(x) -> bool`

Returns True when the argument `x` is true, False otherwise. The builtins True and False are the only two instances of the class bool. The class bool is a subclass of the class int, and cannot be subclassed.

`static matrix_from_values(a, b, c, d, e, f)`

(staticmethod) Create a new transformation matrix as a 3x3 numpy array of the form:

```
a c e
b d f
0 0 1
```

`output_dims = 2`

`to_values(self)`

Return the values of the matrix as an (a, b, c, d, e, f) tuple.

`transform_affine(self, points)`

Performs only the affine part of this transformation on the given array of values.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.

In non-affine transformations, this is generally a no-op. In affine transformations, this is equivalent to `transform(values)`.

Accepts a numpy array of shape (N x `input_dims`) and returns a numpy array of shape (N x `output_dims`).

Alternatively, accepts a numpy array of length `input_dims` and returns a numpy array of length `output_dims`.

`transform_point(self, point)`

A convenience function that returns the transformed copy of a single point.

The point is given as a sequence of length `input_dims`. The transformed point is returned as a sequence of length `output_dims`.

`class matplotlib.transforms.AffineBase(*args, **kwargs)`

Bases: `matplotlib.transforms.Transform`

The base class of all affine transformations of any number of dimensions.

`get_affine(self)`

Get the affine part of this transform.

`is_affine = True`

`transform(self, values)`

Performs the transformation on the given array of values.

Accepts a numpy array of shape (N x input\_dims) and returns a numpy array of shape (N x output\_dims).

Alternatively, accepts a numpy array of length input\_dims and returns a numpy array of length output\_dims.

`transform_affine(self, values)`

Performs only the affine part of this transformation on the given array of values.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.

In non-affine transformations, this is generally a no-op. In affine transformations, this is equivalent to `transform(values)`.

Accepts a numpy array of shape (N x input\_dims) and returns a numpy array of shape (N x output\_dims).

Alternatively, accepts a numpy array of length input\_dims and returns a numpy array of length output\_dims.

`transform_non_affine(self, points)`

Performs only the non-affine part of the transformation.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.

In non-affine transformations, this is generally equivalent to `transform(values)`. In affine transformations, this is always a no-op.

Accepts a numpy array of shape (N x input\_dims) and returns a numpy array of shape (N x output\_dims).

Alternatively, accepts a numpy array of length input\_dims and returns a numpy array of length output\_dims.

`transform_path(self, path)`

Returns a transformed path.

*path*: a *Path* instance.

In some cases, this transform may insert curves into the path that began as line segments.

`transform_path_affine(self, path)`

Returns a path, transformed only by the affine part of this transform.

*path*: a *Path* instance.

`transform_path(path)` is equivalent to `transform_path_affine(transform_path_non_affine(values))`.

`transform_path_non_affine(self, path)`

Returns a path, transformed only by the non-affine part of this transform.

*path*: a *Path* instance.

`transform_path(path)` is equivalent to `transform_path_affine(transform_path_non_affine(values))`.

`class matplotlib.transforms.Bbox(points, **kwargs)`

Bases: `matplotlib.transforms.BboxBase`

A mutable bounding box.

## Parameters

**points** [ndarray] A 2x2 numpy array of the form `[[x0, y0], [x1, y1]]`.

## Notes

If you need to create a *Bbox* object from another form of data, consider the static methods *unit()*, *from\_bounds()* and *from\_extents()*.

### bounds

Return *(x0, y0, width, height)*.

`static from_bounds(x0, y0, width, height)`

(staticmethod) Create a new *Bbox* from *x0, y0, width* and *height*.

*width* and *height* may be negative.

`static from_extents(*args)`

(staticmethod) Create a new *Bbox* from *left, bottom, right* and *top*.

The y-axis increases upwards.

`get_points(self)`

Get the points of the bounding box directly as a numpy array of the form: `[[x0, y0], [x1, y1]]`.

`ignore(self, value)`

Set whether the existing bounds of the box should be ignored by subsequent calls to *update\_from\_data\_xy()*.

**value** [bool]

- When `True`, subsequent calls to *update\_from\_data\_xy()* will ignore the existing bounds of the *Bbox*.
- When `False`, subsequent calls to *update\_from\_data\_xy()* will include the existing bounds of the *Bbox*.

`intervalx`

The pair of x coordinates that define the bounding box.

This is not guaranteed to be sorted from left to right.

`intervaly`

The pair of y coordinates that define the bounding box.

This is not guaranteed to be sorted from bottom to top.

`minpos`

`minposx`

`minposy`

`mutated(self)`

Return whether the *bbox* has changed since *init*.

`mutatedx(self)`

Return whether the x-limits have changed since *init*.

`mutatedy(self)`

Return whether the y-limits have changed since *init*.

`static null()`  
 (staticmethod) Create a new null *Bbox* from (inf, inf) to (-inf, -inf).

`p0`  
 The first pair of (x, y) coordinates that define the bounding box.  
 This is not guaranteed to be the bottom-left corner (for that, use `min`).

`p1`  
 The second pair of (x, y) coordinates that define the bounding box.  
 This is not guaranteed to be the top-right corner (for that, use `max`).

`set(self, other)`  
 Set this bounding box from the "frozen" bounds of another *Bbox*.

`set_points(self, points)`  
 Set the points of the bounding box directly from a numpy array of the form: `[[x0, y0], [x1, y1]]`. No error checking is performed, as this method is mainly for internal use.

`static unit()`  
 (staticmethod) Create a new unit *Bbox* from (0, 0) to (1, 1).

`update_from_data_xy(self, xy, ignore=None, updatex=True, updatey=True)`  
 Update the bounds of the *Bbox* based on the passed in data. After updating, the bounds will have positive *width* and *height*; `x0` and `y0` will be the minimal values.

**Parameters**

**xy** [ndarray] A numpy array of 2D points.

**ignore** [bool, optional]

- When `True`, ignore the existing bounds of the *Bbox*.
- When `False`, include the existing bounds of the *Bbox*.
- When `None`, use the last value passed to `ignore()`.

**updatex, updatey** [bool, optional] When `True`, update the x/y values.

`update_from_path(self, path, ignore=None, updatex=True, updatey=True)`  
 Update the bounds of the *Bbox* based on the passed in data. After updating, the bounds will have positive *width* and *height*; `x0` and `y0` will be the minimal values.

**Parameters**

**path** [*Path*]

**ignore** [bool, optional]

- when `True`, ignore the existing bounds of the *Bbox*.
- when `False`, include the existing bounds of the *Bbox*.
- when `None`, use the last value passed to `ignore()`.

**updatex, updatey** [bool, optional] When `True`, update the x/y values.

`x0`  
 The first of the pair of x coordinates that define the bounding box.  
 This is not guaranteed to be less than `x1` (for that, use `xmin`).

- x1**  
The second of the pair of  $x$  coordinates that define the bounding box.  
This is not guaranteed to be greater than  $x0$  (for that, use `xmax`).
- y0**  
The first of the pair of  $y$  coordinates that define the bounding box.  
This is not guaranteed to be less than  $y1$  (for that, use `ymin`).
- y1**  
The second of the pair of  $y$  coordinates that define the bounding box.  
This is not guaranteed to be greater than  $y0$  (for that, use `ymax`).

`class matplotlib.transforms.BboxBase(shorthand_name=None)`

Bases: `matplotlib.transforms.TransformNode`

This is the base class of all bounding boxes, and provides read-only access to its data. A mutable bounding box is provided by the `Bbox` class.

The canonical representation is as two points, with no restrictions on their ordering. Convenience properties are provided to get the left, bottom, right and top edges and width and height, but these are not stored explicitly.

Creates a new `TransformNode`.

#### Parameters

**shorthand\_name** [str] A string representing the "name" of the transform. The name carries no significance other than to improve the readability of `str(transform)` when `DEBUG=True`.

`anchored(self, c, container=None)`

Return a copy of the `Bbox`, shifted to position  $c$  within a container.

#### Parameters

**c** [(float, float) or str] May be either:

- A sequence ( $cx$ ,  $cy$ ) where  $cx$  and  $cy$  range from 0 to 1, where 0 is left or bottom and 1 is right or top
- a string: - 'C' for centered - 'S' for bottom-center - 'SE' for bottom-left - 'E' for left - etc.

**container** [Bbox, optional] The box within which the `Bbox` is positioned; it defaults to the initial `Bbox`.

`bounds`

Return ( $x0$ ,  $y0$ , *width*, *height*).

`coefs = {'C': (0.5, 0.5), 'E': (1.0, 0.5), 'N': (0.5, 1.0), 'NE': (1.0, 1.0), 'NW': (0, 1.0), 'S':`

`contains(self, x, y)`

Return whether ( $x$ ,  $y$ ) is in the bounding box or on its edge.

`containsx(self, x)`

Return whether  $x$  is in the closed ( $x0$ ,  $x1$ ) interval.

`containsy(self, y)`

Return whether  $y$  is in the closed ( $y0$ ,  $y1$ ) interval.

`corners(self)`

Return the corners of this rectangle as an array of points.

Specifically, this returns the array `[[x0, y0], [x0, y1], [x1, y0], [x1, y1]]`.

`count_contains(self, vertices)`

Count the number of vertices contained in the *Bbox*. Any vertices with a non-finite x or y value are ignored.

#### Parameters

**vertices** [Nx2 Numpy array.]

`count_overlaps(self, bboxes)`

Count the number of bounding boxes that overlap this one.

#### Parameters

**bboxes** [sequence of *BboxBase* objects]

`expanded(self, sw, sh)`

Construct a *Bbox* by expanding this one around its center by the factors *sw* and *sh*.

`extents`

Return `(x0, y0, x1, y1)`.

`frozen(self)`

*TransformNode* is the base class for anything that participates in the transform tree and needs to invalidate its parents or be invalidated. This includes classes that are not really transforms, such as bounding boxes, since some transforms depend on bounding boxes to compute their values.

`fully_contains(self, x, y)`

Return whether *x*, *y* is in the bounding box, but not on its edge.

`fully_containsx(self, x)`

Return whether *x* is in the open `(x0, x1)` interval.

`fully_containsy(self, y)`

Return whether *y* is in the open `(y0, y1)` interval.

`fully_overlaps(self, other)`

Return whether this bounding box overlaps with the other bounding box, not including the edges.

#### Parameters

**other** [BboxBase]

`get_points(self)`

`height`

The (signed) height of the bounding box.

`static intersection(bbox1, bbox2)`

Return the intersection of *bbox1* and *bbox2* if they intersect, or `None` if they don't.

`intervalx`

The pair of *x* coordinates that define the bounding box.

This is not guaranteed to be sorted from left to right.

`intervaly`

The pair of *y* coordinates that define the bounding box.

This is not guaranteed to be sorted from bottom to top.

`inverse_transformed(self, transform)`

Construct a *Bbox* by statically transforming this one by the inverse of *transform*.

`is_affine = True`

`is_bbox = True`

`is_unit(self)`

Return whether this is the unit box (from (0, 0) to (1, 1)).

`max`

The top-right corner of the bounding box.

`min`

The bottom-left corner of the bounding box.

`overlaps(self, other)`

Return whether this bounding box overlaps with the other bounding box.

### Parameters

**other** [*BboxBase*]

`p0`

The first pair of (x, y) coordinates that define the bounding box.

This is not guaranteed to be the bottom-left corner (for that, use *min*).

`p1`

The second pair of (x, y) coordinates that define the bounding box.

This is not guaranteed to be the top-right corner (for that, use *max*).

`padded(self, p)`

Construct a *Bbox* by padding this one on all four sides by *p*.

`rotated(self, radians)`

Return a new bounding box that bounds a rotated version of this bounding box by the given radians. The new bounding box is still aligned with the axes, of course.

`shrunk(self, mx, my)`

Return a copy of the *Bbox*, shrunk by the factor *mx* in the x direction and the factor *my* in the y direction. The lower left corner of the box remains unchanged. Normally *mx* and *my* will be less than 1, but this is not enforced.

`shrunk_to_aspect(self, box_aspect, container=None, fig_aspect=1.0)`

Return a copy of the *Bbox*, shrunk so that it is as large as it can be while having the desired aspect ratio, *box\_aspect*. If the box coordinates are relative—that is, fractions of a larger box such as a figure—then the physical aspect ratio of that figure is specified with *fig\_aspect*, so that *box\_aspect* can also be given as a ratio of the absolute dimensions, not the relative dimensions.

`size`

The (signed) width and height of the bounding box.

`splitx(self, *args)`

Return a list of new *Bbox* objects formed by splitting the original one with vertical lines at fractional positions given by *args*.

`splity(self, *args)`

Return a list of new *Bbox* objects formed by splitting the original one with horizontal lines at fractional positions given by *args*.

```

transformed(self, transform)
    Construct a Bbox by statically transforming this one by transform.

translated(self, tx, ty)
    Construct a Bbox by translating this one by tx and ty.

static union(bboxes)
    Return a Bbox that contains all of the given bboxes.

width
    The (signed) width of the bounding box.

x0
    The first of the pair of x coordinates that define the bounding box.
    This is not guaranteed to be less than x1 (for that, use xmin).

x1
    The second of the pair of x coordinates that define the bounding box.
    This is not guaranteed to be greater than x0 (for that, use xmax).

xmax
    The right edge of the bounding box.

xmin
    The left edge of the bounding box.

y0
    The first of the pair of y coordinates that define the bounding box.
    This is not guaranteed to be less than y1 (for that, use ymin).

y1
    The second of the pair of y coordinates that define the bounding box.
    This is not guaranteed to be greater than y0 (for that, use ymax).

ymax
    The top edge of the bounding box.

ymin
    The bottom edge of the bounding box.

class matplotlib.transforms.BboxTransform(boxin, boxout, **kwargs)
    Bases: matplotlib.transforms.Affine2DBase

    BboxTransform linearly transforms points from one Bbox to another Bbox.
    Create a new BboxTransform that linearly transforms points from boxin to boxout.

    get_matrix(self)
        Get the Affine transformation array for the affine part of this transform.

    is_separable = True

class matplotlib.transforms.BboxTransformFrom(boxin, **kwargs)
    Bases: matplotlib.transforms.Affine2DBase

    BboxTransformFrom linearly transforms points from a given Bbox to the unit bounding box.

    get_matrix(self)
        Get the Affine transformation array for the affine part of this transform.

    is_separable = True

```

```
class matplotlib.transforms.BboxTransformTo(boxout, **kwargs)
```

```
    Bases: matplotlib.transforms.Affine2DBase
```

*BboxTransformTo* is a transformation that linearly transforms points from the unit bounding box to a given *Bbox*.

Create a new *BboxTransformTo* that linearly transforms points from the unit bounding box to *boxout*.

```
    get_matrix(self)
```

Get the Affine transformation array for the affine part of this transform.

```
    is_separable = True
```

```
class matplotlib.transforms.BboxTransformToMaxOnly(boxout, **kwargs)
```

```
    Bases: matplotlib.transforms.BboxTransformTo
```

*BboxTransformTo* is a transformation that linearly transforms points from the unit bounding box to a given *Bbox* with a fixed upper left of (0, 0).

Create a new *BboxTransformTo* that linearly transforms points from the unit bounding box to *boxout*.

```
    get_matrix(self)
```

Get the Affine transformation array for the affine part of this transform.

```
class matplotlib.transforms.BlendedAffine2D(x_transform, y_transform, **kwargs)
```

```
    Bases: matplotlib.transforms.Affine2DBase
```

A "blended" transform uses one transform for the x-direction, and another transform for the y-direction.

This version is an optimization for the case where both child transforms are of type *Affine2DBase*.

Create a new "blended" transform using *x\_transform* to transform the x-axis and *y\_transform* to transform the y-axis.

Both *x\_transform* and *y\_transform* must be 2D affine transforms.

You will generally not call this constructor directly but use the *blended\_transform\_factory()* function instead, which can determine automatically which kind of blended transform to create.

```
    contains_branch_seperately(self, transform)
```

Returns whether the given branch is a sub-tree of this transform on each separate dimension.

A common use for this method is to identify if a transform is a blended transform containing an axes' data transform. e.g.:

```
x_isdata, y_isdata = trans.contains_branch_seperately(ax.transData)
```

```
    get_matrix(self)
```

Get the Affine transformation array for the affine part of this transform.

```
    is_separable = True
```

```
class matplotlib.transforms.BlendedGenericTransform(x_transform, y_transform, **kwargs)
```

```
    Bases: matplotlib.transforms.Transform
```

A "blended" transform uses one transform for the x-direction, and another transform for the y-direction.

This “generic” version can handle any given child transform in the  $x$ - and  $y$ -directions.

Create a new “blended” transform using `x_transform` to transform the  $x$ -axis and `y_transform` to transform the  $y$ -axis.

You will generally not call this constructor directly but use the `blended_transform_factory()` function instead, which can determine automatically which kind of blended transform to create.

`contains_branch(self, other)`

Return whether the given transform is a sub-tree of this transform.

This routine uses transform equality to identify sub-trees, therefore in many situations it is object id which will be used.

For the case where the given transform represents the whole of this transform, returns True.

`contains_branch_seperately(self, transform)`

Returns whether the given branch is a sub-tree of this transform on each separate dimension.

A common use for this method is to identify if a transform is a blended transform containing an axes’ data transform. e.g.:

```
x_isdata, y_isdata = trans.contains_branch_seperately(ax.transData)
```

`depth`

Returns the number of transforms which have been chained together to form this Transform instance.

---

**Note:** For the special case of a Composite transform, the maximum depth of the two is returned.

---

`frozen(self)`

Returns a frozen copy of this transform node. The frozen copy will not update when its children change. Useful for storing a previously known state of a transform where `copy.deepcopy()` might normally be used.

`get_affine(self)`

Get the affine part of this transform.

`has_inverse`

`input_dims = 2`

`inverted(self)`

Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to `self` does not cause a corresponding update to its inverted copy.

```
x == self.inverted().transform(self.transform(x))
```

`is_affine`

`is_separable = True`

`output_dims = 2`

`pass_through = True`

`transform_non_affine(self, points)`

Performs only the non-affine part of the transformation.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.

In non-affine transformations, this is generally equivalent to `transform(values)`. In affine transformations, this is always a no-op.

Accepts a numpy array of shape  $(N \times \text{input\_dims})$  and returns a numpy array of shape  $(N \times \text{output\_dims})$ .

Alternatively, accepts a numpy array of length `input_dims` and returns a numpy array of length `output_dims`.

`class matplotlib.transforms.CompositeAffine2D(a, b, **kwargs)`

Bases: `matplotlib.transforms.Affine2DBase`

A composite transform formed by applying transform `a` then transform `b`.

This version is an optimization that handles the case where both `a` and `b` are 2D affines.

Create a new composite transform that is the result of applying transform `a` then transform `b`.

Both `a` and `b` must be instances of `Affine2DBase`.

You will generally not call this constructor directly but use the `composite_transform_factory()` function instead, which can automatically choose the best kind of composite transform instance to create.

`depth`

Returns the number of transforms which have been chained together to form this Transform instance.

---

**Note:** For the special case of a Composite transform, the maximum depth of the two is returned.

---

`get_matrix(self)`

Get the Affine transformation array for the affine part of this transform.

`class matplotlib.transforms.CompositeGenericTransform(a, b, **kwargs)`

Bases: `matplotlib.transforms.Transform`

A composite transform formed by applying transform `a` then transform `b`.

This "generic" version can handle any two arbitrary transformations.

Create a new composite transform that is the result of applying transform `a` then transform `b`.

You will generally not call this constructor directly but use the `composite_transform_factory()` function instead, which can automatically choose the best kind of composite transform instance to create.

`depth`

`frozen(self)`

Returns a frozen copy of this transform node. The frozen copy will not update when its children change. Useful for storing a previously known state of a transform where `copy.deepcopy()` might normally be used.

```

get_affine(self)
    Get the affine part of this transform.

has_inverse

inverted(self)
    Return the corresponding inverse transformation.

    The return value of this method should be treated as temporary. An update to self
    does not cause a corresponding update to its inverted copy.

    x == self.inverted().transform(self.transform(x))

is_affine

is_separable

pass_through = True

transform_affine(self, points)
    Performs only the affine part of this transformation on the given array of values.

    transform(values) is always equivalent to transform_affine(transform_non_affine(values)).

    In non-affine transformations, this is generally a no-op. In affine transformations,
    this is equivalent to transform(values).

    Accepts a numpy array of shape (N x input_dims) and returns a numpy array of shape
    (N x output_dims).

    Alternatively, accepts a numpy array of length input_dims and returns a numpy array
    of length output_dims.

transform_non_affine(self, points)
    Performs only the non-affine part of the transformation.

    transform(values) is always equivalent to transform_affine(transform_non_affine(values)).

    In non-affine transformations, this is generally equivalent to transform(values). In
    affine transformations, this is always a no-op.

    Accepts a numpy array of shape (N x input_dims) and returns a numpy array of shape
    (N x output_dims).

    Alternatively, accepts a numpy array of length input_dims and returns a numpy array
    of length output_dims.

transform_path_non_affine(self, path)
    Returns a path, transformed only by the non-affine part of this transform.

    path: a Path instance.

    transform_path(path) is equivalent to transform_path_affine(transform_path_non_affine(values)).

```

```

class matplotlib.transforms.IdentityTransform(*args, **kwargs)
    Bases: matplotlib.transforms.Affine2DBase

    A special class that does one thing, the identity transform, in a fast way.

    frozen(self)
        Returns a frozen copy of this transform node. The frozen copy will not update when
        its children change. Useful for storing a previously known state of a transform
        where copy.deepcopy() might normally be used.

    get_affine(self)
        Get the affine part of this transform.

```

`get_matrix(self)`

Get the Affine transformation array for the affine part of this transform.

`inverted(self)`

Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to *self* does not cause a corresponding update to its inverted copy.

```
x == self.inverted().transform(self.transform(x))
```

`transform(self, points)`

Performs the transformation on the given array of values.

Accepts a numpy array of shape (N x input\_dims) and returns a numpy array of shape (N x output\_dims).

Alternatively, accepts a numpy array of length input\_dims and returns a numpy array of length output\_dims.

`transform_affine(self, points)`

Performs only the affine part of this transformation on the given array of values.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.

In non-affine transformations, this is generally a no-op. In affine transformations, this is equivalent to `transform(values)`.

Accepts a numpy array of shape (N x input\_dims) and returns a numpy array of shape (N x output\_dims).

Alternatively, accepts a numpy array of length input\_dims and returns a numpy array of length output\_dims.

`transform_non_affine(self, points)`

Performs only the non-affine part of the transformation.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.

In non-affine transformations, this is generally equivalent to `transform(values)`. In affine transformations, this is always a no-op.

Accepts a numpy array of shape (N x input\_dims) and returns a numpy array of shape (N x output\_dims).

Alternatively, accepts a numpy array of length input\_dims and returns a numpy array of length output\_dims.

`transform_path(self, path)`

Returns a transformed path.

*path*: a *Path* instance.

In some cases, this transform may insert curves into the path that began as line segments.

`transform_path_affine(self, path)`

Returns a path, transformed only by the affine part of this transform.

*path*: a *Path* instance.

`transform_path(path)` is equivalent to `transform_path_affine(transform_path_non_affine(values))`.

`transform_path_non_affine(self, path)`

Returns a path, transformed only by the non-affine part of this transform.

*path*: a *Path* instance.

`transform_path(path)` is equivalent to `transform_path_affine(transform_path_non_affine(values))`.

```
class matplotlib.transforms.LockableBbox(bbox, x0=None, y0=None, x1=None,
                                       y1=None, **kwargs)
```

Bases: *matplotlib.transforms.BboxBase*

A *Bbox* where some elements may be locked at certain values.

When the child bounding box changes, the bounds of this *bbox* will update accordingly with the exception of the locked elements.

### Parameters

**bbox** [*Bbox*] The child bounding box to wrap.

**x0** [float or None] The locked value for *x0*, or None to leave unlocked.

**y0** [float or None] The locked value for *y0*, or None to leave unlocked.

**x1** [float or None] The locked value for *x1*, or None to leave unlocked.

**y1** [float or None] The locked value for *y1*, or None to leave unlocked.

```
get_points(self)
```

```
locked_x0
```

float or None: The value used for the locked *x0*.

```
locked_x1
```

float or None: The value used for the locked *x1*.

```
locked_y0
```

float or None: The value used for the locked *y0*.

```
locked_y1
```

float or None: The value used for the locked *y1*.

```
class matplotlib.transforms.ScaledTranslation(xt, yt, scale_trans, **kwargs)
```

Bases: *matplotlib.transforms.Affine2DBase*

A transformation that translates by *xt* and *yt*, after *xt* and *yt* have been transformed by *scale\_trans*.

```
get_matrix(self)
```

Get the Affine transformation array for the affine part of this transform.

```
class matplotlib.transforms.Transform(shorthand_name=None)
```

Bases: *matplotlib.transforms.TransformNode*

The base class of all *TransformNode* instances that actually perform a transformation.

All non-affine transformations should be subclasses of this class. New affine transformations should be subclasses of *Affine2D*.

Subclasses of this class should override the following members (at minimum):

- *input\_dims*
- *output\_dims*
- *transform()*
- *is\_separable*
- *has\_inverse*

- `inverted()` (if `has_inverse` is True)

If the transform needs to do something non-standard with `matplotlib.path.Path` objects, such as adding curves where there were once line segments, it should override:

- `transform_path()`

Creates a new `TransformNode`.

### Parameters

**shorthand\_name** [str] A string representing the "name" of the transform. The name carries no significance other than to improve the readability of `str(transform)` when `DEBUG=True`.

`contains_branch(self, other)`

Return whether the given transform is a sub-tree of this transform.

This routine uses transform equality to identify sub-trees, therefore in many situations it is object id which will be used.

For the case where the given transform represents the whole of this transform, returns True.

`contains_branch_seperately(self, other_transform)`

Returns whether the given branch is a sub-tree of this transform on each separate dimension.

A common use for this method is to identify if a transform is a blended transform containing an axes' data transform. e.g.:

```
x_isdata, y_isdata = trans.contains_branch_seperately(ax.transData)
```

`depth`

Returns the number of transforms which have been chained together to form this Transform instance.

---

**Note:** For the special case of a Composite transform, the maximum depth of the two is returned.

---

`get_affine(self)`

Get the affine part of this transform.

`get_matrix(self)`

Get the Affine transformation array for the affine part of this transform.

`has_inverse = False`

True if this transform has a corresponding inverse transform.

`input_dims = None`

The number of input dimensions of this transform. Must be overridden (with integers) in the subclass.

`inverted(self)`

Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to `self` does not cause a corresponding update to its inverted copy.

```
x == self.inverted().transform(self.transform(x))
```

`is_separable = False`

True if this transform is separable in the x- and y- dimensions.

`output_dims = None`

The number of output dimensions of this transform. Must be overridden (with integers) in the subclass.

`transform(self, values)`

Performs the transformation on the given array of values.

Accepts a numpy array of shape  $(N \times \text{input\_dims})$  and returns a numpy array of shape  $(N \times \text{output\_dims})$ .

Alternatively, accepts a numpy array of length `input_dims` and returns a numpy array of length `output_dims`.

`transform_affine(self, values)`

Performs only the affine part of this transformation on the given array of values.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.

In non-affine transformations, this is generally a no-op. In affine transformations, this is equivalent to `transform(values)`.

Accepts a numpy array of shape  $(N \times \text{input\_dims})$  and returns a numpy array of shape  $(N \times \text{output\_dims})$ .

Alternatively, accepts a numpy array of length `input_dims` and returns a numpy array of length `output_dims`.

`transform_angles(self, angles, pts, radians=False, pushoff=1e-05)`

Transforms a set of angles anchored at specific locations.

### Parameters

**angles** [(N,) array-like] The angles to transform.

**pts** [(N, 2) array-like] The points where the angles are anchored.

**radians** [bool, default: False] Whether `angles` are radians or degrees.

**pushoff** [float] For each point in `pts` and angle in `angles`, the transformed angle is computed by transforming a segment of length `pushoff` starting at that point and making that angle relative to the horizontal axis, and measuring the angle between the horizontal axis and the transformed segment.

### Returns

**transformed\_angles** [(N,) array]

`transform_bbox(self, bbox)`

Transform the given bounding box.

Note, for smarter transforms including caching (a common requirement for matplotlib figures), see `TransformedBbox`.

`transform_non_affine(self, values)`

Performs only the non-affine part of the transformation.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.

In non-affine transformations, this is generally equivalent to `transform(values)`. In affine transformations, this is always a no-op.

Accepts a numpy array of shape (N x *input\_dims*) and returns a numpy array of shape (N x *output\_dims*).

Alternatively, accepts a numpy array of length *input\_dims* and returns a numpy array of length *output\_dims*.

`transform_path(self, path)`

Returns a transformed path.

*path*: a *Path* instance.

In some cases, this transform may insert curves into the path that began as line segments.

`transform_path_affine(self, path)`

Returns a path, transformed only by the affine part of this transform.

*path*: a *Path* instance.

`transform_path(path)` is equivalent to `transform_path_affine(transform_path_non_affine(values))`.

`transform_path_non_affine(self, path)`

Returns a path, transformed only by the non-affine part of this transform.

*path*: a *Path* instance.

`transform_path(path)` is equivalent to `transform_path_affine(transform_path_non_affine(values))`.

`transform_point(self, point)`

A convenience function that returns the transformed copy of a single point.

The point is given as a sequence of length *input\_dims*. The transformed point is returned as a sequence of length *output\_dims*.

`class matplotlib.transforms.TransformNode(shorthand_name=None)`

Bases: `object`

*TransformNode* is the base class for anything that participates in the transform tree and needs to invalidate its parents or be invalidated. This includes classes that are not really transforms, such as bounding boxes, since some transforms depend on bounding boxes to compute their values.

Creates a new *TransformNode*.

### Parameters

**shorthand\_name** [str] A string representing the "name" of the transform. The name carries no significance other than to improve the readability of `str(transform)` when `DEBUG=True`.

`INVALID = 3`

`INVALID_AFFINE = 2`

`INVALID_NON_AFFINE = 1`

`frozen(self)`

Returns a frozen copy of this transform node. The frozen copy will not update when its children change. Useful for storing a previously known state of a transform where `copy.deepcopy()` might normally be used.

`invalidate(self)`

Invalidate this *TransformNode* and triggers an invalidation of its ancestors. Should be called any time the transform changes.

```
is_affine = False
```

```
is_bbox = False
```

```
pass_through = False
```

If `pass_through` is `True`, all ancestors will always be invalidated, even if 'self' is already invalid.

```
set_children(self, *children)
```

Set the children of the transform, to let the invalidation system know which transforms can invalidate this transform. Should be called from the constructor of any transforms that depend on other transforms.

```
class matplotlib.transforms.TransformWrapper(child)
```

```
Bases: matplotlib.transforms.Transform
```

A helper class that holds a single child transform and acts equivalently to it.

This is useful if a node of the transform tree must be replaced at run time with a transform of a different type. This class allows that replacement to correctly trigger invalidation.

Note that *TransformWrapper* instances must have the same input and output dimensions during their entire lifetime, so the child transform may only be replaced with another child transform of the same dimensions.

*child*: A class:*Transform* instance. This child may later be replaced with *set()*.

```
frozen(self)
```

Returns a frozen copy of this transform node. The frozen copy will not update when its children change. Useful for storing a previously known state of a transform where `copy.deepcopy()` might normally be used.

```
has_inverse
```

```
is_affine
```

```
is_separable
```

```
pass_through = True
```

```
set(self, child)
```

Replace the current child of this transform with another one.

The new child must have the same number of input and output dimensions as the current child.

```
class matplotlib.transforms.TransformedException(bbox, transform, **kwargs)
```

```
Bases: matplotlib.transforms.BboxBase
```

A *Bbox* that is automatically transformed by a given transform. When either the child bounding box or transform changes, the bounds of this *bbox* will update accordingly.

### Parameters

**bbox** [*Bbox*]

**transform** [*Transform*]

```
get_points(self)
```

```
class matplotlib.transforms.TransformedException(patch)
```

```
Bases: matplotlib.transforms.TransformedException
```

A *TransformedPatchPath* caches a non-affine transformed copy of the *Patch*. This cached copy is automatically updated when the non-affine part of the transform or the patch changes.

Create a new *TransformedPatchPath* from the given *Patch*.

```
class matplotlib.transforms.TransformPath(path, transform)
```

Bases: *matplotlib.transforms.TransformNode*

A *TransformedPath* caches a non-affine transformed copy of the *Path*. This cached copy is automatically updated when the non-affine part of the transform changes.

---

**Note:** Paths are considered immutable by this class. Any update to the path's vertices/codes will not trigger a transform recomputation.

---

Create a new *TransformedPath* from the given *Path* and *Transform*.

```
get_affine(self)
```

```
get_fully_transformed_path(self)
```

Return a fully-transformed copy of the child path.

```
get_transformed_path_and_affine(self)
```

Return a copy of the child path, with the non-affine part of the transform already applied, along with the affine part of the path necessary to complete the transformation.

```
get_transformed_points_and_affine(self)
```

Return a copy of the child path, with the non-affine part of the transform already applied, along with the affine part of the path necessary to complete the transformation. Unlike *get\_transformed\_path\_and\_affine()*, no interpolation will be performed.

```
matplotlib.transforms.blended_transform_factory(x_transform, y_transform)
```

Create a new "blended" transform using *x\_transform* to transform the x-axis and *y\_transform* to transform the y-axis.

A faster version of the blended transform is returned for the case where both child transforms are affine.

```
matplotlib.transforms.composite_transform_factory(a, b)
```

Create a new composite transform that is the result of applying transform a then transform b.

Shortcut versions of the blended transform are provided for the case where both child transforms are affine, or one or the other is the identity transform.

Composite transforms may also be created using the '+' operator, e.g.:

```
c = a + b
```

```
matplotlib.transforms.interval_contains(interval, val)
```

Check, inclusively, whether an interval includes a given value.

#### Parameters

**interval** [sequence of scalar] A 2-length sequence, endpoints that define the interval.

**val** [scalar] Value to check is within interval.

#### Returns

**bool** Returns *True* if given *val* is within the *interval*.

`matplotlib.transforms.interval_contains_open(interval, val)`

Check, excluding endpoints, whether an interval includes a given value.

#### Parameters

**interval** [sequence of scalar] A 2-length sequence, endpoints that define the interval.

**val** [scalar] Value to check is within interval.

#### Returns

**bool** Returns true if given *val* is within the interval.

`matplotlib.transforms.nonsingular(vmin, vmax, expander=0.001, tiny=1e-15, increasing=True)`

Modify the endpoints of a range as needed to avoid singularities.

#### Parameters

**vmin, vmax** [float] The initial endpoints.

**expander** [float, optional, default: 0.001] Fractional amount by which *vmin* and *vmax* are expanded if the original interval is too small, based on *tiny*.

**tiny** [float, optional, default: 1e-15] Threshold for the ratio of the interval to the maximum absolute value of its endpoints. If the interval is smaller than this, it will be expanded. This value should be around 1e-15 or larger; otherwise the interval will be approaching the double precision resolution limit.

**increasing** [bool, optional, default: True] If True, swap *vmin*, *vmax* if *vmin* > *vmax*.

#### Returns

**vmin, vmax** [float] Endpoints, expanded and/or swapped if necessary. If either input is inf or NaN, or if both inputs are 0 or very close to zero, it returns *-expander, expander*.

`matplotlib.transforms.offset_copy(trans, fig=None, x=0.0, y=0.0, units='inches')`

Return a new transform with an added offset.

#### Parameters

**trans** [*Transform* instance] Any transform, to which offset will be applied.

**fig** [*Figure*, optional, default: None] Current figure. It can be None if *units* are 'dots'.

**x, y** [float, optional, default: 0.0] Specifies the offset to apply.

**units** [{'inches', 'points', 'dots'}, optional] Units of the offset.

#### Returns

**trans** [*Transform* instance] Transform with applied offset.

## 17.52 matplotlib.tri

Unstructured triangular grid functions.

```
class matplotlib.tri.Triangulation(x, y, triangles=None, mask=None)
```

An unstructured triangular grid consisting of `npoints` points and `ntri` triangles. The triangles can either be specified by the user or automatically generated using a Delaunay triangulation.

### Parameters

**x, y** [array-like of shape (`npoints`)] Coordinates of grid points.

**triangles** [integer array\_like of shape (`ntri`, 3), optional] For each triangle, the indices of the three points that make up the triangle, ordered in an anticlockwise manner. If not specified, the Delaunay triangulation is calculated.

**mask** [boolean array-like of shape (`ntri`), optional] Which triangles are masked out.

### Notes

For a Triangulation to be valid it must not have duplicate points, triangles formed from colinear points, or overlapping triangles.

### Attributes

**edges** [int array of shape (`nedges`, 2)] Return integer array of shape (`nedges`, 2) containing all edges of non-masked triangles.

**neighbors** [int array of shape (`ntri`, 3)] Return integer array of shape (`ntri`, 3) containing neighbor triangles.

**mask** [bool array of shape (`ntri`, 3)] Masked out triangles.

**is\_delaunay** [bool] Whether the Triangulation is a calculated Delaunay triangulation (where `triangles` was not specified) or not.

```
calculate_plane_coefficients(self, z)
```

Calculate plane equation coefficients for all unmasked triangles from the point (`x`, `y`) coordinates and specified `z`-array of shape (`npoints`). The returned array has shape (`npoints`, 3) and allows `z`-value at (`x`, `y`) position in triangle `tri` to be calculated using  $z = \text{array}[\text{tri}, 0] * x + \text{array}[\text{tri}, 1] * y + \text{array}[\text{tri}, 2]$ .

```
edges
```

Return integer array of shape (`nedges`, 2) containing all edges of non-masked triangles.

Each row defines an edge by its start point index and end point index. Each edge appears only once, i.e. for an edge between points *i* and *j*, there will only be either (*i*, *j*) or (*j*, *i*).

```
get_cpp_triangulation(self)
```

Return the underlying C++ Triangulation object, creating it if necessary.

```
static get_from_args_and_kwargs(*args, **kwargs)
```

Return a Triangulation object from the `args` and `kwargs`, and the remaining `args` and `kwargs` with the consumed values removed.

There are two alternatives: either the first argument is a Triangulation object, in which case it is returned, or the args and kwargs are sufficient to create a new Triangulation to return. In the latter case, see Triangulation.\_\_init\_\_ for the possible args and kwargs.

`get_masked_triangles(self)`

Return an array of triangles that are not masked.

`get_trifinder(self)`

Return the default `matplotlib.tri.TriFinder` of this triangulation, creating it if necessary. This allows the same TriFinder object to be easily shared.

`neighbors`

Return integer array of shape (ntri, 3) containing neighbor triangles.

For each triangle, the indices of the three triangles that share the same edges, or -1 if there is no such neighboring triangle. `neighbors[i,j]` is the triangle that is the neighbor to the edge from point index `triangles[i,j]` to point index `triangles[i,(j+1)%3]`.

`set_mask(self, mask)`

Set or clear the mask array. This is either None, or a boolean array of shape (ntri).

`class matplotlib.tri.TriFinder(triangulation)`

Abstract base class for classes used to find the triangles of a Triangulation in which (x,y) points lie.

Rather than instantiate an object of a class derived from TriFinder, it is usually better to use the function `matplotlib.tri.Triangulation.get_trifinder()`.

Derived classes implement `__call__(x,y)` where x,y are array\_like point coordinates of the same shape.

`class matplotlib.tri.TrapezoidMapTriFinder(triangulation)`

Bases: `matplotlib.tri.trifinder.TriFinder`

*TriFinder* class implemented using the trapezoid map algorithm from the book "Computational Geometry, Algorithms and Applications", second edition, by M. de Berg, M. van Kreveld, M. Overmars and O. Schwarzkopf.

The triangulation must be valid, i.e. it must not have duplicate points, triangles formed from colinear points, or overlapping triangles. The algorithm has some tolerance to triangles formed from colinear points, but this should not be relied upon.

`class matplotlib.tri.TriInterpolator(triangulation, z, trifinder=None)`

Abstract base class for classes used to perform interpolation on triangular grids.

Derived classes implement the following methods:

- `__call__(x, y)`, where x, y are array\_like point coordinates of the same shape, and that returns a masked array of the same shape containing the interpolated z-values.
- `gradient(x, y)`, where x, y are array\_like point coordinates of the same shape, and that returns a list of 2 masked arrays of the same shape containing the 2 derivatives of the interpolator (derivatives of interpolated z values with respect to x and y).

`class matplotlib.tri.LinearTriInterpolator(triangulation, z, trifinder=None)`

Bases: `matplotlib.tri.triinterpolate.TriInterpolator`

A LinearTriInterpolator performs linear interpolation on a triangular grid.

Each triangle is represented by a plane so that an interpolated value at point (x,y) lies on the plane of the triangle containing (x,y). Interpolated values are therefore continuous

across the triangulation, but their first derivatives are discontinuous at edges between triangles.

### Parameters

**triangulation** [*Triangulation* object] The triangulation to interpolate over.

**z** [array\_like of shape (npoints,)] Array of values, defined at grid points, to interpolate between.

**trifinder** [*TriFinder* object, optional] If this is not specified, the Triangulation's default TriFinder will be used by calling `matplotlib.tri.Triangulation.get_trifinder()`.

### Methods

<code>'__call__' (x, y)</code>	(Returns interpolated values at x,y points)
<code>'gradient' (x, y)</code>	(Returns interpolated derivatives at x,y points)

`gradient(self, x, y)`

Returns a list of 2 masked arrays containing interpolated derivatives at the specified x,y points.

### Parameters

**x, y** [array-like] x and y coordinates of the same shape and any number of dimensions.

### Returns

**dzdx, dzdy** [np.ma.array] 2 masked arrays of the same shape as x and y; values corresponding to (x,y) points outside of the triangulation are masked out. The first returned array contains the values of  $\frac{\partial z}{\partial x}$  and the second those of  $\frac{\partial z}{\partial y}$ .

```
class matplotlib.tri.CubicTriInterpolator(triangulation, z, kind='min_E',
                                         trifinder=None, dz=None)
```

Bases: `matplotlib.tri.triinterpolate.TriInterpolator`

A CubicTriInterpolator performs cubic interpolation on triangular grids.

In one-dimension - on a segment - a cubic interpolating function is defined by the values of the function and its derivative at both ends. This is almost the same in 2-d inside a triangle, except that the values of the function and its 2 derivatives have to be defined at each triangle node.

The CubicTriInterpolator takes the value of the function at each node - provided by the user - and internally computes the value of the derivatives, resulting in a smooth interpolation. (As a special feature, the user can also impose the value of the derivatives at each node, but this is not supposed to be the common usage.)

### Parameters

**triangulation** [*Triangulation* object] The triangulation to interpolate over.

**z** [array\_like of shape (npoints,)] Array of values, defined at grid points, to interpolate between.

**kind** [{`'min_E'`, `'geom'`, `'user'`}, optional] Choice of the smoothing algorithm, in order to compute the interpolant derivatives (defaults to `'min_E'`):

- if `'min_E'`: (default) The derivatives at each node is computed to minimize a bending energy.
- if `'geom'`: The derivatives at each node is computed as a weighted average of relevant triangle normals. To be used for speed optimization (large grids).
- if `'user'`: The user provides the argument `dz`, no computation is hence needed.

**trifinder** [*TriFinder* object, optional] If not specified, the Triangulation's default TriFinder will be used by calling `matplotlib.tri.Triangulation.get_trifinder()`.

**dz** [tuple of array\_likes (`dzdx`, `dzdy`), optional] Used only if `kind = 'user'`. In this case `dz` must be provided as (`dzdx`, `dzdy`) where `dzdx`, `dzdy` are arrays of the same shape as `z` and are the interpolant first derivatives at the *triangulation* points.

## Notes

This note is a bit technical and details the way a *CubicTriInterpolator* computes a cubic interpolation.

The interpolation is based on a Clough-Tocher subdivision scheme of the *triangulation* mesh (to make it clearer, each triangle of the grid will be divided in 3 child-triangles, and on each child triangle the interpolated function is a cubic polynomial of the 2 coordinates). This technique originates from FEM (Finite Element Method) analysis; the element used is a reduced Hsieh-Clough-Tocher (HCT) element. Its shape functions are described in [?]. The assembled function is guaranteed to be C1-smooth, i.e. it is continuous and its first derivatives are also continuous (this is easy to show inside the triangles but is also true when crossing the edges).

In the default case (`kind = 'min_E'`), the interpolant minimizes a curvature energy on the functional space generated by the HCT element shape functions - with imposed values but arbitrary derivatives at each node. The minimized functional is the integral of the so-called total curvature (implementation based on an algorithm from [?] - PCG sparse solver):

$$E(z) = \frac{1}{2} \int_{\Omega} \left( \left( \frac{\partial^2 z}{\partial x^2} \right)^2 + \left( \frac{\partial^2 z}{\partial y^2} \right)^2 + 2 \left( \frac{\partial^2 z}{\partial y \partial x} \right)^2 \right) dx dy$$

If the case `kind = 'geom'` is chosen by the user, a simple geometric approximation is used (weighted average of the triangle normal vectors), which could improve speed on very large grids.

## References

[?], [?]

## Methods

' <b>__call__</b> ' (x, y)	( Returns interpolated values at x,y points)
' <b>gradient</b> ' (x, y)	(Returns interpolated derivatives at x,y points)

`gradient(self, x, y)`

Returns a list of 2 masked arrays containing interpolated derivatives at the specified x,y points.

**Parameters**

**x, y** [array-like] x and y coordinates of the same shape and any number of dimensions.

**Returns**

**dzdx, dzdy** [np.ma.array] 2 masked arrays of the same shape as x and y; values corresponding to (x,y) points outside of the triangulation are masked out. The first returned array contains the values of  $\frac{\partial z}{\partial x}$  and the second those of  $\frac{\partial z}{\partial y}$ .

`class matplotlib.tri.TriRefiner(triangulation)`

Abstract base class for classes implementing mesh refinement.

A TriRefiner encapsulates a Triangulation object and provides tools for mesh refinement and interpolation.

Derived classes must implements:

- `refine_triangulation(return_tri_index=False, **kwargs)` , where the optional keyword arguments *kwargs* are defined in each TriRefiner concrete implementation, and which returns:
  - a refined triangulation
  - optionally (depending on *return\_tri\_index*), for each point of the refined triangulation: the index of the initial triangulation triangle to which it belongs.
- `refine_field(z, triinterpolator=None, **kwargs)` , where:
  - *z* array of field values (to refine) defined at the base triangulation nodes
  - *triinterpolator* is a *TriInterpolator* (optional)
  - the other optional keyword arguments *kwargs* are defined in each TriRefiner concrete implementation

and which returns (as a tuple) a refined triangular mesh and the interpolated values of the field at the refined triangulation nodes.

`class matplotlib.tri.UniformTriRefiner(triangulation)`

Bases: `matplotlib.tri.trirefine.TriRefiner`

Uniform mesh refinement by recursive subdivisions.

**Parameters**

**triangulation** [*Triangulation*] The encapsulated triangulation (to be refined)

`refine_field(self, z, triinterpolator=None, subdiv=3)`

Refines a field defined on the encapsulated triangulation.

Returns *refi\_tri* (refined triangulation), *refi\_z* (interpolated values of the field at the node of the refined triangulation).

### Parameters

- z** [1d-array-like of length *n\_points*] Values of the field to refine, defined at the nodes of the encapsulated triangulation. (*n\_points* is the number of points in the initial triangulation)
- triinterpolator** [*TriInterpolator*, optional] Interpolator used for field interpolation. If not specified, a *CubicTriInterpolator* will be used.
- subdiv** [integer, optional] Recursion level for the subdivision. Defaults to 3. Each triangle will be divided into  $4^{**}subdiv$  child triangles.

### Returns

- refi\_tri** [*Triangulation* object] The returned refined triangulation
- refi\_z** [1d array of length: *refi\_tri* node count.] The returned interpolated field (at *refi\_tri* nodes)

`refine_triangulation(self, return_tri_index=False, subdiv=3)`

Computes an uniformly refined triangulation *refi\_triangulation* of the encapsulated triangulation.

This function refines the encapsulated triangulation by splitting each father triangle into 4 child sub-triangles built on the edges midside nodes, recursively (level of recursion *subdiv*). In the end, each triangle is hence divided into  $4^{**}subdiv$  child triangles. The default value for *subdiv* is 3 resulting in 64 refined subtriangles for each triangle of the initial triangulation.

### Parameters

- return\_tri\_index** [boolean, optional] Boolean indicating whether an index table indicating the father triangle index of each point will be returned. Default value False.
- subdiv** [integer, optional] Recursion level for the subdivision. Defaults value 3. Each triangle will be divided into  $4^{**}subdiv$  child triangles.

### Returns

- refi\_triangulation** [*Triangulation*] The returned refined triangulation
- found\_index** [array-like of integers] Index of the initial triangulation containing triangle, for each point of *refi\_triangulation*. Returned only if *return\_tri\_index* is set to True.

`class matplotlib.tri.TriAnalyzer(triangulation)`

Define basic tools for triangular mesh analysis and improvement.

A *TriAnalyzer* encapsulates a *Triangulation* object and provides basic tools for mesh analysis and mesh improvement.

### Parameters

- triangulation** [*Triangulation* object] The encapsulated triangulation to analyze.

### Attributes

'**scale\_factors**'

`circle_ratios(self, rescale=True)`

Returns a measure of the triangulation triangles flatness.

The ratio of the incircle radius over the circumcircle radius is a widely used indicator of a triangle flatness. It is always  $\leq 0.5$  and  $= 0.5$  only for equilateral triangles. Circle ratios below 0.01 denote very flat triangles.

To avoid unduly low values due to a difference of scale between the 2 axis, the triangular mesh can first be rescaled to fit inside a unit square with `scale_factors` (Only if `rescale` is True, which is its default value).

### Parameters

**rescale** [boolean, optional] If True, a rescaling will be internally performed (based on `scale_factors`, so that the (unmasked) triangles fit exactly inside a unit square mesh. Default is True.

### Returns

**circle\_ratios** [masked array] Ratio of the incircle radius over the circumcircle radius, for each 'rescaled' triangle of the encapsulated triangulation. Values corresponding to masked triangles are masked out.

`get_flat_tri_mask(self, min_circle_ratio=0.01, rescale=True)`

Eliminates excessively flat border triangles from the triangulation.

Returns a mask `new_mask` which allows to clean the encapsulated triangulation from its border-located flat triangles (according to their `circle_ratios()`). This mask is meant to be subsequently applied to the triangulation using `matplotlib.tri.Triangulation.set_mask()`. `new_mask` is an extension of the initial triangulation mask in the sense that an initially masked triangle will remain masked.

The `new_mask` array is computed recursively; at each step flat triangles are removed only if they share a side with the current mesh border. Thus no new holes in the triangulated domain will be created.

### Parameters

**min\_circle\_ratio** [float, optional] Border triangles with incircle/circumcircle radii ratio  $r/R$  will be removed if  $r/R < min\_circle\_ratio$ . Default value: 0.01

**rescale** [boolean, optional] If True, a rescaling will first be internally performed (based on `scale_factors`), so that the (unmasked) triangles fit exactly inside a unit square mesh. This rescaling accounts for the difference of scale which might exist between the 2 axis. Default (and recommended) value is True.

### Returns

**new\_mask** [array-like of booleans] Mask to apply to encapsulated triangulation. All the initially masked triangles remain masked in the `new_mask`.

### Notes

The rationale behind this function is that a Delaunay triangulation - of an unstructured set of points - sometimes contains almost flat triangles at its border, leading

to artifacts in plots (especially for high-resolution contouring). Masked with computed *new\_mask*, the encapsulated triangulation would contain no more unmasked border triangles with a circle ratio below *min\_circle\_ratio*, thus improving the mesh quality for subsequent plots or interpolation.

`scale_factors`

Factors to rescale the triangulation into a unit square.

Returns *k*, tuple of 2 scale factors.

### Returns

**k** [tuple of 2 floats (kx, ky)] Tuple of floats that would rescale the triangulation: `[triangulation.x * kx, triangulation.y * ky]` fits exactly inside a unit square.

## 17.53 matplotlib.type1font

This module contains a class representing a Type 1 font.

This version reads pfa and pfb files and splits them for embedding in pdf files. It also supports SlantFont and ExtendFont transformations, similarly to pdfTeX and friends. There is no support yet for subsetting.

Usage:

```
>>> font = Type1Font(filename)
>>> clear_part, encrypted_part, finale = font.parts
>>> slanted_font = font.transform({'slant': 0.167})
>>> extended_font = font.transform({'extend': 1.2})
```

Sources:

- Adobe Technical Note #5040, Supporting Downloadable PostScript Language Fonts.
- Adobe Type 1 Font Format, Adobe Systems Incorporated, third printing, v1.1, 1993. ISBN 0-201-57044-0.

```
class matplotlib.type1font.Type1Font(input)
```

Bases: `object`

A class representing a Type-1 font, for use by backends.

### Attributes

**parts** [tuple] A 3-tuple of the cleartext part, the encrypted part, and the finale of zeros.

**prop** [Dict[str, Any]] A dictionary of font properties.

Initialize a Type-1 font. *input* can be either the file name of a pfb file or a 3-tuple of already-decoded Type-1 font parts.

`parts`

`prop`

`transform(self, effects)`

Transform the font by slanting or extending. *effects* should be a dict where `effects['slant']` is the tangent of the angle that the font is to be slanted to the

right (so negative values slant to the left) and `effects['extend']` is the multiplier by which the font is to be extended (so values less than 1.0 condense). Returns a new *Type1Font* object.

## 17.54 matplotlib.units

The classes here provide support for using custom classes with Matplotlib, e.g., those that do not expose the array interface but know how to convert themselves to arrays. It also supports classes with units and units conversion. Use cases include converters for custom objects, e.g., a list of datetime objects, as well as for objects that are unit aware. We don't assume any particular units implementation; rather a units implementation must provide the register with the Registry converter dictionary and a *ConversionInterface*. For example, here is a complete implementation which supports plotting with native datetime objects:

```
import matplotlib.units as units
import matplotlib.dates as dates
import matplotlib.ticker as ticker
import datetime

class DateConverter(units.ConversionInterface):

    @staticmethod
    def convert(value, unit, axis):
        'Convert a datetime value to a scalar or array'
        return dates.date2num(value)

    @staticmethod
    def axisinfo(unit, axis):
        'Return major and minor tick locators and formatters'
        if unit != 'date': return None
        majloc = dates.AutoDateLocator()
        majfmt = dates.AutoDateFormatter(majloc)
        return AxisInfo(majloc=majloc,
                        majfmt=majfmt,
                        label='date')

    @staticmethod
    def default_units(x, axis):
        'Return the default unit for x or None'
        return 'date'

# Finally we register our object type with the Matplotlib units registry.
units.registry[datetime.date] = DateConverter()
```

```
class matplotlib.units.AxisInfo(majloc=None, minloc=None, majfmt=None,
                                minfmt=None, label=None, default_limits=None)
```

Bases: `object`

Information to support default axis labeling, tick labeling, and limits.

An instance of this class must be returned by *ConversionInterface.axisinfo*.

### Parameters

**majloc, minloc** [Locator, optional] Tick locators for the major and minor ticks.

**majfmt, minfmt** [Formatter, optional] Tick formatters for the major and minor ticks.

**label** [str, optional] The default axis label.

**default\_limits** [optional] The default min and max limits of the axis if no data has been plotted.

### Notes

If any of the above are `None`, the axis will simply use the default value.

```
exception matplotlib.units.ConversionError
    Bases: TypeError
```

```
class matplotlib.units.ConversionInterface
    Bases: object
```

The minimal interface for a converter to take custom data types (or sequences) and convert them to values Matplotlib can use.

```
static axisinfo(unit, axis)
    Return an AxisInfo for the axis with the specified units.
```

```
static convert(obj, unit, axis)
    Convert obj using unit for the specified axis.
```

If *obj* is a sequence, return the converted sequence. The output must be a sequence of scalars that can be used by the numpy array layer.

```
static default_units(x, axis)
    Return the default unit for x or None for the given axis.
```

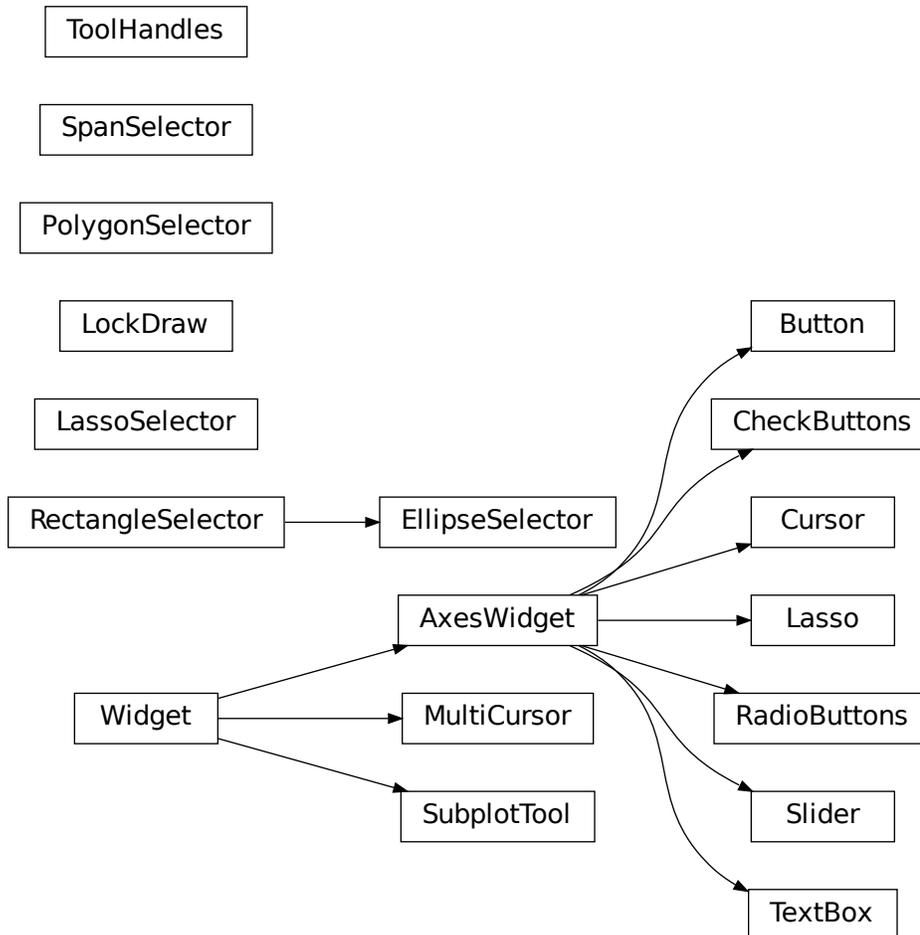
```
static is_numlike(x)
    The Matplotlib datalim, autoscaling, locators etc work with scalars which are the units converted to floats given the current unit. The converter may be passed these floats, or arrays of them, even when units are set.
```

```
class matplotlib.units.Registry
    Bases: dict
```

Register types with conversion interface.

```
get_converter(self, x)
    Get the converter interface instance for x, or None.
```

## 17.55 matplotlib.widgets



### 17.55.1 GUI neutral widgets

Widgets that are designed to work for any of the GUI backends. All of these widgets require you to predefine a `matplotlib.axes.Axes` instance and pass that as the first arg. matplotlib doesn't try to be too smart with respect to layout - you will have to figure out how wide and tall you want your Axes to be to accommodate your widget.

```
class matplotlib.widgets.AxesWidget(ax)
    Bases: matplotlib.widgets.Widget
```

Widget that is connected to a single *Axes*.

To guarantee that the widget remains responsive and not garbage-collected, a reference to the object should be maintained by the user.

This is necessary because the callback registry maintains only weak-refs to the functions, which are member functions of the widget. If there are no references to the widget object it may be garbage collected which will disconnect the callbacks.

Attributes:

**ax** [*Axes*] The parent axes for the widget

**canvas** [*FigureCanvasBase* subclass] The parent figure canvas for the widget.

**active** [bool] If False, the widget does not respond to events.

`connect_event(self, event, callback)`  
Connect callback with an event.

This should be used in lieu of `figure.canvas.mpl_connect` since this function stores callback ids for later clean up.

`disconnect_events(self)`  
Disconnect all events created by this widget.

```
class matplotlib.widgets.Button(ax, label, image=None, color='0.85', hover-
                                color='0.95')
```

Bases: *matplotlib.widgets.AxesWidget*

A GUI neutral button.

For the button to remain responsive you must keep a reference to it. Call `on_clicked()` to connect to the button.

#### Attributes

**ax** The *matplotlib.axes.Axes* the button renders into.

**label** A *matplotlib.text.Text* instance.

**color** The color of the button when not hovering.

**hovercolor** The color of the button when hovering.

#### Parameters

**ax** [*matplotlib.axes.Axes*] The *matplotlib.axes.Axes* instance the button will be placed into.

**label** [str] The button text. Accepts string.

**image** [array, mpl image, Pillow Image] The image to place in the button, if not *None*. Can be any legal arg to `imshow` (numpy array, *matplotlib* Image instance, or Pillow Image).

**color** [color] The color of the button when not activated

**hovercolor** [color] The color of the button when the mouse is over it

`disconnect(self, cid)`  
Remove the callback function with connection id *cid*.

`on_clicked(self, func)`  
Connect the callback function *func* to button click events.

Returns a connection id, which can be used to disconnect the callback.

```
class matplotlib.widgets.CheckButtons(ax, labels, actives=None)
Bases: matplotlib.widgets.AxesWidget
```

A GUI neutral set of check buttons.

For the check buttons to remain responsive you must keep a reference to this object.

The following attributes are exposed

**ax** The `matplotlib.axes.Axes` instance the buttons are located in

**labels** List of `matplotlib.text.Text` instances

**lines** List of (line1, line2) tuples for the x's in the check boxes. These lines exist for each box, but have `set_visible(False)` when its box is not checked.

**rectangles** List of `matplotlib.patches.Rectangle` instances

Connect to the CheckButtons with the `on_clicked()` method

Add check buttons to `matplotlib.axes.Axes` instance `ax`

### Parameters

**ax** [`Axes`] The parent axes for the widget.

**labels** [List[str]] The labels of the check buttons.

**actives** [List[bool], optional] The initial check states of the buttons. The list must have the same length as `labels`. If not given, all buttons are unchecked.

`disconnect(self, cid)`

remove the observer with connection id `cid`

`get_status(self)`

Return a tuple of the status (True/False) of all of the check buttons.

`on_clicked(self, func)`

Connect the callback function `func` to button click events.

Returns a connection id, which can be used to disconnect the callback.

`set_active(self, index)`

Directly (de)activate a check button by index.

**index is an index into the original label list** that this object was constructed with. Raises `ValueError` if `index` is invalid.

Callbacks will be triggered if `eventson` is True.

```
class matplotlib.widgets.Cursor(ax, horizOn=True, vertOn=True, useblit=False, **line-props)
```

Bases: `matplotlib.widgets.AxesWidget`

A crosshair cursor that spans the axes and moves with mouse cursor.

For the cursor to remain responsive you must keep a reference to it.

### Parameters

**ax** [`matplotlib.axes.Axes`] The `Axes` to attach the cursor to.

**horizOn** [bool, optional, default: True] Whether to draw the horizontal line.

**vertOn** [bool, optional, default: True] Whether to draw the vertical line.

**useblit** [bool, optional, default: False] Use blitting for faster drawing if supported by the backend.

## Other Parameters

**\*\*lineprops** *Line2D* properties that control the appearance of the lines.  
See also *axhline*.

### Examples

See </gallery/widgets/cursor>.

`clear(self, event)`

Internal event handler to clear the cursor.

`onmove(self, event)`

Internal event handler to draw the cursor when the mouse moves.

```
class matplotlib.widgets.EllipseSelector(ax,          onselect,          drawtype='box',
                                         minspanx=None,          minspany=None,
                                         useblit=False,          lineprops=None,          rect-
                                         props=None,          spancoords='data',
                                         button=None,          maxdist=10,
                                         marker_props=None,          interactive=False,
                                         state_modifier_keys=None)
```

Bases: `matplotlib.widgets.RectangleSelector`

Select an elliptical region of an axes.

For the cursor to remain responsive you must keep a reference to it.

Example usage:

```
import numpy as np
import matplotlib.pyplot as plt
from matplotlib.widgets import EllipseSelector

def onselect(eclick, erelease):
    "eclick and erelease are matplotlib events at press and release."
    print('startposition: (%f, %f)' % (eclick.xdata, eclick.ydata))
    print('endposition   : (%f, %f)' % (erelease.xdata, erelease.ydata))
    print('used button   : ', eclick.button)

def toggle_selector(event):
    print(' Key pressed.')
    if event.key in ['Q', 'q'] and toggle_selector.ES.active:
        print('EllipseSelector deactivated.')
        toggle_selector.RS.set_active(False)
    if event.key in ['A', 'a'] and not toggle_selector.ES.active:
        print('EllipseSelector activated.')
        toggle_selector.ES.set_active(True)

x = np.arange(100.) / 99
y = np.sin(x)
fig, ax = plt.subplots()
ax.plot(x, y)

toggle_selector.ES = EllipseSelector(ax, onselect, drawtype='line')
```

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```
fig.canvas.mpl_connect('key_press_event', toggle_selector)
plt.show()
```

Create a selector in *ax*. When a selection is made, clear the span and call `onselect` with:

```
onselect(pos_1, pos_2)
```

and clear the drawn box/line. The `pos_1` and `pos_2` are arrays of length 2 containing the x- and y-coordinate.

If `minspanx` is not `None` then events smaller than `minspanx` in x direction are ignored (it's the same for y).

The rectangle is drawn with `rectprops`; default:

```
rectprops = dict(facecolor='red', edgecolor = 'black',
                 alpha=0.2, fill=True)
```

The line is drawn with `lineprops`; default:

```
lineprops = dict(color='black', linestyle='-',
                 linewidth = 2, alpha=0.5)
```

Use `drawtype` if you want the mouse to draw a line, a box or nothing between click and actual position by setting

`drawtype = 'line', drawtype='box' or drawtype = 'none'`. Drawing a line would result in a line from vertex A to vertex C in a rectangle ABCD.

`spancoords` is one of 'data' or 'pixels'. If 'data', `minspanx` and `minspany` will be interpreted in the same coordinates as the x and y axis. If 'pixels', they are in pixels.

`button` is a list of integers indicating which mouse buttons should be used for rectangle selection. You can also specify a single integer if only a single button is desired. Default is `None`, which does not limit which button can be used.

**Note, typically:** 1 = left mouse button 2 = center mouse button (scroll wheel) 3 = right mouse button

`interactive` will draw a set of handles and allow you interact with the widget after it is drawn.

`state_modifier_keys` are keyboard modifiers that affect the behavior of the widget.

The defaults are: `dict(move=' ', clear='escape', square='shift', center='ctrl')`

Keyboard modifiers, which: 'move': Move the existing shape. 'clear': Clear the current shape. 'square': Makes the shape square. 'center': Make the initial point the center of the shape. 'square' and 'center' can be combined.

`draw_shape(self, extents)`

```
class matplotlib.widgets.Lasso(ax, xy, callback=None, useblit=True)
```

Bases: `matplotlib.widgets.AxesWidget`

Selection curve of an arbitrary shape.

The selected path can be used in conjunction with `contains_point()` to select data points from an image.

Unlike *LassoSelector*, this must be initialized with a starting point *xy*, and the *Lasso* events are destroyed upon release.

### Parameters

**ax** [*Axes*] The parent axes for the widget.

**xy** [(float, float)] Coordinates of the start of the lasso.

**callback** [callable] Whenever the lasso is released, the *callback* function is called and passed the vertices of the selected path.

`onmove(self, event)`

`onrelease(self, event)`

```
class matplotlib.widgets.LassoSelector(ax, onselect=None, useblit=True, line-
                                     props=None, button=None)
```

Bases: `matplotlib.widgets._SelectorWidget`

Selection curve of an arbitrary shape.

For the selector to remain responsive you must keep a reference to it.

The selected path can be used in conjunction with *contains\_point* to select data points from an image.

In contrast to *Lasso*, *LassoSelector* is written with an interface similar to *RectangleSelector* and *SpanSelector*, and will continue to interact with the axes until disconnected.

Example usage:

```
ax = subplot(111)
ax.plot(x,y)

def onselect(verts):
    print(verts)
lasso = LassoSelector(ax, onselect)
```

### Parameters

**ax** [*Axes*] The parent axes for the widget.

**onselect** [function] Whenever the lasso is released, the *onselect* function is called and passed the vertices of the selected path.

**button** [List[Int], optional] A list of integers indicating which mouse buttons should be used for rectangle selection. You can also specify a single integer if only a single button is desired. Default is *None*, which does not limit which button can be used.

Note, typically:

- 1 = left mouse button
- 2 = center mouse button (scroll wheel)
- 3 = right mouse button

`onpress(self, event)`

`onrelease(self, event)`

```
class matplotlib.widgets.LockDraw
```

Bases: `object`

Some widgets, like the cursor, draw onto the canvas, and this is not desirable under all circumstances, like when the toolbar is in zoom-to-rect mode and drawing a rectangle. To avoid this, a widget can acquire a canvas' lock with `canvas.widgetlock(widget)` before drawing on the canvas; this will prevent other widgets from doing so at the same time (if they also try to acquire the lock first).

```
available(self, o)
```

Return whether drawing is available to *o*.

```
isowner(self, o)
```

Return whether *o* owns this lock.

```
locked(self)
```

Return whether the lock is currently held by an owner.

```
release(self, o)
```

Release the lock from *o*.

```
class matplotlib.widgets.MultiCursor(canvas, axes, useblit=True, horizOn=False, ver-
                                     tOn=True, **lineprops)
```

Bases: `matplotlib.widgets.Widget`

Provide a vertical (default) and/or horizontal line cursor shared between multiple axes.

For the cursor to remain responsive you must keep a reference to it.

Example usage:

```
from matplotlib.widgets import MultiCursor
import matplotlib.pyplot as plt
import numpy as np

fig, (ax1, ax2) = plt.subplots(nrows=2, sharex=True)
t = np.arange(0.0, 2.0, 0.01)
ax1.plot(t, np.sin(2*np.pi*t))
ax2.plot(t, np.sin(4*np.pi*t))

multi = MultiCursor(fig.canvas, (ax1, ax2), color='r', lw=1,
                    horizOn=False, vertOn=True)
plt.show()
```

```
clear(self, event)
```

clear the cursor

```
connect(self)
```

connect events

```
disconnect(self)
```

disconnect events

```
onmove(self, event)
```

```
class matplotlib.widgets.PolygonSelector(ax, onselect, useblit=False, line-
                                         props=None, markerprops=None, ver-
                                         tex_select_radius=15)
```

Bases: `matplotlib.widgets._SelectorWidget`

Select a polygon region of an axes.

Place vertices with each mouse click, and make the selection by completing the polygon (clicking on the first vertex). Hold the *ctrl* key and click and drag a vertex to reposition it (the *ctrl* key is not necessary if the polygon has already been completed). Hold the *shift* key and click and drag anywhere in the axes to move all vertices. Press the *esc* key to start a new polygon.

For the selector to remain responsive you must keep a reference to it.

### Parameters

**ax** [*Axes*] The parent axes for the widget.

**onselect** [function] When a polygon is completed or modified after completion, the `onselect` function is called and passed a list of the vertices as (*xdata*, *ydata*) tuples.

**useblit** [bool, optional]

**lineprops** [dict, optional] The line for the sides of the polygon is drawn with the properties given by `lineprops`. The default is `dict(color='k', linestyle='-', linewidth=2, alpha=0.5)`.

**markerprops** [dict, optional] The markers for the vertices of the polygon are drawn with the properties given by `markerprops`. The default is `dict(marker='o', markersize=7, mec='k', mfc='k', alpha=0.5)`.

**vertex\_select\_radius** [float, optional] A vertex is selected (to complete the polygon or to move a vertex) if the mouse click is within `vertex_select_radius` pixels of the vertex. The default radius is 15 pixels.

### Examples

`/gallery/widgets/polygon_selector_demo`

`onmove(self, event)`

Cursor move event handler and validator

`verts`

Get the polygon vertices.

### Returns

**list** A list of the vertices of the polygon as (*xdata*, *ydata*) tuples.

```
class matplotlib.widgets.RadioButtons(ax, labels, active=0, activecolor='blue')
```

Bases: `matplotlib.widgets.AxesWidget`

A GUI neutral radio button.

For the buttons to remain responsive you must keep a reference to this object.

Connect to the `RadioButtons` with the `on_clicked()` method.

### Attributes

**ax** The containing *Axes* instance.

**activecolor** The color of the selected button.

**labels** A list of *Text* instances containing the button labels.

**circles** A list of *Circle* instances defining the buttons.

**value\_selected** [str] The label text of the currently selected button.

Add radio buttons to an *Axes*.

### Parameters

**ax** [*Axes*] The axes to add the buttons to.

**labels** [list of str] The button labels.

**active** [int] The index of the initially selected button.

**activecolor** [color] The color of the selected button.

`disconnect(self, cid)`

Remove the observer with connection id *cid*.

`on_clicked(self, func)`

Connect the callback function *func* to button click events.

Returns a connection id, which can be used to disconnect the callback.

`set_active(self, index)`

Select button with number *index*.

Callbacks will be triggered if `eventson` is `True`.

```
class matplotlib.widgets.RectangleSelector(ax,          onselect,          drawtype='box',
                                           minspanx=None,    minspany=None,
                                           useblit=False,   lineprops=None,  rect-
                                           props=None,      spancoords='data',
                                           button=None,      maxdist=10,
                                           marker_props=None, interactive=False,
                                           state_modifier_keys=None)
```

Bases: `matplotlib.widgets._SelectorWidget`

Select a rectangular region of an axes.

For the cursor to remain responsive you must keep a reference to it.

Example usage:

```
import numpy as np
import matplotlib.pyplot as plt
from matplotlib.widgets import RectangleSelector

def onselect(eclick, erelease):
    "eclick and erelease are matplotlib events at press and release."
    print('startposition: (%f, %f)' % (eclick.xdata, eclick.ydata))
    print('endposition   : (%f, %f)' % (erelease.xdata, erelease.ydata))
    print('used button   : ', eclick.button)

def toggle_selector(event):
    print('Key pressed.')
    if event.key in ['Q', 'q'] and toggle_selector.RS.active:
        print('RectangleSelector deactivated.')
        toggle_selector.RS.set_active(False)
    if event.key in ['A', 'a'] and not toggle_selector.RS.active:
        print('RectangleSelector activated.')
        toggle_selector.RS.set_active(True)
```

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```
x = np.arange(100.) / 99
y = np.sin(x)
fig, ax = plt.subplots()
ax.plot(x, y)

toggle_selector.RS = RectangleSelector(ax, onselect, drawtype='line')
fig.canvas.mpl_connect('key_press_event', toggle_selector)
plt.show()
```

Create a selector in *ax*. When a selection is made, clear the span and call *onselect* with:

```
onselect(pos_1, pos_2)
```

and clear the drawn box/line. The *pos\_1* and *pos\_2* are arrays of length 2 containing the x- and y-coordinate.

If *minspanx* is not *None* then events smaller than *minspanx* in x direction are ignored (it's the same for y).

The rectangle is drawn with *rectprops*; default:

```
rectprops = dict(facecolor='red', edgecolor = 'black',
                 alpha=0.2, fill=True)
```

The line is drawn with *lineprops*; default:

```
lineprops = dict(color='black', linestyle='-',
                 linewidth = 2, alpha=0.5)
```

Use *drawtype* if you want the mouse to draw a line, a box or nothing between click and actual position by setting

*drawtype* = 'line', *drawtype*='box' or *drawtype* = 'none'. Drawing a line would result in a line from vertex A to vertex C in a rectangle ABCD.

*spancoords* is one of 'data' or 'pixels'. If 'data', *minspanx* and *minspany* will be interpreted in the same coordinates as the x and y axis. If 'pixels', they are in pixels.

*button* is a list of integers indicating which mouse buttons should be used for rectangle selection. You can also specify a single integer if only a single button is desired. Default is *None*, which does not limit which button can be used.

**Note, typically:** 1 = left mouse button 2 = center mouse button (scroll wheel) 3 = right mouse button

*interactive* will draw a set of handles and allow you interact with the widget after it is drawn.

*state\_modifier\_keys* are keyboard modifiers that affect the behavior of the widget.

The defaults are: dict(move=' ', clear='escape', square='shift', center='ctrl')

Keyboard modifiers, which: 'move': Move the existing shape. 'clear': Clear the current shape. 'square': Makes the shape square. 'center': Make the initial point the center of the shape. 'square' and 'center' can be combined.

**center**

Center of rectangle

**corners**

Corners of rectangle from lower left, moving clockwise.

`draw_shape(self, extents)`

**edge\_centers**

Midpoint of rectangle edges from left, moving clockwise.

**extents**

Return (xmin, xmax, ymin, ymax).

**geometry**

Returns numpy.ndarray of shape (2,5) containing x (`RectangleSelector.geometry[1, :]`) and y (`RectangleSelector.geometry[0, :]`) coordinates of the four corners of the rectangle starting and ending in the top left corner.

```
class matplotlib.widgets.Slider(ax, label, valmin, valmax, valinit=0.5, valfmt='%1.2f',
                                closedmin=True, closedmax=True, slidermin=None,
                                slidermax=None, dragging=True, valstep=None, ori-
                                entation='horizontal', **kwargs)
```

Bases: `matplotlib.widgets.AxesWidget`

A slider representing a floating point range.

Create a slider from *valmin* to *valmax* in axes *ax*. For the slider to remain responsive you must maintain a reference to it. Call `on_changed()` to connect to the slider event.

**Attributes**

**val** [float] Slider value.

**Parameters**

**ax** [Axes] The Axes to put the slider in.

**label** [str] Slider label.

**valmin** [float] The minimum value of the slider.

**valmax** [float] The maximum value of the slider.

**valinit** [float, optional, default: 0.5] The slider initial position.

**valfmt** [str, optional, default: "%1.2f"] Used to format the slider value, fprint format string.

**closedmin** [bool, optional, default: True] Indicate whether the slider interval is closed on the bottom.

**closedmax** [bool, optional, default: True] Indicate whether the slider interval is closed on the top.

**slidermin** [Slider, optional, default: None] Do not allow the current slider to have a value less than the value of the Slider `slidermin`.

**slidermax** [Slider, optional, default: None] Do not allow the current slider to have a value greater than the value of the Slider `slidermax`.

**dragging** [bool, optional, default: True] If True the slider can be dragged by the mouse.

**valstep** [float, optional, default: None] If given, the slider will snap to multiples of `valstep`.

**orientation** [str, 'horizontal' or 'vertical', default: 'horizontal'] The orientation of the slider.

### Notes

Additional kwargs are passed on to `self.poly` which is the *Rectangle* that draws the slider knob. See the *Rectangle* documentation for valid property names (e.g., `facecolor`, `edgecolor`, `alpha`).

`disconnect(self, cid)`

Remove the observer with connection id `cid`

### Parameters

**cid** [int] Connection id of the observer to be removed

`on_changed(self, func)`

When the slider value is changed call `func` with the new slider value

### Parameters

**func** [callable] Function to call when slider is changed. The function must accept a single float as its arguments.

### Returns

**cid** [int] Connection id (which can be used to disconnect `func`)

`reset(self)`

Reset the slider to the initial value

`set_val(self, val)`

Set slider value to `val`

### Parameters

**val** [float]

```
class matplotlib.widgets.SpanSelector(ax, onselect, direction, minspan=None,
                                     useblit=False, rectprops=None, on-
                                     move_callback=None, span_stays=False, but-
                                     ton=None)
```

Bases: `matplotlib.widgets._SelectorWidget`

Visually select a min/max range on a single axis and call a function with those values.

To guarantee that the selector remains responsive, keep a reference to it.

In order to turn off the `SpanSelector`, set `span_selector.active=False`. To turn it back on, set `span_selector.active=True`.

### Parameters

**ax** [`matplotlib.axes.Axes` object]

**onselect** [func(min, max), min/max are floats]

**direction** ["horizontal" or "vertical"] The axis along which to draw the span selector

**minspan** [float, default is None] If selection is less than `minspan`, do not call `onselect`

**useblit** [bool, default is False] If True, use the backend-dependent blitting features for faster canvas updates.

**rectprops** [dict, default is None] Dictionary of `matplotlib.patches.Patch` properties

**onmove\_callback** [func(min, max), min/max are floats, default is None] Called on mouse move while the span is being selected

**span\_stays** [bool, default is False] If True, the span stays visible after the mouse is released

**button** [int or list of ints]

**Determines which mouse buttons activate the span selector** 1

= left mouse button

2 = center mouse button (scroll wheel)

3 = right mouse button

### Examples

```
>>> import matplotlib.pyplot as plt
>>> import matplotlib.widgets as mwidgets
>>> fig, ax = plt.subplots()
>>> ax.plot([1, 2, 3], [10, 50, 100])
>>> def onselect(vmin, vmax):
...     print(vmin, vmax)
>>> rectprops = dict(facecolor='blue', alpha=0.5)
>>> span = mwidgets.SpanSelector(ax, onselect, 'horizontal',
...                               rectprops=rectprops)
>>> fig.show()
```

See also: [/gallery/widgets/span\\_selector](/gallery/widgets/span_selector)

`buttonDown`

`ignore(self, event)`  
return *True* if *event* should be ignored

`new_axes(self, ax)`  
Set `SpanSelector` to operate on a new `Axes`

`class matplotlib.widgets.SubplotTool(targetfig, toolfig)`  
Bases: `matplotlib.widgets.Widget`

A tool to adjust the subplot params of a `matplotlib.figure.Figure`.

**targetfig** The figure instance to adjust.

**toolfig** The figure instance to embed the subplot tool into. If *None*, a default figure will be created. If you are using this from the GUI

`funcbottom(self, val)`

`funcspace(self, val)`

`funcleft(self, val)`

`funcright(self, val)`

```
functop(self, val)
```

```
funcwspace(self, val)
```

```
class matplotlib.widgets.TextBox(ax, label, initial="", color='.95', hovercolor='1', label_pad=0.01)
```

Bases: `matplotlib.widgets.AxesWidget`

A GUI neutral text input box.

For the text box to remain responsive you must keep a reference to it.

The following attributes are accessible:

**ax** The `matplotlib.axes.Axes` the button renders into.

**label** A `matplotlib.text.Text` instance.

**color** The color of the text box when not hovering.

**hovercolor** The color of the text box when hovering.

Call `on_text_change()` to be updated whenever the text changes.

Call `on_submit()` to be updated whenever the user hits enter or leaves the text entry field.

#### Parameters

**ax** [`matplotlib.axes.Axes`] The `matplotlib.axes.Axes` instance the button will be placed into.

**label** [`str`] Label for this text box. Accepts string.

**initial** [`str`] Initial value in the text box

**color** [`color`] The color of the box

**hovercolor** [`color`] The color of the box when the mouse is over it

**label\_pad** [`float`] the distance between the label and the right side of the textbox

```
begin_typing(self, x)
```

```
disconnect(self, cid)
```

Remove the observer with connection id `cid`.

```
on_submit(self, func)
```

When the user hits enter or leaves the submission box, call this `func` with event.

A connection id is returned which can be used to disconnect.

```
on_text_change(self, func)
```

When the text changes, call this `func` with event.

A connection id is returned which can be used to disconnect.

```
position_cursor(self, x)
```

```
set_val(self, val)
```

```
stop_typing(self)
```

```
class matplotlib.widgets.ToolHandles(ax, x, y, marker='o', marker_props=None, useblit=True)
```

Bases: `object`

Control handles for canvas tools.

**Parameters**

**ax** [*matplotlib.axes.Axes*] Matplotlib axes where tool handles are displayed.

**x, y** [1D arrays] Coordinates of control handles.

**marker** [str] Shape of marker used to display handle. See *matplotlib.pyplot.plot*.

**marker\_props** [dict] Additional marker properties. See *matplotlib.lines.Line2D*.

`closest(self, x, y)`

Return index and pixel distance to closest index.

`set_animated(self, val)`

`set_data(self, pts, y=None)`

Set x and y positions of handles

`set_visible(self, val)`

x

y

`class matplotlib.widgets.Widget`

Bases: `object`

Abstract base class for GUI neutral widgets

`active`

Is the widget active?

`drawon = True`

`eventson = True`

`get_active(self)`

Get whether the widget is active.

`ignore(self, event)`

Return True if event should be ignored.

This method (or a version of it) should be called at the beginning of any event callback.

`set_active(self, active)`

Set whether the widget is active.

## TOOLKITS

*Toolkits* are collections of application-specific functions that extend Matplotlib. The following toolkits are included:

### 18.1 Toolkits

Toolkits are collections of application-specific functions that extend Matplotlib.

#### 18.1.1 `mplot3d`

`mpl_toolkits.mplot3d` provides some basic 3D plotting (scatter, surf, line, mesh) tools. Not the fastest or most feature complete 3D library out there, but it ships with Matplotlib and thus may be a lighter weight solution for some use cases. Check out the *mplot3d tutorial* for more information.

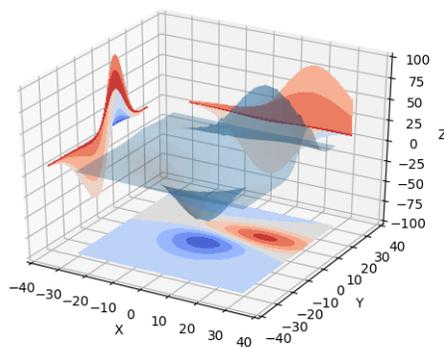


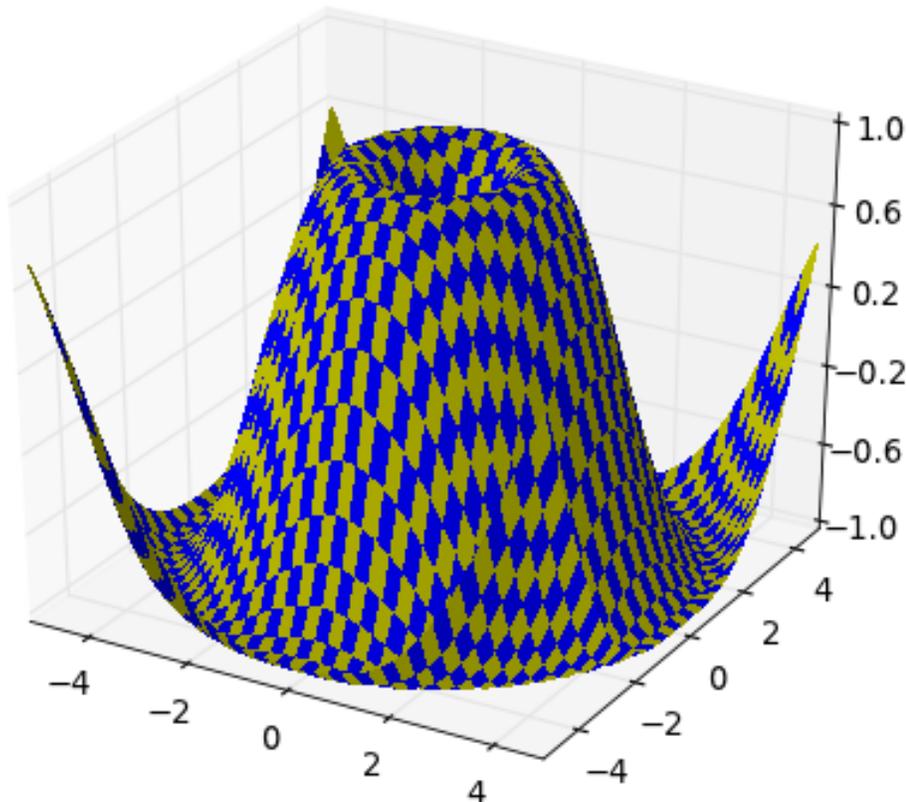
Fig. 1: Contourf3d 2

`mplot3d`

### Matplotlib mplot3d toolkit

The `mplot3d` toolkit adds simple 3D plotting capabilities to matplotlib by supplying an axes object that can create a 2D projection of a 3D scene. The resulting graph will have the same look and feel as regular 2D plots.

See the *mplot3d tutorial* for more information on how to use this toolkit.



The interactive backends also provide the ability to rotate and zoom the 3D scene. One can rotate the 3D scene by simply clicking-and-dragging the scene. Zooming is done by right-clicking the scene and dragging the mouse up and down. Note that one does not use the zoom button like one would use for regular 2D plots.

### mplot3d FAQ

#### How is mplot3d different from MayaVi?

[MayaVi2](#) is a very powerful and featureful 3D graphing library. For advanced 3D scenes and excellent rendering capabilities, it is highly recommended to use MayaVi2.

`mplot3d` was intended to allow users to create simple 3D graphs with the same “look-and-feel” as matplotlib’s 2D plots. Furthermore, users can use the same toolkit that they are already familiar with to generate both their 2D and 3D plots.

### My 3D plot doesn't look right at certain viewing angles

This is probably the most commonly reported issue with `mplot3d`. The problem is that - from some viewing angles - a 3D object would appear in front of another object, even though it is physically behind it. This can result in plots that do not look "physically correct."

Unfortunately, while some work is being done to reduce the occurrence of this artifact, it is currently an intractable problem, and can not be fully solved until matplotlib supports 3D graphics rendering at its core.

The problem occurs due to the reduction of 3D data down to 2D + z-order scalar. A single value represents the 3rd dimension for all parts of 3D objects in a collection. Therefore, when the bounding boxes of two collections intersect, it becomes possible for this artifact to occur. Furthermore, the intersection of two 3D objects (such as polygons or patches) can not be rendered properly in matplotlib's 2D rendering engine.

This problem will likely not be solved until OpenGL support is added to all of the backends (patches are greatly welcomed). Until then, if you need complex 3D scenes, we recommend using [Mayavi](#).

### I don't like how the 3D plot is laid out, how do I change that?

Historically, `mplot3d` has suffered from a hard-coding of parameters used to control visuals such as label spacing, tick length, and grid line width. Work is being done to eliminate this issue. For matplotlib v1.1.0, there is a semi-official manner to modify these parameters. See the note in the `axis3d` section of the `mplot3d` API documentation for more information.

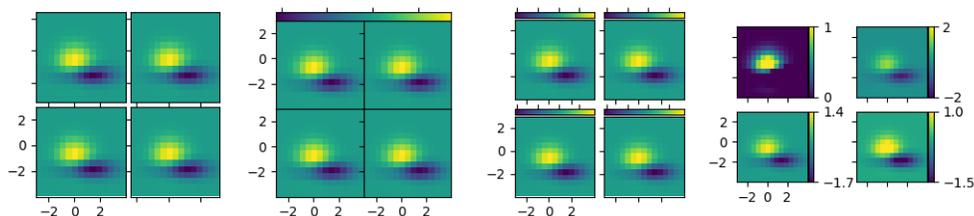
### Links

- `mplot3d` API: *mplot3d* API

## 18.1.2 Matplotlib `axes_grid1` Toolkit

The matplotlib `mpl_toolkits.axes_grid1` toolkit is a collection of helper classes to ease displaying multiple images in matplotlib. While the `aspect` parameter in matplotlib adjust the position of the single axes, `axes_grid1` toolkit provides a framework to adjust the position of multiple axes according to their aspects.

See *What is `axes_grid1` toolkit?* for a guide on the usage of `axes_grid1`.



**The submodules of the `axes_grid1` API are:**

<i>axes_grid1.anchored_artists</i>	
<i>axes_grid1.axes_divider</i>	The axes_divider module provides helper classes to adjust the positions of multiple axes at drawing time.
<i>axes_grid1.axes_grid</i>	
<i>axes_grid1.axes_rgb</i>	
<i>axes_grid1.axes_size</i>	Provides classes of simple units that will be used with AxesDivider class (or others) to determine the size of each axes.
<i>axes_grid1.colorbar</i>	Colorbar toolkit with two classes and a function:
<i>axes_grid1.inset_locator</i>	A collection of functions and objects for creating or placing inset axes.
<i>axes_grid1.mpl_axes</i>	
<i>axes_grid1.parasite_axes</i>	

**mpl\_toolkits.axes\_grid1.anchored\_artists**

**Classes**

<i>AnchoredAuxTransformBox</i> (transform, loc[, ...])	An anchored container with transformed coordinates.
<i>AnchoredDirectionArrows</i> (transform, label_x, ...)	Draw two perpendicular arrows to indicate directions.
<i>AnchoredDrawingArea</i> (width, height, xdescent, ...)	An anchored container with a fixed size and fillable DrawingArea.
<i>AnchoredEllipse</i> (transform, width, height, ...)	Draw an anchored ellipse of a given size.
<i>AnchoredSizeBar</i> (transform, size, label, loc)	Draw a horizontal scale bar with a center-aligned label underneath.

**mpl\_toolkits.axes\_grid1.anchored\_artists.AnchoredAuxTransformBox**

```
class mpl_toolkits.axes_grid1.anchored_artists.AnchoredAuxTransformBox(transform,
                                                                    loc, pad=0.4,
                                                                    border-
                                                                    pad=0.5,
                                                                    prop=None,
                                                                    frameon=True,
                                                                    **kwargs)
```

Bases: *matplotlib.offsetbox.AnchoredOffsetbox*

An anchored container with transformed coordinates.

Artists added to the *drawing\_area* are scaled according to the coordinates of the transformation used. The dimensions of this artist will scale to contain the artists added.

**Parameters**

**transform** [*matplotlib.transforms.Transform*] The transformation object for the coordinate system in use, i.e., *matplotlib.axes.Axes.transData*.

**loc** [int] Location of this artist. Valid location codes are:

```
'upper right' : 1,
'upper left'  : 2,
'lower left'  : 3,
'lower right' : 4,
'right'       : 5,
'center left' : 6,
'center right': 7,
'lower center': 8,
'upper center': 9,
'center'      : 10
```

**pad** [int or float, optional] Padding around the child objects, in fraction of the font size. Defaults to 0.4.

**borderpad** [int or float, optional] Border padding, in fraction of the font size. Defaults to 0.5.

**prop** [*matplotlib.font\_manager.FontProperties*, optional] Font property used as a reference for paddings.

**frameon** [bool, optional] If True, draw a box around this artists. Defaults to True.

**\*\*kwargs** Keyworded arguments to pass to *matplotlib.offsetbox.AnchoredOffsetbox*.

### Examples

To display an ellipse in the upper left, with a width of 0.1 and height of 0.4 in data coordinates:

```
>>> box = AnchoredAuxTransformBox(ax.transData, loc='upper left')
>>> el = Ellipse((0,0), width=0.1, height=0.4, angle=30)
>>> box.drawing_area.add_artist(el)
>>> ax.add_artist(box)
```

### Attributes

**drawing\_area** [*matplotlib.offsetbox.AuxTransformBox*] A container for artists to display.

Examples using `mpl_toolkits.axes_grid1.anchored_artists.AnchoredAuxTransformBox`

- `sphx_glr_gallery_userdemo_anchored_box03.py`

`mpl_toolkits.axes_grid1.anchored_artists.AnchoredDirectionArrows`

```
class mpl_toolkits.axes_grid1.anchored_artists.AnchoredDirectionArrows(transform, label_x, label_y,
                                length=0.15,
                                font-
                                size=0.08,
                                loc=2, angle=0, aspect_ratio=1,
                                pad=0.4, borderpad=0.4,
                                frameon=False,
                                color='w',
                                alpha=1,
                                sep_x=0.01,
                                sep_y=0,
                                fontprop-
                                erties=None,
                                back_length=0.15,
                                head_width=10,
                                head_length=15,
                                tail_width=2,
                                text_props=None,
                                ar-
                                row_props=None,
                                **kwargs)
```

Bases: `matplotlib.offsetbox.AnchoredOffsetbox`

Draw two perpendicular arrows to indicate directions.

**Parameters**

**transform** [`matplotlib.transforms.Transform`] The transformation object for the coordinate system in use, i.e., `matplotlib.axes.Axes.transAxes`.

**label\_x, label\_y** [string] Label text for the x and y arrows

**length** [int or float, optional] Length of the arrow, given in coordinates of `transform`. Defaults to 0.15.

**fontsize** [int, optional] Size of label strings, given in coordinates of `transform`. Defaults to 0.08.

**loc** [int, optional] Location of the direction arrows. Valid location codes are:

```
'upper right' : 1,
'upper left'  : 2,
'lower left'  : 3,
'lower right' : 4,
'right'       : 5,
'center left' : 6,
'center right': 7,
'lower center': 8,
'upper center': 9,
'center'      : 10
```

Defaults to 2.

**angle** [int or float, optional] The angle of the arrows in degrees. Defaults to 0.

**aspect\_ratio** [int or float, optional] The ratio of the length of arrow\_x and arrow\_y. Negative numbers can be used to change the direction. Defaults to 1.

**pad** [int or float, optional] Padding around the labels and arrows, in fraction of the font size. Defaults to 0.4.

**borderpad** [int or float, optional] Border padding, in fraction of the font size. Defaults to 0.4.

**frameon** [bool, optional] If True, draw a box around the arrows and labels. Defaults to False.

**color** [str, optional] Color for the arrows and labels. Defaults to white.

**alpha** [int or float, optional] Alpha values of the arrows and labels Defaults to 1.

**sep\_x, sep\_y** [int or float, optional] Separation between the arrows and labels in coordinates of *transform*. Defaults to 0.01 and 0.

**fontproperties** [*matplotlib.font\_manager.FontProperties*, optional] Font properties for the label text.

**back\_length** [float, optional] Fraction of the arrow behind the arrow crossing. Defaults to 0.15.

**head\_width** [int or float, optional] Width of arrow head, sent to ArrowStyle. Defaults to 10.

**head\_length** [int or float, optional] Length of arrow head, sent to ArrowStyle. Defaults to 15.

**tail\_width** [int or float, optional] Width of arrow tail, sent to ArrowStyle. Defaults to 2.

**text\_props, arrow\_props** [dict] Properties of the text and arrows, passed to *matplotlib.text.TextPath* and *matplotlib.patches.FancyArrowPatch*

**\*\*kwargs** Keyworded arguments to pass to *matplotlib.offsetbox.AnchoredOffsetbox*.

## Notes

If *prop* is passed as a keyword argument, but *fontproperties* is not, then *prop* is assumed to be the intended *fontproperties*. Using both *prop* and *fontproperties* is not supported.

## Examples

```
>>> import matplotlib.pyplot as plt
>>> import numpy as np
>>> from mpl_toolkits.axes_grid1.anchored_artists import (
```

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```

...     AnchoredDirectionArrows)
>>> fig, ax = plt.subplots()
>>> ax.imshow(np.random.random((10,10)))
>>> arrows = AnchoredDirectionArrows(ax.transAxes, '111', '110')
>>> ax.add_artist(arrows)
>>> fig.show()

```

Using several of the optional parameters, creating downward pointing arrow and high contrast text labels.

```

>>> import matplotlib.font_manager as fm
>>> fontprops = fm.FontProperties(family='monospace')
>>> arrows = AnchoredDirectionArrows(ax.transAxes, 'East', 'South',
...                                 loc='lower left', color='k',
...                                 aspect_ratio=-1, sep_x=0.02,
...                                 sep_y=-0.01,
...                                 text_props={'ec':'w', 'fc':'k'},
...                                 fontproperties=fontprops)

```

### Attributes

- arrow\_x, arrow\_y** [*matplotlib.patches.FancyArrowPatch*] Arrow x and y
- text\_path\_x, text\_path\_y** [*matplotlib.text.TextPath*] Path for arrow labels
- p\_x, p\_y** [*matplotlib.patches.PathPatch*] Patch for arrow labels
- box** [*matplotlib.offsetbox.AuxTransformBox*] Container for the arrows and labels.

### Examples using `mpl_toolkits.axes_grid1.anchored_artists.AnchoredDirectionArrows`

- `sphx_glr_gallery_axes_grid1_demo_anchored_direction_arrows.py`

### `mpl_toolkits.axes_grid1.anchored_artists.AnchoredDrawingArea`

```

class mpl_toolkits.axes_grid1.anchored_artists.AnchoredDrawingArea(width, height,
                                                                    xdescent, ydescent,
                                                                    loc,
                                                                    pad=0.4, borderpad=0.5,
                                                                    prop=None,
                                                                    frameon=True,
                                                                    **kwargs)

```

Bases: *matplotlib.offsetbox.AnchoredOffsetbox*

An anchored container with a fixed size and fillable `DrawingArea`.

Artists added to the `drawing_area` will have their coordinates interpreted as pixels. Any transformations set on the artists will be overridden.

### Parameters

**width, height** [int or float] width and height of the container, in pixels.

**xdescent, ydescent** [int or float] descent of the container in the x- and y-direction, in pixels.

**loc** [int] Location of this artist. Valid location codes are:

```
'upper right' : 1,
'upper left'  : 2,
'lower left'  : 3,
'lower right' : 4,
'right'       : 5,
'center left' : 6,
'center right': 7,
'lower center': 8,
'upper center': 9,
'center'      : 10
```

**pad** [int or float, optional] Padding around the child objects, in fraction of the font size. Defaults to 0.4.

**borderpad** [int or float, optional] Border padding, in fraction of the font size. Defaults to 0.5.

**prop** [*matplotlib.font\_manager.FontProperties*, optional] Font property used as a reference for paddings.

**frameon** [bool, optional] If True, draw a box around this artists. Defaults to True.

**\*\*kwargs** Keyworded arguments to pass to *matplotlib.offsetbox.AnchoredOffsetbox*.

## Examples

To display blue and red circles of different sizes in the upper right of an axes *ax*:

```
>>> ada = AnchoredDrawingArea(20, 20, 0, 0,
...                           loc='upper right', frameon=False)
>>> ada.drawing_area.add_artist(Circle((10, 10), 10, fc="b"))
>>> ada.drawing_area.add_artist(Circle((30, 10), 5, fc="r"))
>>> ax.add_artist(ada)
```

## Attributes

**drawing\_area** [*matplotlib.offsetbox.DrawingArea*] A container for artists to display.

Examples using `mpl_toolkits.axes_grid1.anchored_artists.AnchoredDrawingArea`

- `sphx_glr_gallery_axes_grid1_simple_anchored_artists.py`
- `sphx_glr_gallery_userdemo_anchored_box02.py`

`mpl_toolkits.axes_grid1.anchored_artists.AnchoredEllipse`

```
class mpl_toolkits.axes_grid1.anchored_artists.AnchoredEllipse(transform, width,
                                                                height, angle, loc,
                                                                pad=0.1, border-
                                                                pad=0.1, prop=None,
                                                                frameon=True,
                                                                **kwargs)
```

Bases: `matplotlib.offsetbox.AnchoredOffsetbox`

Draw an anchored ellipse of a given size.

**Parameters**

**transform** [`matplotlib.transforms.Transform`] The transformation object for the coordinate system in use, i.e., `matplotlib.axes.Axes.transData`.

**width, height** [int or float] Width and height of the ellipse, given in coordinates of *transform*.

**angle** [int or float] Rotation of the ellipse, in degrees, anti-clockwise.

**loc** [int] Location of this size bar. Valid location codes are:

```
'upper right' : 1,
'upper left'  : 2,
'lower left'  : 3,
'lower right' : 4,
'right'       : 5,
'center left' : 6,
'center right': 7,
'lower center': 8,
'upper center': 9,
'center'      : 10
```

**pad** [int or float, optional] Padding around the ellipse, in fraction of the font size. Defaults to 0.1.

**borderpad** [int or float, optional] Border padding, in fraction of the font size. Defaults to 0.1.

**frameon** [bool, optional] If True, draw a box around the ellipse. Defaults to True.

**prop** [`matplotlib.font_manager.FontProperties`, optional] Font property used as a reference for paddings.

**\*\*kwargs** Keyworded arguments to pass to `matplotlib.offsetbox.AnchoredOffsetbox`.

**Attributes**

**ellipse** [`matplotlib.patches.Ellipse`] Ellipse patch drawn.

**Examples using `mpl_toolkits.axes_grid1.anchored_artists.AnchoredEllipse`**

- `sphinx_glr_gallery_axes_grid1_simple_anchored_artists.py`

`mpl_toolkits.axes_grid1.anchored_artists.AnchoredSizeBar`

```
class mpl_toolkits.axes_grid1.anchored_artists.AnchoredSizeBar(transform, size, label,
                                                                loc, pad=0.1, border-
                                                                pad=0.1, sep=2,
                                                                frameon=True,
                                                                size_vertical=0,
                                                                color='black', la-
                                                                bel_top=False, font-
                                                                properties=None,
                                                                fill_bar=None,
                                                                **kwargs)
```

Bases: `matplotlib.offsetbox.AnchoredOffsetbox`

Draw a horizontal scale bar with a center-aligned label underneath.

**Parameters**

**transform** [`matplotlib.transforms.Transform`] The transformation object for the coordinate system in use, i.e., `matplotlib.axes.Axes.transData`.

**size** [int or float] Horizontal length of the size bar, given in coordinates of *transform*.

**label** [str] Label to display.

**loc** [int] Location of this size bar. Valid location codes are:

```
'upper right' : 1,
'upper left'  : 2,
'lower left'  : 3,
'lower right' : 4,
'right'       : 5,
'center left' : 6,
'center right': 7,
'lower center': 8,
'upper center': 9,
'center'      : 10
```

**pad** [int or float, optional] Padding around the label and size bar, in fraction of the font size. Defaults to 0.1.

**borderpad** [int or float, optional] Border padding, in fraction of the font size. Defaults to 0.1.

**sep** [int or float, optional] Separation between the label and the size bar, in points. Defaults to 2.

**frameon** [bool, optional] If True, draw a box around the horizontal bar and label. Defaults to True.

**size\_vertical** [int or float, optional] Vertical length of the size bar, given in coordinates of *transform*. Defaults to 0.

**color** [str, optional] Color for the size bar and label. Defaults to black.

**label\_top** [bool, optional] If True, the label will be over the size bar. Defaults to False.

**fontproperties** [*matplotlib.font\_manager.FontProperties*, optional] Font properties for the label text.

**fill\_bar** [bool, optional] If True and if `size_vertical` is nonzero, the size bar will be filled in with the color specified by the size bar. Defaults to True if `size_vertical` is greater than zero and False otherwise.

**\*\*kwargs** Keyworded arguments to pass to *matplotlib.offsetbox.AnchoredOffsetbox*.

## Notes

If *prop* is passed as a keyworded argument, but *fontproperties* is not, then *prop* is assumed to be the intended *fontproperties*. Using both *prop* and *fontproperties* is not supported.

## Examples

```
>>> import matplotlib.pyplot as plt
>>> import numpy as np
>>> from mpl_toolkits.axes_grid1.anchored_artists import (
...     AnchoredSizeBar)
>>> fig, ax = plt.subplots()
>>> ax.imshow(np.random.random((10,10)))
>>> bar = AnchoredSizeBar(ax.transData, 3, '3 data units', 4)
>>> ax.add_artist(bar)
>>> fig.show()
```

Using all the optional parameters

```
>>> import matplotlib.font_manager as fm
>>> fontprops = fm.FontProperties(size=14, family='monospace')
>>> bar = AnchoredSizeBar(ax.transData, 3, '3 units', 4, pad=0.5,
...                       sep=5, borderpad=0.5, frameon=False,
...                       size_vertical=0.5, color='white',
...                       fontproperties=fontprops)
```

## Attributes

**size\_bar** [*matplotlib.offsetbox.AuxTransformBox*] Container for the size bar.

**txt\_label** [*matplotlib.offsetbox.TextArea*] Container for the label of the size bar.

Examples using `mpl_toolkits.axes_grid1.anchored_artists.AnchoredSizeBar`

- `sphinx_gallery_axes_grid1_inset_locator_demo2.py`
- `sphinx_gallery_axes_grid1_simple_anchored_artists.py`

`mpl_toolkits.axes_grid1.axes_divider`

The `axes_divider` module provides helper classes to adjust the positions of multiple axes at drawing time.

**Divider:** this is the class that is used to calculate the axes position. It divides the given rectangular area into several sub rectangles. You initialize the divider by setting the horizontal and vertical lists of sizes that the division will be based on. You then use the `new_locator` method, whose return value is a callable object that can be used to set the `axes_locator` of the axes.

## Classes

<code>Axes(**kwargs)</code>	<i>[Deprecated]</i>
<code>AxesDivider(axes[, xref, yref])</code>	Divider based on the pre-existing axes.
<code>AxesLocator(axes_divider, nx, ny[, nx1, ny1])</code>	A simple callable object, initialized with <code>AxesDivider</code> class, returns the position and size of the given cell.
<code>Divider(fig, pos, horizontal, vertical[, ...])</code>	This class calculates the axes position.
<code>HBoxDivider(fig, *args, **kwargs)</code>	
<code>LocatableAxes(**kwargs)</code>	<i>[Deprecated]</i>
<code>LocatableAxesBase(**kwargs)</code>	<i>[Deprecated]</i>
<code>SubplotDivider(fig, *args[, horizontal, ...])</code>	The <code>Divider</code> class whose rectangle area is specified as a subplot geometry.
<code>VBoxDivider(fig, *args, **kwargs)</code>	The <code>Divider</code> class whose rectangle area is specified as a subplot geometry.

`mpl_toolkits.axes_grid1.axes_divider.Axes`

```
class mpl_toolkits.axes_grid1.axes_divider.Axes(**kwargs)
    Bases: mpl_toolkits.axes_grid1.mpl_axes.Axes
    [Deprecated]
```

## Notes

Deprecated since version 3.0:

`mpl_toolkits.axes_grid1.axes_divider.AxesDivider`

```
class mpl_toolkits.axes_grid1.axes_divider.AxesDivider(axes, xref=None, yref=None)
    Bases: mpl_toolkits.axes_grid1.axes_divider.Divider
    Divider based on the pre-existing axes.
```

## Parameters

**axes** [`Axes`]  
**xref**  
**yref**

`append_axes(self, position, size, pad=None, add_to_figure=True, **kwargs)`  
Create an axes at the given *position* with the same height (or width) of the main axes.

**position** ["left"|"right"|"bottom"|"top"]

*size* and *pad* should be axes\_grid.axes\_size compatible.

`get_anchor(self)`  
return the anchor

`get_aspect(self)`  
return aspect

`get_position(self)`  
return the position of the rectangle.

`get_subplotspec(self)`

`new_horizontal(self, size, pad=None, pack_start=False, **kwargs)`  
Add a new axes on the right (or left) side of the main axes.

#### Parameters

**size** [axes\_size or float or string] A width of the axes. If float or string is given, *from\_any* function is used to create the size, with *ref\_size* set to AxesX instance of the current axes.

**pad** [axes\_size or float or string] Pad between the axes. It takes same argument as *size*.

**pack\_start** [bool] If False, the new axes is appended at the end of the list, i.e., it became the right-most axes. If True, it is inserted at the start of the list, and becomes the left-most axes.

**kwargs** All extra keywords arguments are passed to the created axes. If *axes\_class* is given, the new axes will be created as an instance of the given class. Otherwise, the same class of the main axes will be used.

`new_vertical(self, size, pad=None, pack_start=False, **kwargs)`  
Add a new axes on the top (or bottom) side of the main axes.

#### Parameters

**size** [axes\_size or float or string] A height of the axes. If float or string is given, *from\_any* function is used to create the size, with *ref\_size* set to AxesX instance of the current axes.

**pad** [axes\_size or float or string] Pad between the axes. It takes same argument as *size*.

**pack\_start** [bool] If False, the new axes is appended at the end of the list, i.e., it became the right-most axes. If True, it is inserted at the start of the list, and becomes the left-most axes.

**kwargs** All extra keywords arguments are passed to the created axes. If *axes\_class* is given, the new axes will be created as an instance of the given class. Otherwise, the same class of the main axes will be used.

`mpl_toolkits.axes_grid1.axes_divider.AxesLocator`

```
class mpl_toolkits.axes_grid1.axes_divider.AxesLocator(axes_divider, nx, ny,
                                                    nx1=None, ny1=None)
```

Bases: `object`

A simple callable object, initialized with `AxesDivider` class, returns the position and size of the given cell.

**Parameters**

**axes\_divider** [`AxesDivider`]

**nx, nx1** [`int`] Integers specifying the column-position of the cell. When *nx1* is `None`, a single *nx*-th column is specified. Otherwise location of columns spanning between *nx* to *nx1* (but excluding *nx1*-th column) is specified.

**ny, ny1** [`int`] Same as *nx* and *nx1*, but for row positions.

`get_subplotspec(self)`

`mpl_toolkits.axes_grid1.axes_divider.Divider`

```
class mpl_toolkits.axes_grid1.axes_divider.Divider(fig, pos, horizontal, vertical, aspect=None, anchor='C')
```

Bases: `object`

This class calculates the axes position. It divides the given rectangular area into several sub-rectangles. You initialize the divider by setting the horizontal and vertical lists of sizes (`mpl_toolkits.axes_grid.axes_size`) that the division will be based on. You then use the `new_locator` method to create a callable object that can be used as the `axes_locator` of the axes.

**Parameters**

**fig** [`Figure`]

**pos** [`tuple` of 4 floats] position of the rectangle that will be divided

**horizontal** [`list` of `axes_size`] sizes for horizontal division

**vertical** [`list` of `axes_size`] sizes for vertical division

**aspect** [`bool`] if `True`, the overall rectangular area is reduced so that the relative part of the horizontal and vertical scales have the same scale.

**anchor** [`{'C', 'SW', 'S', 'SE', 'E', 'NE', 'N', 'NW', 'W'}`] placement of the reduced rectangle when *aspect* is `True`

`add_auto_adjustable_area(self, use_axes, pad=0.1, adjust_dirs=None)`

`append_size(self, position, size)`

`get_anchor(self)`  
return the anchor

`get_aspect(self)`  
return aspect

`get_horizontal(self)`  
return horizontal sizes

`get_horizontal_sizes(self, renderer)`

`get_locator(self)`

`get_position(self)`  
return the position of the rectangle.

`get_position_runtime(self, ax, renderer)`

`get_vertical(self)`  
return vertical sizes

`get_vertical_sizes(self, renderer)`

`get_vsize_hsize(self)`

`locate(self, nx, ny, nx1=None, ny1=None, axes=None, renderer=None)`

#### Parameters

**nx, nx1** [int] Integers specifying the column-position of the cell. When *nx1* is None, a single *nx*-th column is specified. Otherwise location of columns spanning between *nx* to *nx1* (but excluding *nx1*-th column) is specified.

**ny, ny1** [int] Same as *nx* and *nx1*, but for row positions.

**axes**

**renderer**

`new_locator(self, nx, ny, nx1=None, ny1=None)`

Returns a new locator (`mpl_toolkits.axes_grid.axes_divider.AxesLocator`) for specified cell.

#### Parameters

**nx, nx1** [int] Integers specifying the column-position of the cell. When *nx1* is None, a single *nx*-th column is specified. Otherwise location of columns spanning between *nx* to *nx1* (but excluding *nx1*-th column) is specified.

**ny, ny1** [int] Same as *nx* and *nx1*, but for row positions.

`set_anchor(self, anchor)`

#### Parameters

**anchor** [{'C', 'SW', 'S', 'SE', 'E', 'NE', 'N', 'NW', 'W'}]

anchor position

value	description
'C'	Center
'SW'	bottom left
'S'	bottom
'SE'	bottom right
'E'	right
'NE'	top right
'N'	top
'NW'	top left
'W'	left

`set_aspect(self, aspect=False)`

**Parameters**

**aspect** [bool]

`set_horizontal(self, h)`

**Parameters**

**h** [list of axes\_size] sizes for horizontal division

`set_locator(self, _locator)`

`set_position(self, pos)`

set the position of the rectangle.

**Parameters**

**pos** [tuple of 4 floats] position of the rectangle that will be divided

`set_vertical(self, v)`

**Parameters**

**v** [list of axes\_size] sizes for vertical division

**mpl\_toolkits.axes\_grid1.axes\_divider.HBoxDivider**

`class mpl_toolkits.axes_grid1.axes_divider.HBoxDivider(fig, *args, **kwargs)`

Bases: `mpl_toolkits.axes_grid1.axes_divider.SubplotDivider`

`locate(self, nx, ny, nx1=None, ny1=None, axes=None, renderer=None)`

**Parameters**

**axes\_divider** [AxesDivider]

**nx, nx1** [int] Integers specifying the column-position of the cell. When `nx1` is None, a single `nx`-th column is specified. Otherwise location of columns spanning between `nx` to `nx1` (but excluding `nx1`-th column) is specified.

**ny, ny1** [int] Same as `nx` and `nx1`, but for row positions.

**axes**

**renderer**

`new_locator(self, nx, nx1=None)`

Create a new AxesLocator for the specified cell.

**Parameters**

**nx, nx1** [int] Integers specifying the column-position of the cell. When `nx1` is None, a single `nx`-th column is specified. Otherwise location of columns spanning between `nx` to `nx1` (but excluding `nx1`-th column) is specified.

**ny, ny1** [int] Same as `nx` and `nx1`, but for row positions.

Examples using `mpl_toolkits.axes_grid1.axes_divider.HBoxDivider`

- `sphx_glr_gallery_axes_grid1_demo_axes_hbox_divider.py`

`mpl_toolkits.axes_grid1.axes_divider.LocatableAxes`

```
class mpl_toolkits.axes_grid1.axes_divider.LocatableAxes(**kwargs)
    Bases: mpl_toolkits.axes_grid1.mpl_axes.Axes
    [Deprecated]
```

#### Notes

Deprecated since version 3.0:

`mpl_toolkits.axes_grid1.axes_divider.LocatableAxesBase`

```
class mpl_toolkits.axes_grid1.axes_divider.LocatableAxesBase(**kwargs)
    Bases: object
    [Deprecated]
```

#### Notes

Deprecated since version 3.0:

`mpl_toolkits.axes_grid1.axes_divider.SubplotDivider`

```
class mpl_toolkits.axes_grid1.axes_divider.SubplotDivider(fig, *args, horizontal=None, vertical=None, aspect=None, anchor='C')
    Bases: mpl_toolkits.axes_grid1.axes_divider.Divider
```

The Divider class whose rectangle area is specified as a subplot geometry.

#### Parameters

**fig** [*matplotlib.figure.Figure*]

**\*args** [tuple (*numRows*, *numCols*, *plotNum*)] The array of subplots in the figure has dimensions *numRows*, *numCols*, and *plotNum* is the number of the subplot being created. *plotNum* starts at 1 in the upper left corner and increases to the right.

If  $numRows \leq numCols \leq plotNum < 10$ , *args* can be the decimal integer  $numRows * 100 + numCols * 10 + plotNum$ .

`change_geometry(self, numrows, numcols, num)`  
change subplot geometry, e.g., from 1,1,1 to 2,2,3

`get_geometry(self)`  
get the subplot geometry, e.g., 2,2,3

`get_position(self)`  
return the bounds of the subplot box

`get_subplotspec(self)`  
get the SubplotSpec instance

`set_subplotspec(self, subplotspec)`  
set the SubplotSpec instance

`update_params(self)`  
update the subplot position from `fig.subplotspars`

### `mpl_toolkits.axes_grid1.axes_divider.VBoxDivider`

`class mpl_toolkits.axes_grid1.axes_divider.VBoxDivider(fig, *args, **kwargs)`

Bases: `mpl_toolkits.axes_grid1.axes_divider.HBoxDivider`

The Divider class whose rectangle area is specified as a subplot geometry.

`locate(self, nx, ny, nx1=None, ny1=None, axes=None, renderer=None)`

#### Parameters

**axes\_divider** [AxesDivider]

**nx, nx1** [int] Integers specifying the column-position of the cell. When `nx1` is None, a single `nx`-th column is specified. Otherwise location of columns spanning between `nx` to `nx1` (but excluding `nx1`-th column) is specified.

**ny, ny1** [int] Same as `nx` and `nx1`, but for row positions.

**axes**

**renderer**

`new_locator(self, ny, ny1=None)`

Create a new AxesLocator for the specified cell.

#### Parameters

**ny, ny1** [int] Integers specifying the row-position of the cell. When `ny1` is None, a single `ny`-th row is specified. Otherwise location of rows spanning between `ny` to `ny1` (but excluding `ny1`-th row) is specified.

### Functions

`locatable_axes_factory(axes_class)` [Deprecated]

`make_axes_area_auto_adjustable(ax[, ...])`

`make_axes_locatable(axes)`

### `mpl_toolkits.axes_grid1.axes_divider.locatable_axes_factory`

`mpl_toolkits.axes_grid1.axes_divider.locatable_axes_factory(axes_class)`  
[Deprecated]

## Notes

Deprecated since version 3.0:

### `mpl_toolkits.axes_grid1.axes_divider.make_axes_area_auto_adjustable`

```
mpl_toolkits.axes_grid1.axes_divider.make_axes_area_auto_adjustable(ax,
                                                                    use_axes=None,
                                                                    pad=0.1,    ad-
                                                                    just_dirs=None)
```

### Examples using `mpl_toolkits.axes_grid1.axes_divider.make_axes_area_auto_adjustable`

- `sphx_glr_gallery_axes_grid1_make_room_for_ylabel_using_axesgrid.py`

### `mpl_toolkits.axes_grid1.axes_divider.make_axes_locatable`

```
mpl_toolkits.axes_grid1.axes_divider.make_axes_locatable(axes)
```

### `mpl_toolkits.axes_grid1.axes_grid`

## Classes

<i>AxesGrid</i>	alias of <code>mpl_toolkits.axes_grid1.axes_grid.ImageGrid</code> .
<i>CbarAxes</i> (*args, orientation, **kwargs)	
<i>CbarAxesBase</i>	
<i>Grid</i> (fig, rect, nrows_ncols[, ngrids, ...])	A class that creates a grid of Axes.
<i>ImageGrid</i> (fig, rect, nrows_ncols[, ngrids, ...])	A class that creates a grid of Axes.

### `mpl_toolkits.axes_grid1.axes_grid.AxesGrid`

```
mpl_toolkits.axes_grid1.axes_grid.AxesGrid
    alias of mpl_toolkits.axes_grid1.axes_grid.ImageGrid
```

### `mpl_toolkits.axes_grid1.axes_grid.CbarAxes`

```
class mpl_toolkits.axes_grid1.axes_grid.CbarAxes(*args, orientation, **kwargs)
    Bases: mpl_toolkits.axes_grid1.axes_grid.CbarAxesBase, mpl_toolkits.axes_grid1.mpl_axes.Axes
    cla(self)
        Clear the current axes.
```

`mpl_toolkits.axes_grid1.axes_grid.CbarAxesBase`

```
class mpl_toolkits.axes_grid1.axes_grid.CbarAxesBase
    Bases: object
    colorbar(self, mappable, *, locator=None, **kwargs)
    toggle_label(self, b)
```

`mpl_toolkits.axes_grid1.axes_grid.Grid`

```
class mpl_toolkits.axes_grid1.axes_grid.Grid(fig, rect, nrows_ncols, ngrids=None,
                                             direction='row', axes_pad=0.02,
                                             add_all=True, share_all=False,
                                             share_x=True, share_y=True, label_mode='L',
                                             axes_class=None)

Bases: object
```

A class that creates a grid of Axes. In matplotlib, the axes location (and size) is specified in the normalized figure coordinates. This may not be ideal for images that needs to be displayed with a given aspect ratio. For example, displaying images of a same size with some fixed padding between them cannot be easily done in matplotlib. AxesGrid is used in such case.

**Parameters**

**fig** [*Figure*] The parent figure.

**rect** [(float, float, float, float) or int] The axes position, as a (left, bottom, width, height) tuple or as a three-digit subplot position code (e.g., "121").

**direction** [{"row", "column"}, default: "row"]

**axes\_pad** [float or (float, float), default: 0.02] Padding or (horizontal padding, vertical padding) between axes, in inches.

**add\_all** [bool, default: True]

**share\_all** [bool, default: False]

**share\_x** [bool, default: True]

**share\_y** [bool, default: True]

**label\_mode** [{"L", "1", "all"}, default: "L"] Determines which axes will get tick labels:

- "L": All axes on the left column get vertical tick labels; all axes on the bottom row get horizontal tick labels.
- "1": Only the bottom left axes is labelled.
- "all": all axes are labelled.

**axes\_class** [a type that is a subclass of `matplotlib.axes.Axes`, default: None]

```
get_aspect(self)
    Return the aspect of the SubplotDivider.
```

```
get_axes_locator(self)
```

`get_axes_pad(self)`  
Return the axes padding.

**Returns**

**hpad, vpad** Padding (horizontal pad, vertical pad) in inches.

`get_divider(self)`

`get_geometry(self)`

Return the number of rows and columns of the grid as (nrows, ncols).

`get_vsize_hsize(self)`

`set_aspect(self, aspect)`

Set the aspect of the SubplotDivider.

`set_axes_locator(self, locator)`

`set_axes_pad(self, axes_pad)`

Set the padding between the axes.

**Parameters**

**axes\_pad** [(float, float)] The padding (horizontal pad, vertical pad) in inches.

`set_label_mode(self, mode)`

Define which axes have tick labels.

**Parameters**

**mode** [{"L", "1", "all"}] The label mode:

- "L": All axes on the left column get vertical tick labels; all axes on the bottom row get horizontal tick labels.
- "1": Only the bottom left axes is labelled.
- "all": all axes are labelled.

`mpl_toolkits.axes_grid1.axes_grid.ImageGrid`

```
class mpl_toolkits.axes_grid1.axes_grid.ImageGrid(fig,          rect,          nrows_ncols,
                                                  ngrids=None,    direction='row',
                                                  axes_pad=0.02,    add_all=True,
                                                  share_all=False, aspect=True, la-
                                                  bel_mode='L',   cbar_mode=None,
                                                  cbar_location='right',
                                                  cbar_pad=None,   cbar_size='5%',
                                                  cbar_set_cax=True,
                                                  axes_class=None)
```

Bases: `mpl_toolkits.axes_grid1.axes_grid.Grid`

A class that creates a grid of Axes. In matplotlib, the axes location (and size) is specified in the normalized figure coordinates. This may not be ideal for images that needs to be displayed with a given aspect ratio. For example, displaying images of a same size with some fixed padding between them cannot be easily done in matplotlib. ImageGrid is used in such case.

**Parameters**

**fig** [*Figure*] The parent figure.

**rect** [(float, float, float, float) or int] The axes position, as a (left, bottom, width, height) tuple or as a three-digit subplot position code (e.g., "121").

**direction** [{"row", "column"}, default: "row"]

**axes\_pad** [float or (float, float), default: 0.02] Padding or (horizontal padding, vertical padding) between axes, in inches.

**add\_all** [bool, default: True]

**share\_all** [bool, default: False]

**aspect** [bool, default: True]

**label\_mode** [{"L", "1", "all"}, default: "L"] Determines which axes will get tick labels:

- "L": All axes on the left column get vertical tick labels; all axes on the bottom row get horizontal tick labels.
- "1": Only the bottom left axes is labelled.
- "all": all axes are labelled.

**cbar\_mode** [{"each", "single", "edge", None }, default: None]

**cbar\_location** [{"left", "right", "bottom", "top"}, default: "right"]

**cbar\_pad** [float, default: None]

**cbar\_size** [size specification (see `Size.from_any`), default: "5%"]

**cbar\_set\_cax** [bool, default: True] If True, each axes in the grid has a *cax* attribute that is bound to associated *cbar\_axes*.

**axes\_class** [a type that is a subclass of `matplotlib.axes.Axes`, default: None]

`mpl_toolkits.axes_grid1.axes_rgb`

## Classes

`RGBAxes(*args[, pad, add_all])`

### Parameters

<code>RGBAxesBase(*args[, pad, add_all])</code>	base class for a 4-panel imshow (RGB, R, G, B)
---	--

`mpl_toolkits.axes_grid1.axes_rgb.RGBAxes`

```
class mpl_toolkits.axes_grid1.axes_rgb.RGBAxes(*args, pad=0, add_all=True, **kwargs)
    Bases: mpl_toolkits.axes_grid1.axes_rgb.RGBAxesBase
```

### Parameters

**pad** [float] fraction of the axes height to put as padding. defaults to 0.0

**add\_all** [bool] True: Add the {rgb, r, g, b} axes to the figure defaults to

True.

**axes\_class** [matplotlib.axes.Axes]

**\*args** Unpacked into axes\_class() init for RGB

**\*\*kwargs** Unpacked into axes\_class() init for RGB, R, G, B axes

Examples using `mpl_toolkits.axes_grid1.axes_rgb.RGBAxes`

- sphx\_glr\_gallery\_pyplots\_whats\_new\_99\_axes\_grid.py
- sphx\_glr\_gallery\_axes\_grid1\_demo\_axes\_rgb.py
- sphx\_glr\_gallery\_axes\_grid1\_simple\_rgb.py

`mpl_toolkits.axes_grid1.axes_rgb.RGBAxesBase`

```
class mpl_toolkits.axes_grid1.axes_rgb.RGBAxesBase(*args, pad=0, add_all=True,
                                                    **kwargs)
```

Bases: `object`

base class for a 4-panel imshow (RGB, R, G, B)

Layout: +-----+--+ || R | + +--+ | RGB | G | + +--+ || B | +-----+--+

#### Attributes

**\_defaultAxesClass** [matplotlib.axes.Axes] defaults to 'Axes' in RGBAxes child class. No default in abstract base class

**RGB** [\_defaultAxesClass] The axes object for the three-channel imshow

**R** [\_defaultAxesClass] The axes object for the red channel imshow

**G** [\_defaultAxesClass] The axes object for the green channel imshow

**B** [\_defaultAxesClass] The axes object for the blue channel imshow

#### Parameters

**pad** [float] fraction of the axes height to put as padding. defaults to 0.0

**add\_all** [bool] True: Add the {rgb, r, g, b} axes to the figure defaults to True.

**axes\_class** [matplotlib.axes.Axes]

**\*args** Unpacked into axes\_class() init for RGB

**\*\*kwargs** Unpacked into axes\_class() init for RGB, R, G, B axes

`add_RGB_to_figure(self)`

Add the red, green and blue axes to the RGB composite's axes figure

`imshow_rgb(self, r, g, b, **kwargs)`

Create the four images {rgb, r, g, b}

#### Parameters

**r** [array-like] The red array

**g** [array-like] The green array

**b** [array-like] The blue array

**kwargs** [imshow kwargs] kwargs get unpacked into the imshow calls for the four images

### Returns

**rgb** [matplotlib.image.AxesImage]

**r** [matplotlib.image.AxesImage]

**g** [matplotlib.image.AxesImage]

**b** [matplotlib.image.AxesImage]

## Functions

---

```
imshow_rgb(ax, r, g, b, kwargs)
make_rgb_axes(ax[, pad, axes_class, add_all])
```

---

### Parameters

---

`mpl_toolkits.axes_grid1.axes_rgb.imshow_rgb`

```
mpl_toolkits.axes_grid1.axes_rgb.imshow_rgb(ax, r, g, b, kwargs)
```

`mpl_toolkits.axes_grid1.axes_rgb.make_rgb_axes`

```
mpl_toolkits.axes_grid1.axes_rgb.make_rgb_axes(ax, pad=0.01, axes_class=None,
add_all=True)
```

### Parameters

**pad** [float] Fraction of the axes height.

Examples using `mpl_toolkits.axes_grid1.axes_rgb.make_rgb_axes`

- `sphx_glr_gallery_axes_grid1_demo_axes_rgb.py`

`mpl_toolkits.axes_grid1.axes_size`

Provides classes of simple units that will be used with `AxesDivider` class (or others) to determine the size of each axes. The unit classes define `get_size` method that returns a tuple of two floats, meaning relative and absolute sizes, respectively.

Note that this class is nothing more than a simple tuple of two floats. Take a look at the `Divider` class to see how these two values are used.

## Classes

<code>Add(a, b)</code>	
<code>AddList(add_list)</code>	
<code>AxesX(axes[, aspect, ref_ax])</code>	Scaled size whose relative part corresponds to the data width of the <i>axes</i> multiplied by the <i>aspect</i> .
<code>AxesY(axes[, aspect, ref_ax])</code>	Scaled size whose relative part corresponds to the data height of the <i>axes</i> multiplied by the <i>aspect</i> .
<code>Fixed(fixed_size)</code>	Simple fixed size with absolute part = <i>fixed_size</i> and relative part = 0.
<code>Fraction(fraction, ref_size)</code>	An instance whose size is a <i>fraction</i> of the <i>ref_size</i> .
<code>GetExtentHelper(ax, direction)</code>	
<code>MaxExtent(artist_list, w_or_h)</code>	Size whose absolute part is the largest width (or height) of the given <i>artist_list</i> .
<code>MaxHeight(artist_list)</code>	Size whose absolute part is the largest height of the given <i>artist_list</i> .
<code>MaxWidth(artist_list)</code>	Size whose absolute part is the largest width of the given <i>artist_list</i> .
<code>Padded(size, pad)</code>	Return a instance where the absolute part of <i>size</i> is increase by the amount of <i>pad</i> .
<code>Scalable</code>	alias of <code>mpl_toolkits.axes_grid1.axes_size.Scaled</code>
<code>Scaled(scalable_size)</code>	Simple scaled(?) size with absolute part = 0 and relative part = <i>scalable_size</i> .
<code>SizeFromFunc(func)</code>	

#### `mpl_toolkits.axes_grid1.axes_size.Add`

```
class mpl_toolkits.axes_grid1.axes_size.Add(a, b)
    Bases: mpl_toolkits.axes_grid1.axes_size._Base
    get_size(self, renderer)
```

#### `mpl_toolkits.axes_grid1.axes_size.AddList`

```
class mpl_toolkits.axes_grid1.axes_size.AddList(add_list)
    Bases: mpl_toolkits.axes_grid1.axes_size._Base
    get_size(self, renderer)
```

#### `mpl_toolkits.axes_grid1.axes_size.AxesX`

```
class mpl_toolkits.axes_grid1.axes_size.AxesX(axes, aspect=1.0, ref_ax=None)
    Bases: mpl_toolkits.axes_grid1.axes_size._Base
    Scaled size whose relative part corresponds to the data width of the axes multiplied by the aspect.
    get_size(self, renderer)
```

**Examples using `mpl_toolkits.axes_grid1.axes_size.AxesX`**

- `sphx_glr_gallery_axes_grid1_demo_axes_hbox_divider.py`
- `sphx_glr_gallery_axes_grid1_simple_axes_divider3.py`

**`mpl_toolkits.axes_grid1.axes_size.AxesY`**

```
class mpl_toolkits.axes_grid1.axes_size.AxesY(axes, aspect=1.0, ref_ax=None)
```

```
    Bases: mpl_toolkits.axes_grid1.axes_size._Base
```

Scaled size whose relative part corresponds to the data height of the *axes* multiplied by the *aspect*.

```
    get_size(self, renderer)
```

**Examples using `mpl_toolkits.axes_grid1.axes_size.AxesY`**

- `sphx_glr_gallery_axes_grid1_demo_axes_hbox_divider.py`
- `sphx_glr_gallery_axes_grid1_simple_axes_divider3.py`

**`mpl_toolkits.axes_grid1.axes_size.Fixed`**

```
class mpl_toolkits.axes_grid1.axes_size.Fixed(fixed_size)
```

```
    Bases: mpl_toolkits.axes_grid1.axes_size._Base
```

Simple fixed size with absolute part = *fixed\_size* and relative part = 0.

```
    get_size(self, renderer)
```

**Examples using `mpl_toolkits.axes_grid1.axes_size.Fixed`**

- `sphx_glr_gallery_axes_grid1_demo_axes_hbox_divider.py`
- `sphx_glr_gallery_axes_grid1_simple_axes_divider2.py`
- `sphx_glr_gallery_axes_grid1_simple_axes_divider3.py`

**`mpl_toolkits.axes_grid1.axes_size.Fraction`**

```
class mpl_toolkits.axes_grid1.axes_size.Fraction(fraction, ref_size)
```

```
    Bases: mpl_toolkits.axes_grid1.axes_size._Base
```

An instance whose size is a *fraction* of the *ref\_size*.

```
>>> s = Fraction(0.3, AxesX(ax))
```

```
    get_size(self, renderer)
```

**mpl\_toolkits.axes\_grid1.axes\_size.GetExtentHelper**

```
class mpl_toolkits.axes_grid1.axes_size.GetExtentHelper(ax, direction)
    Bases: object
```

**mpl\_toolkits.axes\_grid1.axes\_size.MaxExtent**

```
class mpl_toolkits.axes_grid1.axes_size.MaxExtent(artist_list, w_or_h)
    Bases: mpl_toolkits.axes_grid1.axes_size._Base
    Size whose absolute part is the largest width (or height) of the given artist_list.
    add_artist(self, a)
    get_size(self, renderer)
```

**mpl\_toolkits.axes\_grid1.axes\_size.MaxHeight**

```
class mpl_toolkits.axes_grid1.axes_size.MaxHeight(artist_list)
    Bases: mpl_toolkits.axes_grid1.axes_size._Base
    Size whose absolute part is the largest height of the given artist_list.
    add_artist(self, a)
    get_size(self, renderer)
```

**mpl\_toolkits.axes\_grid1.axes\_size.MaxWidth**

```
class mpl_toolkits.axes_grid1.axes_size.MaxWidth(artist_list)
    Bases: mpl_toolkits.axes_grid1.axes_size._Base
    Size whose absolute part is the largest width of the given artist_list.
    add_artist(self, a)
    get_size(self, renderer)
```

**mpl\_toolkits.axes\_grid1.axes\_size.Padded**

```
class mpl_toolkits.axes_grid1.axes_size.Padded(size, pad)
    Bases: mpl_toolkits.axes_grid1.axes_size._Base
    Return a instance where the absolute part of size is increase by the amount of pad.
    get_size(self, renderer)
```

**mpl\_toolkits.axes\_grid1.axes\_size.Scalable**

```
mpl_toolkits.axes_grid1.axes_size.Scalable
    alias of mpl_toolkits.axes_grid1.axes_size.Scaled
```

**mpl\_toolkits.axes\_grid1.axes\_size.Scaled**

```
class mpl_toolkits.axes_grid1.axes_size.Scaled(scalable_size)
    Bases: mpl_toolkits.axes_grid1.axes_size._Base
    Simple scaled(?) size with absolute part = 0 and relative part = scalable_size.
    get_size(self, renderer)
```

**Examples using `mpl_toolkits.axes_grid1.axes_size.Scaled`**

- sphx\_glr\_gallery\_axes\_grid1\_demo\_axes\_hbox\_divider.py
- sphx\_glr\_gallery\_axes\_grid1\_simple\_axes\_divider2.py

**mpl\_toolkits.axes\_grid1.axes\_size.SizeFromFunc**

```
class mpl_toolkits.axes_grid1.axes_size.SizeFromFunc(func)
    Bases: mpl_toolkits.axes_grid1.axes_size._Base
    get_size(self, renderer)
```

**Functions**

<i>from_any</i> (size[, fraction_ref])	Creates Fixed unit when the first argument is a float, or a Fraction unit if that is a string that ends with %.
--	---

---

**mpl\_toolkits.axes\_grid1.axes\_size.from\_any**

```
mpl_toolkits.axes_grid1.axes_size.from_any(size, fraction_ref=None)
    Creates Fixed unit when the first argument is a float, or a Fraction unit if that is a string that ends with %. The second argument is only meaningful when Fraction unit is created.:
```

```
>>> a = Size.from_any(1.2) # => Size.Fixed(1.2)
>>> Size.from_any("50%", a) # => Size.Fraction(0.5, a)
```

**mpl\_toolkits.axes\_grid1.colorbar**

Colorbar toolkit with two classes and a function:

*ColorbarBase* the base class with full colorbar drawing functionality. It can be used as-is to make a colorbar for a given colormap; a mappable object (e.g., image) is not needed.

*Colorbar* the derived class for use with images or contour plots.

*make\_axes*() a function for resizing an axes and adding a second axes suitable for a colorbar

The `colorbar()` method uses `make_axes()` and `Colorbar`; the `colorbar()` function is a thin wrapper over `colorbar()`.

```
class mpl_toolkits.axes_grid1.colorbar.CbarAxesLocator(locator=None, extend=ex-
                                                    tend='neither', orientation=orienta-
                                                    tion='vertical')
```

`CbarAxesLocator` is a `axes_locator` for colorbar axes. It adjust the position of the axes to make a room for extended ends, i.e., the extended ends are located outside the axes area.

**locator** [the `bbox` returned from the locator is used as a] initial axes location. If `None`, `axes.bbox` is used.

*extend* : same as in `ColorbarBase` *orientation* : same as in `ColorbarBase`

```
get_end_vertices(self)
```

return a tuple of two vertices for the colorbar extended ends. The first vertices is for the minimum end, and the second is for the maximum end.

```
get_original_position(self, axes, renderer)
```

get the original position of the axes.

```
get_path_ends(self)
```

get the paths for extended ends

```
get_path_patch(self)
```

get the path for axes patch

```
class mpl_toolkits.axes_grid1.colorbar.Colorbar(ax, mappable, **kw)
```

```
add_lines(self, CS)
```

Add the lines from a non-filled `ContourSet` to the colorbar.

```
update_bruteforce(self, mappable)
```

Update the colorbar artists to reflect the change of the associated mappable.

```
class mpl_toolkits.axes_grid1.colorbar.ColorbarBase(ax, cmap=None, norm=None,
                                                    alpha=1.0, values=None,
                                                    boundaries=None, orientation=orienta-
                                                    tion='vertical', extend='neither',
                                                    spacing='uniform', ticks=None,
                                                    format=None, drawedges=False,
                                                    filled=True)
```

Draw a colorbar in an existing axes.

This is a base class for the `Colorbar` class, which is the basis for the `colorbar()` method and `pyplot` function.

It is also useful by itself for showing a colormap. If the `cmap` kwarg is given but `boundaries` and `values` are left as `None`, then the colormap will be displayed on a 0-1 scale. To show the under- and over-value colors, specify the `norm` as:

```
colors.Normalize(clip=False)
```

To show the colors versus index instead of on the 0-1 scale, use:

```
norm=colors.NoNorm.
```

Useful attributes:

`ax` the `Axes` instance in which the colorbar is drawn

`lines` a LineCollection if lines were drawn, otherwise None  
`dividers` a LineCollection if `drawedges` is True, otherwise None

Useful public methods are `set_label()` and `add_lines()`.

`add_lines(self, levels, colors, linewidths)`

Draw lines on the colorbar. It deletes preexisting lines.

`set_alpha(self, alpha)`

set alpha value.

`set_label_text(self, label, **kw)`

Label the long axis of the colorbar

`update_artists(self)`

Update the colorbar associated artists, *filled* and *ends*. Note that *lines* are not updated. This needs to be called whenever `clim` of associated image changes.

`mpl_toolkits.axes_grid1.colorbar.colorbar(mappable, cax=None, ax=None, **kw)`

Create a colorbar for a ScalarMappable instance.

Documentation for the pyplot thin wrapper:

Add a colorbar to a plot.

Function signatures for the *pyplot* interface; all but the first are also method signatures for the `colorbar()` method:

```
colorbar(**kwargs)
colorbar(mappable, **kwargs)
colorbar(mappable, cax=cax, **kwargs)
colorbar(mappable, ax=ax, **kwargs)
```

arguments:

***mappable*** the *Image*, *ContourSet*, etc. to which the colorbar applies; this argument is mandatory for the `colorbar()` method but optional for the `colorbar()` function, which sets the default to the current image.

keyword arguments:

***cax*** None | axes object into which the colorbar will be drawn

***ax*** None | parent axes object from which space for a new colorbar axes will be stolen

Additional keyword arguments are of two kinds:

axes properties:

Property	Description
<i>orientation</i>	vertical or horizontal
<i>fraction</i>	0.15; fraction of original axes to use for colorbar
<i>pad</i>	0.05 if vertical, 0.15 if horizontal; fraction of original axes between colorbar and new image axes
<i>shrink</i>	1.0; fraction by which to shrink the colorbar
<i>aspect</i>	20; ratio of long to short dimensions

colorbar properties:

Property	Description
<i>extend</i>	[ 'neither'   'both'   'min'   'max' ] If not 'neither', make pointed end(s) for out-of-range values. These are set for a given colormap using the colormap <code>set_under</code> and <code>set_over</code> methods.
<i>spacing</i>	[ 'uniform'   'proportional' ] Uniform spacing gives each discrete color the same space; proportional makes the space proportional to the data interval.
<i>ticks</i>	[ None   list of ticks   Locator object ] If None, ticks are determined automatically from the input.
<i>format</i>	[ None   format string   Formatter object ] If None, the <code>ScalarFormatter</code> is used. If a format string is given, e.g., <code>'%.3f'</code> , that is used. An alternative <code>Formatter</code> object may be given instead.
<i>drawedges</i>	Whether to draw lines at color boundaries.

The following will probably be useful only in the context of indexed colors (that is, when the mappable has `norm=NoNorm()`), or other unusual circumstances.

Property	Description
<i>boundaries</i>	None or a sequence
<i>values</i>	None or a sequence which must be of length 1 less than the sequence of <i>boundaries</i> . For each region delimited by adjacent entries in <i>boundaries</i> , the color mapped to the corresponding value in <i>values</i> will be used.

If *mappable* is a `ContourSet`, its *extend* kwarg is included automatically.

Note that the *shrink* kwarg provides a simple way to keep a vertical colorbar, for example, from being taller than the axes of the mappable to which the colorbar is attached; but it is a manual method requiring some trial and error. If the colorbar is too tall (or a horizontal colorbar is too wide) use a smaller value of *shrink*.

For more precise control, you can manually specify the positions of the axes objects in which the mappable and the colorbar are drawn. In this case, do not use any of the axes

properties kwargs.

It is known that some vector graphics viewer (svg and pdf) renders white gaps between segments of the colorbar. This is due to bugs in the viewers not matplotlib. As a workaround the colorbar can be rendered with overlapping segments:

```
cbar = colorbar()
cbar.solids.set_edgecolor("face")
draw()
```

However this has negative consequences in other circumstances. Particularly with semi transparent images ( $\alpha < 1$ ) and colorbar extensions and is not enabled by default see (issue #1188).

**returns:** *Colorbar* instance; see also its base class, *ColorbarBase*. Call the *set\_label()* method to label the colorbar.

The *transData* of the *cax* is adjusted so that the limits in the longest axis actually corresponds to the limits in colorbar range. On the other hand, the shortest axis has a data limits of [1,2], whose unconventional value is to prevent underflow when log scale is used.

```
mpl_toolkits.axes_grid1.colorbar.make_axes(parent, *, fraction=0.15, shrink=1.0, aspect=20, **kw)
```

Resize and reposition a parent axes, and return a child axes suitable for a colorbar

```
cax, kw = make_axes(parent, **kw)
```

Keyword arguments may include the following (with defaults):

**orientation** 'vertical' or 'horizontal'

Property	Description
<i>orientation</i>	vertical or horizontal
<i>fraction</i>	0.15; fraction of original axes to use for colorbar
<i>pad</i>	0.05 if vertical, 0.15 if horizontal; fraction of original axes between colorbar and new image axes
<i>shrink</i>	1.0; fraction by which to shrink the colorbar
<i>aspect</i>	20; ratio of long to short dimensions

All but the first of these are stripped from the input kw set.

Returns (cax, kw), the child axes and the reduced kw dictionary.

### `mpl_toolkits.axes_grid1.inset_locator`

A collection of functions and objects for creating or placing inset axes.

## Classes

<i>AnchoredLocatorBase</i> (bbox_to_anchor, ...[, ...])	
<i>AnchoredSizeLocator</i> (bbox_to_anchor, x_size, ...)	
<i>AnchoredZoomLocator</i> (parent_axes, zoom, loc)	
<i>BboxConnector</i> (bbox1, bbox2, loc1[, loc2])	Connect two bboxes with a straight line.
<i>BboxConnectorPatch</i> (bbox1, bbox2, loc1a, ...)	Connect two bboxes with a quadrilateral.
<i>BboxPatch</i> (bbox, **kwargs)	Patch showing the shape bounded by a Bbox.
<i>InsetPosition</i> (parent, lbwh)	An object for positioning an inset axes.

### mpl\_toolkits.axes\_grid1.inset\_locator.AnchoredLocatorBase

```
class mpl_toolkits.axes_grid1.inset_locator.AnchoredLocatorBase(bbox_to_anchor,
                                                                offsetbox, loc,
                                                                borderpad=0.5,
                                                                bbox_transform=None)
```

Bases: *matplotlib.offsetbox.AnchoredOffsetbox*

*draw*(self, renderer)  
draw the artist

### mpl\_toolkits.axes\_grid1.inset\_locator.AnchoredSizeLocator

```
class mpl_toolkits.axes_grid1.inset_locator.AnchoredSizeLocator(bbox_to_anchor,
                                                                x_size, y_size, loc,
                                                                borderpad=0.5,
                                                                bbox_transform=None)
```

Bases: *mpl\_toolkits.axes\_grid1.inset\_locator.AnchoredLocatorBase*

*get\_extent*(self, renderer)  
return the extent of the artist. The extent of the child added with the pad is returned

### mpl\_toolkits.axes\_grid1.inset\_locator.AnchoredZoomLocator

```
class mpl_toolkits.axes_grid1.inset_locator.AnchoredZoomLocator(parent_axes, zoom,
                                                                loc, borderpad=0.5,
                                                                bbox_to_anchor=None,
                                                                bbox_transform=None)
```

Bases: *mpl\_toolkits.axes\_grid1.inset\_locator.AnchoredLocatorBase*

*get\_extent*(self, renderer)  
return the extent of the artist. The extent of the child added with the pad is returned

### mpl\_toolkits.axes\_grid1.inset\_locator.BboxConnector

```
class mpl_toolkits.axes_grid1.inset_locator.BboxConnector(bbox1, bbox2, loc1,
                                                         loc2=None, **kwargs)
```

Bases: *matplotlib.patches.Patch*

Connect two bboxes with a straight line.

#### Parameters

**bbox1, bbox2** [*matplotlib.transforms.Bbox*] Bounding boxes to connect.

**loc1** [{1, 2, 3, 4}] Corner of *bbox1* to draw the line. Valid values are:

```
'upper right' : 1,
'upper left'  : 2,
'lower left'  : 3,
'lower right' : 4
```

**loc2** [{1, 2, 3, 4}, optional] Corner of *bbox2* to draw the line. If None, defaults to *loc1*. Valid values are:

```
'upper right' : 1,
'upper left'  : 2,
'lower left'  : 3,
'lower right' : 4
```

**\*\*kwargs** Patch properties for the line drawn. Valid arguments include:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<i>alpha</i>		float or None
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i>		unknown
<i>capstyle</i>		{'butt', 'round', 'projecting'}
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>color</i>		color
<i>contains</i>		callable
<i>edgecolor</i> or <i>ec</i>		color or None or 'auto'
<i>facecolor</i> or <i>fc</i>		color or None
<i>figure</i>		<i>Figure</i>
<i>fill</i>		bool
<i>gid</i>		str
<i>hatch</i>		{'/', '\', ' ', '-', '+', 'x', 'o', 'O', '.', '*'}
<i>in_layout</i>		bool
<i>joinstyle</i>		{'miter', 'round', 'bevel'}
<i>label</i>		object
<i>linestyle</i> or <i>ls</i>		{'-', '--', '-.', ':', '', (offset, on-off-seq), ...}
<i>linewidth</i> or <i>lw</i>		float or None
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		None or bool or float or callable
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>transform</i>		<i>Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>zorder</i>		float

```
static connect_bbox(bbox1, bbox2, loc1, loc2=None)
```

Helper function to obtain a Path from one bbox to another.

**Parameters**

**bbox1, bbox2** [*matplotlib.transforms.Bbox*] Bounding boxes to connect.

**loc1** [{1, 2, 3, 4}] Corner of *bbox1* to use. Valid values are:

```
'upper right' : 1,
'upper left'  : 2,
'lower left'  : 3,
'lower right' : 4
```

**loc2** [{1, 2, 3, 4}, optional] Corner of *bbox2* to use. If None, defaults to *loc1*. Valid values are:

```
'upper right' : 1,
'upper left'  : 2,
'lower left'  : 3,
'lower right' : 4
```

**Returns**

**path** [*matplotlib.path.Path*] A line segment from the *loc1* corner of *bbox1* to the *loc2* corner of *bbox2*.

`static get_bbox_edge_pos(bbox, loc)`

Helper function to obtain the location of a corner of a bbox

**Parameters**

**bbox** [*matplotlib.transforms.Bbox*]

**loc** [{1, 2, 3, 4}] Corner of *bbox*. Valid values are:

```
'upper right' : 1,
'upper left'  : 2,
'lower left'  : 3,
'lower right' : 4
```

**Returns**

**x, y** [float] Coordinates of the corner specified by *loc*.

`get_path(self)`

Return the path of this patch

Examples using `mpl_toolkits.axes_grid1.inset_locator.BboxConnector`

- `sphinx_glr_gallery_subplots_axes_and_figures_axes_zoom_effect.py`

`mpl_toolkits.axes_grid1.inset_locator.BboxConnectorPatch`

```
class mpl_toolkits.axes_grid1.inset_locator.BboxConnectorPatch(bbox1, bbox2, loc1a,
                                                                loc2a, loc1b, loc2b,
                                                                **kwargs)
```

Bases: `mpl_toolkits.axes_grid1.inset_locator.BboxConnector`

Connect two bboxes with a quadrilateral.

The quadrilateral is specified by two lines that start and end at corners of the bboxes. The four sides of the quadrilateral are defined by the two lines given, the line between the two corners specified in *bbox1* and the line between the two corners specified in *bbox2*.

**Parameters**

**bbox1, bbox2** [*matplotlib.transforms.Bbox*] Bounding boxes to connect.

**loc1a, loc2a** [{1, 2, 3, 4}] Corners of *bbox1* and *bbox2* to draw the first line. Valid values are:

```
'upper right' : 1,
'upper left'  : 2,
'lower left'  : 3,
'lower right' : 4
```

**loc1b, loc2b** [{1, 2, 3, 4}] Corners of *bbox1* and *bbox2* to draw the second line. Valid values are:

```
'upper right' : 1,
'upper left'  : 2,
'lower left'  : 3,
'lower right' : 4
```

**\*\*kwargs** Patch properties for the line drawn:

	Property	Description
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) float array
<i>alpha</i>		float or None
<i>animated</i>		bool
<i>antialiased</i> or <i>aa</i>		unknown
<i>capstyle</i>		{'butt', 'round', 'projecting'}
<i>clip_box</i>		<i>Bbox</i>
<i>clip_on</i>		bool
<i>clip_path</i>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<i>color</i>		color
<i>contains</i>		callable
<i>edgecolor</i> or <i>ec</i>		color or None or 'auto'
<i>facecolor</i> or <i>fc</i>		color or None
<i>figure</i>		<i>Figure</i>
<i>fill</i>		bool
<i>gid</i>		str
<i>hatch</i>		{'/', '\', ' ', '-.', '+', 'x', 'o', 'O', ':', '*'}
<i>in_layout</i>		bool
<i>joinstyle</i>		{'miter', 'round', 'bevel'}
<i>label</i>		object
<i>linestyle</i> or <i>ls</i>		{'-', '-', '-.', ':', "", (offset, on-off-seq), ...}
<i>linewidth</i> or <i>lw</i>		float or None
<i>path_effects</i>		<i>AbstractPathEffect</i>
<i>picker</i>		None or bool or float or callable
<i>rasterized</i>		bool or None

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	Property	Description
<i>sketch_params</i>	(scale: float, length: float, randomness: float)	
<i>snap</i>	bool or None	
<i>transform</i>	<i>Transform</i>	
<i>url</i>	str	
<i>visible</i>	bool	
<i>zorder</i>	float	

`get_path(self)`  
Return the path of this patch

Examples using `mpl_toolkits.axes_grid1.inset_locator.BboxConnectorPatch`

- `sphx_glr_gallery_subplots_axes_and_figures_axes_zoom_effect.py`

`mpl_toolkits.axes_grid1.inset_locator.BboxPatch`

`class mpl_toolkits.axes_grid1.inset_locator.BboxPatch(bbox, **kwargs)`  
Bases: `matplotlib.patches.Patch`

Patch showing the shape bounded by a Bbox.

**Parameters**

**bbox** [`matplotlib.transforms.Bbox`] Bbox to use for the extents of this patch.

**\*\*kwargs** Patch properties. Valid arguments include:

	Property	Description
<i>agg_filter</i>	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m,	
<i>alpha</i>	float or None	
<i>animated</i>	bool	
<i>antialiased</i> or <i>aa</i>	unknown	
<i>capstyle</i>	{'butt', 'round', 'projecting'}	
<i>clip_box</i>	<i>Bbox</i>	
<i>clip_on</i>	bool	
<i>clip_path</i>	[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]	
<i>color</i>	color	
<i>contains</i>	callable	
<i>edgecolor</i> or <i>ec</i>	color or None or 'auto'	
<i>facecolor</i> or <i>fc</i>	color or None	
<i>figure</i>	<i>Figure</i>	
<i>fill</i>	bool	
<i>gid</i>	str	
<i>hatch</i>	{'/', '\\', ' ', '-.-', '+', 'x', 'o', 'O', ':', '*'}	
<i>in_layout</i>	bool	
<i>joinstyle</i>	{'miter', 'round', 'bevel'}	
<i>label</i>	object	
<i>linestyle</i> or <i>ls</i>	{'-.-', '-.-', '-.-', ':', ':', ' ', (offset, on-off-seq), ...}	

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Property	Description
<i>linewidth</i> or <i>lw</i>	float or None
<i>path_effects</i>	<i>AbstractPathEffect</i>
<i>picker</i>	None or bool or float or callable
<i>rasterized</i>	bool or None
<i>sketch_params</i>	(scale: float, length: float, randomness: float)
<i>snap</i>	bool or None
<i>transform</i>	<i>Transform</i>
<i>url</i>	str
<i>visible</i>	bool
<i>zorder</i>	float

```
get_path(self)
    Return the path of this patch
```

Examples using `mpl_toolkits.axes_grid1.inset_locator.BboxPatch`

- `sphx_glr_gallery_subplots_axes_and_figures_axes_zoom_effect.py`

`mpl_toolkits.axes_grid1.inset_locator.InsetPosition`

```
class mpl_toolkits.axes_grid1.inset_locator.InsetPosition(parent, lbwh)
```

Bases: `object`

An object for positioning an inset axes.

This is created by specifying the normalized coordinates in the axes, instead of the figure.

#### Parameters

**parent** [`matplotlib.axes.Axes`] Axes to use for normalizing coordinates.

**lbwh** [iterable of four floats] The left edge, bottom edge, width, and height of the inset axes, in units of the normalized coordinate of the *parent* axes.

#### See also:

```
matplotlib.axes.Axes.set_axes_locator()
```

#### Examples

The following bounds the inset axes to a box with 20% of the parent axes's height and 40% of the width. The size of the axes specified (`[0, 0, 1, 1]`) ensures that the axes completely fills the bounding box:

```
>>> parent_axes = plt.gca()
>>> ax_ins = plt.axes([0, 0, 1, 1])
>>> ip = InsetPosition(ax, [0.5, 0.1, 0.4, 0.2])
>>> ax_ins.set_axes_locator(ip)
```

## Functions

<code>inset_axes(parent_axes, width, height[, ...])</code>	Create an inset axes with a given width and height.
<code>mark_inset(parent_axes, inset_axes, loc1, ...)</code>	Draw a box to mark the location of an area represented by an inset axes.
<code>zoomed_inset_axes(parent_axes, zoom[, loc, ...])</code>	Create an anchored inset axes by scaling a parent axes.

`mpl_toolkits.axes_grid1.inset_locator.inset_axes`

```
mpl_toolkits.axes_grid1.inset_locator.inset_axes(parent_axes, width,
                                                  height, loc='upper right',
                                                  bbox_to_anchor=None,
                                                  bbox_transform=None,
                                                  axes_class=None,
                                                  axes_kwargs=None, border-
                                                  pad=0.5)
```

Create an inset axes with a given width and height.

Both sizes used can be specified either in inches or percentage. For example,:

```
inset_axes(parent_axes, width='40%', height='30%', loc=3)
```

creates an inset axes in the lower left corner of `parent_axes` which spans over 30% in height and 40% in width of the `parent_axes`. Since the usage of `inset_axes` may become slightly tricky when exceeding such standard cases, it is recommended to read the examples.

**Parameters**

**parent\_axes** [`matplotlib.axes.Axes`] Axes to place the inset axes.

**width, height** [float or str] Size of the inset axes to create. If a float is provided, it is the size in inches, e.g. `width=1.3`. If a string is provided, it is the size in relative units, e.g. `width='40%`. By default, i.e. if neither `bbox_to_anchor` nor `bbox_transform` are specified, those are relative to the `parent_axes`. Otherwise they are to be understood relative to the bounding box provided via `bbox_to_anchor`.

**loc** [int or string, optional, default to 1] Location to place the inset axes. The valid locations are:

```
'upper right' : 1,
'upper left'  : 2,
'lower left'  : 3,
'lower right' : 4,
'right'       : 5,
'center left' : 6,
'center right': 7,
'lower center': 8,
'upper center': 9,
'center'      : 10
```

**bbox\_to\_anchor** [tuple or `matplotlib.transforms.BboxBase`, optional] Bbox that the inset axes will be anchored to. If `None`, a tuple of (0, 0, 1, 1) is used if `bbox_transform` is set to `parent_axes.transAxes` or `parent_axes.figure.transFigure`. Otherwise, `parent_axes.bbox` is used. If a tuple, can be either [left, bottom, width, height], or [left, bottom]. If the kwargs `width` and/or `height` are specified in relative units, the 2-tuple [left, bottom] cannot be used. Note that, unless `bbox_transform` is set, the units of the bounding box are interpreted in the pixel coordinate. When using `bbox_to_anchor` with tuple, it almost always makes sense to also specify a `bbox_transform`. This might often be the axes transform `parent_axes.transAxes`.

**bbox\_transform** [`matplotlib.transforms.Transform`, optional] Transformation for the bbox that contains the inset axes. If `None`, a `transforms.IdentityTransform` is used. The value of `bbox_to_anchor` (or the return value of its `get_points` method) is transformed by the `bbox_transform` and then interpreted as points in the pixel coordinate (which is dpi dependent). You may provide `bbox_to_anchor` in some normalized coordinate, and give an appropriate transform (e.g., `parent_axes.transAxes`).

**axes\_class** [`matplotlib.axes.Axes` type, optional] If specified, the inset axes created will be created with this class's constructor.

**axes\_kwargs** [dict, optional] Keyworded arguments to pass to the constructor of the inset axes. Valid arguments include:

	Property	Description
<code>adjustable</code>		{'box', 'datalim'}
<code>agg_filter</code>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3)
<code>alpha</code>		float
<code>anchor</code>		2-tuple of floats or {'C', 'SW', 'S', 'SE', ...}
<code>animated</code>		bool
<code>aspect</code>		{'auto', 'equal'} or num
<code>autoscale_on</code>		bool
<code>autoscalex_on</code>		bool
<code>autoscaley_on</code>		bool
<code>axes_locator</code>		Callable[[Axes, Renderer], Bbox]
<code>axisbelow</code>		bool or 'line'
<code>clip_box</code>		<i>Bbox</i>
<code>clip_on</code>		bool
<code>clip_path</code>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   <i>None</i> ]
<code>contains</code>		callable
<code>facecolor</code>		color
<code>fc</code>		color
<code>figure</code>		<i>Figure</i>
<code>frame_on</code>		bool
<code>gid</code>		str
<code>in_layout</code>		bool
<code>label</code>		object
<code>navigate</code>		bool
<code>navigate_mode</code>		unknown
<code>path_effects</code>		<i>AbstractPathEffect</i>
<code>picker</code>		None or bool or float or callable

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	Property	Description
<i>position</i>		[left, bottom, width, height] or <i>Bbox</i>
<i>rasterization_zorder</i>		float or None
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>title</i>		str
<i>transform</i>		<i>Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>xbound</i>		unknown
<i>xlabel</i>		str
<i>xlim</i>		(left: float, right: float)
<i>xmargin</i>		float greater than -0.5
<i>xscale</i>		{"linear", "log", "symlog", "logit", ...}
<i>xticklabels</i>		List[str]
<i>xticks</i>		list
<i>ybound</i>		unknown
<i>ylabel</i>		str
<i>ylim</i>		(bottom: float, top: float)
<i>ymargin</i>		float greater than -0.5
<i>yscale</i>		{"linear", "log", "symlog", "logit", ...}
<i>yticklabels</i>		List[str]
<i>yticks</i>		list
<i>zorder</i>		float

**borderpad** [float, optional] Padding between inset axes and the `bbox_to_anchor`. Defaults to 0.5. The units are axes font size, i.e. for a default font size of 10 points `borderpad = 0.5` is equivalent to a padding of 5 points.

### Returns

**inset\_axes** [`axes_class`] Inset axes object created.

### Notes

The meaning of `bbox_to_anchor` and `bbox_to_transform` is interpreted differently from that of `legend`. The value of `bbox_to_anchor` (or the return value of its `get_points` method; the default is `parent_axes.bbox`) is transformed by the `bbox_transform` (the default is Identity transform) and then interpreted as points in the pixel coordinate (which is dpi dependent).

Thus, following three calls are identical and creates an inset axes with respect to the `parent_axes`:

```
axins = inset_axes(parent_axes, "30%", "40%")
axins = inset_axes(parent_axes, "30%", "40%",
                   bbox_to_anchor=parent_axes.bbox)
axins = inset_axes(parent_axes, "30%", "40%",
                   bbox_to_anchor=(0, 0, 1, 1),
                   bbox_transform=parent_axes.transAxes)
```

Examples using `mpl_toolkits.axes_grid1.inset_locator.inset_axes`

- `sphinx_glr_gallery_axes_grid1_demo_colorbar_of_inset_axes.py`
- `sphinx_glr_gallery_axes_grid1_demo_colorbar_with_inset_locator.py`
- `sphinx_glr_gallery_axes_grid1_inset_locator_demo.py`
- *Overview of axes\_grid1 toolkit*

`mpl_toolkits.axes_grid1.inset_locator.mark_inset`

`mpl_toolkits.axes_grid1.inset_locator.mark_inset(parent_axes, inset_axes, loc1, loc2, **kwargs)`

Draw a box to mark the location of an area represented by an inset axes.

This function draws a box in `parent_axes` at the bounding box of `inset_axes`, and shows a connection with the inset axes by drawing lines at the corners, giving a "zoomed in" effect.

**Parameters**

**parent\_axes** [`matplotlib.axes.Axes`] Axes which contains the area of the inset axes.

**inset\_axes** [`matplotlib.axes.Axes`] The inset axes.

**loc1, loc2** [{1, 2, 3, 4}] Corners to use for connecting the inset axes and the area in the parent axes.

**\*\*kwargs** Patch properties for the lines and box drawn:

	Property	Description
<code>agg_filter</code>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m,
<code>alpha</code>		float or None
<code>animated</code>		bool
<code>antialiased</code> or <code>aa</code>		unknown
<code>capstyle</code>		{'butt', 'round', 'projecting'}
<code>clip_box</code>		<i>Bbox</i>
<code>clip_on</code>		bool
<code>clip_path</code>		[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]
<code>color</code>		color
<code>contains</code>		callable
<code>edgecolor</code> or <code>ec</code>		color or None or 'auto'
<code>facecolor</code> or <code>fc</code>		color or None
<code>figure</code>		<i>Figure</i>
<code>fill</code>		bool
<code>gid</code>		str
<code>hatch</code>		{'/', '\\', ' ', '-.', '+', 'x', 'o', 'O', ':', '*'}
<code>in_layout</code>		bool
<code>joinstyle</code>		{'miter', 'round', 'bevel'}
<code>label</code>		object
<code>linestyle</code> or <code>ls</code>		{'-', '-.', '-.-', ':', "", (offset, on-off-seq), ...}
<code>linewidth</code> or <code>lw</code>		float or None
<code>path_effects</code>		<i>AbstractPathEffect</i>

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	Property	Description
<i>picker</i>		None or bool or float or callable
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>transform</i>		<i>Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>zorder</i>		float

**Returns**

**pp** [*matplotlib.patches.Patch*] The patch drawn to represent the area of the inset axes.

**p1, p2** [*matplotlib.patches.Patch*] The patches connecting two corners of the inset axes and its area.

**Examples using `mpl_toolkits.axes_grid1.inset_locator.mark_inset`**

- sphx\_glr\_gallery\_axes\_grid1\_inset\_locator\_demo2.py

**`mpl_toolkits.axes_grid1.inset_locator.zoomed_inset_axes`**

```
mpl_toolkits.axes_grid1.inset_locator.zoomed_inset_axes(parent_axes,          zoom,
                                                         loc='upper          right',
                                                         bbox_to_anchor=None,
                                                         bbox_transform=None,
                                                         axes_class=None,
                                                         axes_kwargs=None,      borderpad=0.5)
```

Create an anchored inset axes by scaling a parent axes. For usage, also see the examples.

**Parameters**

**parent\_axes** [*matplotlib.axes.Axes*] Axes to place the inset axes.

**zoom** [float] Scaling factor of the data axes. *zoom* > 1 will enlarge the coordinates (i.e., "zoomed in"), while *zoom* < 1 will shrink the coordinates (i.e., "zoomed out").

**loc** [int or string, optional, default to 1] Location to place the inset axes. The valid locations are:

```
'upper right' : 1,
'upper left'  : 2,
'lower left'  : 3,
'lower right' : 4,
'right'       : 5,
'center left' : 6,
'center right': 7,
'lower center': 8,
```

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```
'upper center' : 9,
'center'       : 10
```

**bbox\_to\_anchor** [tuple or `matplotlib.transforms.BboxBase`, optional] Bbox that the inset axes will be anchored to. If `None`, `parent_axes.bbox` is used. If a tuple, can be either [left, bottom, width, height], or [left, bottom]. If the kwargs `width` and/or `height` are specified in relative units, the 2-tuple [left, bottom] cannot be used. Note that the units of the bounding box are determined through the transform in use. When using `bbox_to_anchor` it almost always makes sense to also specify a `bbox_transform`. This might often be the axes transform `parent_axes.transAxes`.

**bbox\_transform** [`matplotlib.transforms.Transform`, optional] Transformation for the bbox that contains the inset axes. If `None`, a `transforms.IdentityTransform` is used (i.e. pixel coordinates). This is useful when not providing any argument to `bbox_to_anchor`. When using `bbox_to_anchor` it almost always makes sense to also specify a `bbox_transform`. This might often be the axes transform `parent_axes.transAxes`. Inversely, when specifying the axes- or figure-transform here, be aware that not specifying `bbox_to_anchor` will use `parent_axes.bbox`, the units of which are in display (pixel) coordinates.

**axes\_class** [`matplotlib.axes.Axes` type, optional] If specified, the inset axes created will be created with this class's constructor.

**axes\_kwargs** [dict, optional] Keyworded arguments to pass to the constructor of the inset axes. Valid arguments include:

	Property	Description
<code>adjustable</code>	{'box', 'datalim'}	
<code>agg_filter</code>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3)
<code>alpha</code>	float	
<code>anchor</code>		2-tuple of floats or {'C', 'SW', 'S', 'SE', ...}
<code>animated</code>	bool	
<code>aspect</code>	{'auto', 'equal'} or num	
<code>autoscale_on</code>	bool	
<code>autoscalex_on</code>	bool	
<code>autoscaley_on</code>	bool	
<code>axes_locator</code>		Callable[[Axes, Renderer], Bbox]
<code>axisbelow</code>	bool or 'line'	
<code>clip_box</code>	<code>Bbox</code>	
<code>clip_on</code>	bool	
<code>clip_path</code>		[( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   <code>None</code> ]
<code>contains</code>		callable
<code>facecolor</code>	color	
<code>fc</code>	color	
<code>figure</code>	<code>Figure</code>	
<code>frame_on</code>	bool	
<code>gid</code>	str	
<code>in_layout</code>		bool
<code>label</code>		object

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	Property	Description
<code>navigate</code>	bool	
<code>navigate_mode</code>	unknown	
<code>path_effects</code>	<i>AbstractPathEffect</i>	
<code>picker</code>	None or bool or float or callable	
<code>position</code>	[left, bottom, width, height] or <i>Bbox</i>	
<code>rasterization_zorder</code>	float or None	
<code>rasterized</code>	bool or None	
<code>sketch_params</code>	(scale: float, length: float, randomness: float)	
<code>snap</code>	bool or None	
<code>title</code>	str	
<code>transform</code>	<i>Transform</i>	
<code>url</code>	str	
<code>visible</code>	bool	
<code>xbound</code>	unknown	
<code>xlabel</code>	str	
<code>xlim</code>	(left: float, right: float)	
<code>xmargin</code>	float greater than -0.5	
<code>xscale</code>	{"linear", "log", "symlog", "logit", ...}	
<code>xticklabels</code>	List[str]	
<code>xticks</code>	list	
<code>ybound</code>	unknown	
<code>ylabel</code>	str	
<code>ylim</code>	(bottom: float, top: float)	
<code>ymargin</code>	float greater than -0.5	
<code>yscale</code>	{"linear", "log", "symlog", "logit", ...}	
<code>yticklabels</code>	List[str]	
<code>yticks</code>	list	
<code>zorder</code>	float	

**borderpad** [float, optional] Padding between inset axes and the `bbox_to_anchor`. Defaults to 0.5. The units are axes font size, i.e. for a default font size of 10 points `borderpad = 0.5` is equivalent to a padding of 5 points.

### Returns

**inset\_axes** [`axes_class`] Inset axes object created.

Examples using `mpl_toolkits.axes_grid1.inset_locator.zoomed_inset_axes`

- `sphx_glr_gallery_axes_grid1_demo_colorbar_of_inset_axes.py`
- `sphx_glr_gallery_axes_grid1_inset_locator_demo2.py`

`mpl_toolkits.axes_grid1.mpl_axes`

Classes

*Axes*(fig, rect[, facecolor, frameon, ...]) Build an axes in a figure.

*SimpleAxisArtist*(axis, axisnum, spine)

*SimpleChainedObjects*(objects)

**mpl\_toolkits.axes\_grid1.mpl\_axes.Axes**

```
class mpl_toolkits.axes_grid1.mpl_axes.Axes(fig, rect, facecolor=None, frameon=True,
                                             sharex=None, sharey=None, label="", xscale=None, yscale=None, **kwargs)
```

Bases: matplotlib.axes.\_axes.Axes

Build an axes in a figure.

**Parameters**

**fig** [*Figure*] The axes is build in the *Figure* fig.

**rect** [[left, bottom, width, height]] The axes is build in the rectangle *rect*. *rect* is in *Figure* coordinates.

**sharex, sharey** [*Axes*, optional] The x or y *axis* is shared with the x or y axis in the input *Axes*.

**frameon** [bool, optional] True means that the axes frame is visible.

**\*\*kwargs** Other optional keyword arguments:

	Property	Description
<i>adjustable</i>	{'box', 'datalim'}	
<i>agg_filter</i>		a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3)
<i>alpha</i>	float	
<i>anchor</i>	2-tuple of floats or {'C', 'SW', 'S', 'SE', ...}	
<i>animated</i>	bool	
<i>aspect</i>	{'auto', 'equal'} or num	
<i>autoscale_on</i>	bool	
<i>autoscalex_on</i>	bool	
<i>autoscaley_on</i>	bool	
<i>axes_locator</i>	Callable[[Axes, Renderer], Bbox]	
<i>axisbelow</i>	bool or 'line'	
<i>clip_box</i>	<i>Bbox</i>	
<i>clip_on</i>	bool	
<i>clip_path</i>	[( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   None]	
<i>contains</i>	callable	
<i>facecolor</i>	color	
<i>fc</i>	color	
<i>figure</i>	<i>Figure</i>	
<i>frame_on</i>	bool	
<i>gid</i>	str	
<i>in_layout</i>	bool	
<i>label</i>	object	
<i>navigate</i>	bool	
<i>navigate_mode</i>	unknown	
<i>path_effects</i>	<i>AbstractPathEffect</i>	
<i>picker</i>	None or bool or float or callable	

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	Property	Description
<i>position</i>		[left, bottom, width, height] or <i>Bbox</i>
<i>rasterization_zorder</i>		float or None
<i>rasterized</i>		bool or None
<i>sketch_params</i>		(scale: float, length: float, randomness: float)
<i>snap</i>		bool or None
<i>title</i>		str
<i>transform</i>		<i>Transform</i>
<i>url</i>		str
<i>visible</i>		bool
<i>xbound</i>		unknown
<i>xlabel</i>		str
<i>xlim</i>		(left: float, right: float)
<i>xmargin</i>		float greater than -0.5
<i>xscale</i>		{"linear", "log", "symlog", "logit", ...}
<i>xticklabels</i>		List[str]
<i>xticks</i>		list
<i>ybound</i>		unknown
<i>ylabel</i>		str
<i>ylim</i>		(bottom: float, top: float)
<i>ymargin</i>		float greater than -0.5
<i>yscale</i>		{"linear", "log", "symlog", "logit", ...}
<i>yticklabels</i>		List[str]
<i>yticks</i>		list
<i>zorder</i>		float

## Returns

**axes** [*Axes*] The new *Axes* object.

`class AxisDict()` -> new empty dictionary `dict(mapping)` -> new dictionary initialized from a mapping object's (key, value) pairs `dict(iterable)` -> new dictionary initialized as if via: `d = {}` for `k, v` in `iterable`: `d[k] = v`  
`dict(**kwargs)` -> new dictionary initialized with the name=value pairs in the keyword argument list. For example: `dict(one=1, two=2)`

Bases: `dict`

**axis**

Convenience method to get or set some axis properties.

Call signatures:

```
xmin, xmax, ymin, ymax = axis()
xmin, xmax, ymin, ymax = axis([xmin, xmax, ymin, ymax])
xmin, xmax, ymin, ymax = axis(option)
xmin, xmax, ymin, ymax = axis(**kwargs)
```

## Parameters

**xmin, xmax, ymin, ymax** [float, optional] The axis limits to be set. Either none or all of the limits must be given. This can also be achieved using

```
ax.set(xlim=(xmin, xmax), ylim=(ymin, ymax))
```

**option** [bool or str] If a bool, turns axis lines and labels on or off. If a string, possible values are:

Value	Description
'on'	Turn on axis lines and labels. Same as <code>True</code> .
'off'	Turn off axis lines and labels. Same as <code>False</code> .
'equal'	Set equal scaling (i.e., make circles circular) by changing axis limits.
'scaled'	Set equal scaling (i.e., make circles circular) by changing dimensions of the plot box.
'tight'	Set limits just large enough to show all data.
'auto'	Automatic scaling (fill plot box with data).
'normal'	Same as 'auto'; deprecated.
'image'	'scaled' with axis limits equal to data limits.
'square'	Square plot; similar to 'scaled', but initially forcing $x_{\max} - x_{\min} = y_{\max} - y_{\min}$ .

**emit** [bool, optional, default `True`] Whether observers are notified of the axis limit change. This option is passed on to `set_xlim` and `set_ylim`.

### Returns

**xmin, xmax, ymin, ymax** [float] The axis limits.

### See also:

`matplotlib.axes.Axes.set_xlim`

`matplotlib.axes.Axes.set_ylim`

`cla(self)`

Clear the current axes.

### Examples using `mpl_toolkits.axes_grid1.mpl_axes.Axes`

- `sphx_glr_gallery_axes_grid1_demo_axes_divider.py`
- `sphx_glr_gallery_axes_grid1_demo_fixed_size_axes.py`

### `mpl_toolkits.axes_grid1.mpl_axes.SimpleAxisArtist`

```
class mpl_toolkits.axes_grid1.mpl_axes.SimpleAxisArtist(axis, axisnum, spine)
```

Bases: `matplotlib.artist.Artist`

`label`

`major_ticklabels`

`major_ticks`

`set_label(self, txt)`  
 Set a label that will be displayed in the legend.

**Parameters**

**s** [object] s will be converted to a string by calling `str`.

`set_visible(self, b)`  
 Set the artist's visibility.

**Parameters**

**b** [bool]

`toggle(self, all=None, ticks=None, ticklabels=None, label=None)`

**mpl\_toolkits.axes\_grid1.mpl\_axes.SimpleChainedObjects**

```
class mpl_toolkits.axes_grid1.mpl_axes.SimpleChainedObjects(objects)
    Bases: object
```

**mpl\_toolkits.axes\_grid1.parasite\_axes**

**Classes**

<i>HostAxes</i>	alias of <code>mpl_toolkits.axes_grid1.parasite_axes.AxesHostAxes</code>
<i>HostAxesBase</i> (*args, **kwargs)	
<i>ParasiteAxes</i>	alias of <code>mpl_toolkits.axes_grid1.parasite_axes.AxesParasite</code>
<i>ParasiteAxesAuxTrans</i>	alias of <code>mpl_toolkits.axes_grid1.parasite_axes.AxesParasiteParasiteAuxTrans</code>
<i>ParasiteAxesAuxTransBase</i> (parent_axes, ...[, ...])	
<i>ParasiteAxesBase</i> (parent_axes, **kwargs)	

**mpl\_toolkits.axes\_grid1.parasite\_axes.HostAxes**

```
mpl_toolkits.axes_grid1.parasite_axes.HostAxes
    alias of mpl_toolkits.axes_grid1.parasite_axes.AxesHostAxes
```

**mpl\_toolkits.axes\_grid1.parasite\_axes.HostAxesBase**

```
class mpl_toolkits.axes_grid1.parasite_axes.HostAxesBase(*args, **kwargs)
    Bases: object
    cla(self)
    draw(self, renderer)
    get_aux_axes(self, tr, viewlim_mode='equal', axes_class=None)
    get_tightbbox(self, renderer, call_axes_locator=True, bbox_extra_artists=None)
```

`pick(self, mouseevent)`

`twin(self, aux_trans=None, axes_class=None)`  
Create a twin of Axes with no shared axis.

While `self` will have ticks on the left and bottom axis, the returned axes will have ticks on the top and right axis.

`twinx(self, axes_class=None)`  
Create a twin of Axes with a shared x-axis but independent y-axis.

The y-axis of `self` will have ticks on the left and the returned axes will have ticks on the right.

`twiny(self, axes_class=None)`  
Create a twin of Axes with a shared y-axis but independent x-axis.

The x-axis of `self` will have ticks on the bottom and the returned axes will have ticks on the top.

### `mpl_toolkits.axes_grid1.parasite_axes.ParasiteAxes`

`mpl_toolkits.axes_grid1.parasite_axes.ParasiteAxes`  
alias of `mpl_toolkits.axes_grid1.parasite_axes.AxesParasite`

### `mpl_toolkits.axes_grid1.parasite_axes.ParasiteAxesAuxTrans`

`mpl_toolkits.axes_grid1.parasite_axes.ParasiteAxesAuxTrans`  
alias of `mpl_toolkits.axes_grid1.parasite_axes.AxesParasiteParasiteAuxTrans`

### `mpl_toolkits.axes_grid1.parasite_axes.ParasiteAxesAuxTransBase`

```
class mpl_toolkits.axes_grid1.parasite_axes.ParasiteAxesAuxTransBase(parent_axes,
                                                                    aux_transform,
                                                                    viewlim_mode=None,
                                                                    **kwargs)
```

Bases: `object`

`apply_aspect(self, position=None)`

`contour(self, *XYCL, **kwargs)`

`contourf(self, *XYCL, **kwargs)`

`get_viewlim_mode(self)`

`pcolor(self, *XYC, **kwargs)`

`pcolormesh(self, *XYC, **kwargs)`

`set_viewlim_mode(self, mode)`

`update_viewlim(self)`

**mpl\_toolkits.axes\_grid1.parasite\_axes.ParasiteAxesBase**

```
class mpl_toolkits.axes_grid1.parasite_axes.ParasiteAxesBase(parent_axes, **kwargs)
    Bases: object
    cla(self)
    get_images_artists(self)
    pick(self, mouseevent)
```

**Functions**

<code>host_axes(*args[, axes_class, figure])</code>	Create axes that can act as a hosts to parasitic axes.
<code>host_subplot(*args[, axes_class, figure])</code>	Create a subplot that can act as a host to parasitic axes.
<code>host_subplot_class_factory(axes_class)</code>	

---

**mpl\_toolkits.axes\_grid1.parasite\_axes.host\_axes**

```
mpl_toolkits.axes_grid1.parasite_axes.host_axes(*args, axes_class=None, figure=None, **kwargs)
    Create axes that can act as a hosts to parasitic axes.
```

**Parameters**

**figure** [*matplotlib.figure.Figure*] Figure to which the axes will be added. Defaults to the current figure `pyplot.gcf()`.

**\*args, \*\*kwargs** Will be passed on to the underlying `Axes` object creation.

**mpl\_toolkits.axes\_grid1.parasite\_axes.host\_subplot**

```
mpl_toolkits.axes_grid1.parasite_axes.host_subplot(*args, axes_class=None, figure=None, **kwargs)
    Create a subplot that can act as a host to parasitic axes.
```

**Parameters**

**figure** [*matplotlib.figure.Figure*] Figure to which the subplot will be added. Defaults to the current figure `pyplot.gcf()`.

**\*args, \*\*kwargs** Will be passed on to the underlying `Axes` object creation.

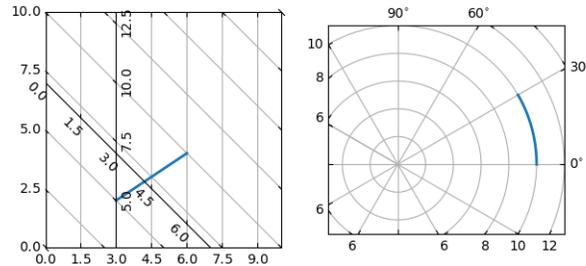
**mpl\_toolkits.axes\_grid1.parasite\_axes.host\_subplot\_class\_factory**

```
mpl_toolkits.axes_grid1.parasite_axes.host_subplot_class_factory(axes_class)
```

### 18.1.3 Matplotlib axisartist Toolkit

The *axisartist* namespace includes a derived Axes implementation (`mpl_toolkits.axisartist.Axes`). The biggest difference is that the artists that are responsible for drawing axis lines, ticks, ticklabels, and axis labels are separated out from the mpl's `Axis` class. This change was strongly motivated to support curvilinear grid.

You can find a tutorial describing usage of *axisartist* at the *axisartist* user guide.



The submodules of the *axisartist* API are:

<code>axisartist.angle_helper</code>	
<code>axisartist.axes_divider</code>	
<code>axisartist.axes_grid</code>	
<code>axisartist.axes_rgb</code>	
<code>axisartist.axis_artist</code>	<code>axis_artist.py</code> module provides axis-related artists.
<code>axisartist.axisline_style</code>	
<code>axisartist.axislines</code>	<code>Axislines</code> includes modified implementation of the <code>Axes</code> class.
<code>axisartist.clip_path</code>	
<code>axisartist.floating_axes</code>	An experimental support for curvilinear grid.
<code>axisartist.grid_finder</code>	
<code>axisartist.grid_helper_curvilinear</code>	An experimental support for curvilinear grid.
<code>axisartist.parasite_axes</code>	

#### `mpl_toolkits.axisartist.angle_helper`

##### Classes

<code>ExtremeFinderCycle(nx, ny[, lon_cycle, ...])</code>	When there is a cycle, e.g., longitude goes from 0-360.
<code>FormatterDMS</code>	
<code>FormatterHMS</code>	
<code>LocatorBase(den[, include_last])</code>	

Continued on next page

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<code>LocatorD(den[, include_last])</code>
<code>LocatorDM(den[, include_last])</code>
<code>LocatorDMS(den[, include_last])</code>
<code>LocatorH(den[, include_last])</code>
<code>LocatorHM(den[, include_last])</code>
<code>LocatorHMS(den[, include_last])</code>

---

**mpl\_toolkits.axisartist.angle\_helper.ExtremeFinderCycle**

```
class mpl_toolkits.axisartist.angle_helper.ExtremeFinderCycle(nx, ny,
                                                             lon_cycle=360.0,
                                                             lat_cycle=None,
                                                             lon_minmax=None,
                                                             lat_minmax=(-90, 90))
    Bases: mpl_toolkits.axisartist.grid_finder.ExtremeFinderSimple
```

When there is a cycle, e.g., longitude goes from 0-360.

**Examples using mpl\_toolkits.axisartist.angle\_helper.ExtremeFinderCycle**

- sphx\_glr\_gallery\_axisartist\_demo\_axis\_direction.py
- sphx\_glr\_gallery\_axisartist\_demo\_curvelinear\_grid.py
- sphx\_glr\_gallery\_axisartist\_demo\_curvelinear\_grid2.py
- sphx\_glr\_gallery\_axisartist\_demo\_floating\_axis.py
- sphx\_glr\_gallery\_axisartist\_simple\_axis\_pad.py

**mpl\_toolkits.axisartist.angle\_helper.FormatterDMS**

```
class mpl_toolkits.axisartist.angle_helper.FormatterDMS
    Bases: object
    deg_mark = '^{\circ}'
    fmt_d = '%d^{\circ}$'
    fmt_d_m = '%s%d^{\circ}\,%02d^{\prime}$'
    fmt_d_m_partial = '%s%d^{\circ}\,%02d^{\prime}\,'
    fmt_d_ms = '%s%d^{\circ}\,%02d.%s^{\prime}$'
    fmt_ds = '%d.%s^{\circ}$'
    fmt_s_partial = '%02d^{\prime}\prime}$'
    fmt_ss_partial = '%02d.%s^{\prime}\prime}$'
    min_mark = '^{\prime}'
    sec_mark = '^{\prime}\prime}'
```



### `mpl_toolkits.axisartist.angle_helper.LocatorDM`

```
class mpl_toolkits.axisartist.angle_helper.LocatorDM(den, include_last=True)  
    Bases: mpl_toolkits.axisartist.angle_helper.LocatorBase
```

### `mpl_toolkits.axisartist.angle_helper.LocatorDMS`

```
class mpl_toolkits.axisartist.angle_helper.LocatorDMS(den, include_last=True)  
    Bases: mpl_toolkits.axisartist.angle_helper.LocatorBase
```

#### Examples using `mpl_toolkits.axisartist.angle_helper.LocatorDMS`

- `sphx_glr_gallery_axisartist_demo_axis_direction.py`
- `sphx_glr_gallery_axisartist_demo_curvilinear_grid.py`
- `sphx_glr_gallery_axisartist_demo_floating_axis.py`
- `sphx_glr_gallery_axisartist_simple_axis_pad.py`

### `mpl_toolkits.axisartist.angle_helper.LocatorH`

```
class mpl_toolkits.axisartist.angle_helper.LocatorH(den, include_last=True)  
    Bases: mpl_toolkits.axisartist.angle_helper.LocatorBase
```

### `mpl_toolkits.axisartist.angle_helper.LocatorHM`

```
class mpl_toolkits.axisartist.angle_helper.LocatorHM(den, include_last=True)  
    Bases: mpl_toolkits.axisartist.angle_helper.LocatorBase
```

### `mpl_toolkits.axisartist.angle_helper.LocatorHMS`

```
class mpl_toolkits.axisartist.angle_helper.LocatorHMS(den, include_last=True)  
    Bases: mpl_toolkits.axisartist.angle_helper.LocatorBase
```

#### Examples using `mpl_toolkits.axisartist.angle_helper.LocatorHMS`

- `sphx_glr_gallery_axisartist_demo_floating_axes.py`

### Functions

```
select_step(v1, v2, nv[, hour, ...])  
select_step24(v1, v2, nv[, include_last, ...])  
select_step360(v1, v2, nv[, include_last, ...])  
select_step_degree(dv)
```

---

Continued on next page

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`select_step_hour(dv)`


---

`select_step_sub(dv)`


---

**mpl\_toolkits.axisartist.angle\_helper.select\_step**

```
mpl_toolkits.axisartist.angle_helper.select_step(v1, v2, nv, hour=False, include_last=True, threshold_factor=3600.0)
```

**mpl\_toolkits.axisartist.angle\_helper.select\_step24**

```
mpl_toolkits.axisartist.angle_helper.select_step24(v1, v2, nv, include_last=True, threshold_factor=3600)
```

**mpl\_toolkits.axisartist.angle\_helper.select\_step360**

```
mpl_toolkits.axisartist.angle_helper.select_step360(v1, v2, nv, include_last=True, threshold_factor=3600)
```

**mpl\_toolkits.axisartist.angle\_helper.select\_step\_degree**

```
mpl_toolkits.axisartist.angle_helper.select_step_degree(dv)
```

**mpl\_toolkits.axisartist.angle\_helper.select\_step\_hour**

```
mpl_toolkits.axisartist.angle_helper.select_step_hour(dv)
```

**mpl\_toolkits.axisartist.angle\_helper.select\_step\_sub**

```
mpl_toolkits.axisartist.angle_helper.select_step_sub(dv)
```

**mpl\_toolkits.axisartist.axes\_divider****Classes**


---

<code>Axes(**kwargs)</code>	<code>[Deprecated]</code>
-----------------------------	---------------------------

---

<code>LocatableAxes(**kwargs)</code>	<code>[Deprecated]</code>
--------------------------------------	---------------------------

---

**mpl\_toolkits.axisartist.axes\_divider.Axes**

```
class mpl_toolkits.axisartist.axes_divider.Axes(**kwargs)
    Bases: mpl_toolkits.axisartist.axislines.Axes
    [Deprecated]
```

**Notes**

Deprecated since version 3.0:

**mpl\_toolkits.axisartist.axes\_divider.LocatableAxes**

```
class mpl_toolkits.axisartist.axes_divider.LocatableAxes(**kwargs)
    Bases: mpl_toolkits.axisartist.axes_lines.Axes
    [Deprecated]
```

**Notes**

Deprecated since version 3.0:

**mpl\_toolkits.axisartist.axes\_grid**

**Classes**

<i>AxesGrid</i>	alias of <i>mpl_toolkits.axisartist.axes_grid.ImageGrid</i>
<i>CbarAxes</i> (*args, orientation, **kwargs)	
<i>Grid</i> (fig, rect, nrows_ncols[, ngrids, ...])	<b>Parameters</b>
<i>ImageGrid</i> (fig, rect, nrows_ncols[, ngrids, ...])	<b>Parameters</b>

**mpl\_toolkits.axisartist.axes\_grid.AxesGrid**

```
mpl_toolkits.axisartist.axes_grid.AxesGrid
    alias of mpl_toolkits.axisartist.axes_grid.ImageGrid
```

**mpl\_toolkits.axisartist.axes\_grid.CbarAxes**

```
class mpl_toolkits.axisartist.axes_grid.CbarAxes(*args, orientation, **kwargs)
    Bases: mpl_toolkits.axes_grid1.axes_grid.CbarAxesBase, mpl_toolkits.axisartist.axes_lines.Axes
    cla(self)
        Clear the current axes.
```

**mpl\_toolkits.axisartist.axes\_grid.Grid**

```
class mpl_toolkits.axisartist.axes_grid.Grid(fig, rect, nrows_ncols, ngrids=None,
                                             direction='row', axes_pad=0.02,
                                             add_all=True, share_all=False,
                                             share_x=True, share_y=True, label_mode='L', axes_class=None)
```

Bases: *mpl\_toolkits.axes\_grid1.axes\_grid.Grid*

**Parameters**

**fig** [*Figure*] The parent figure.

**rect** [(float, float, float, float) or int] The axes position, as a (left, bottom, width, height) tuple or as a three-digit subplot position code (e.g., "121").

**direction** [{"row", "column"}, default: "row"]

**axes\_pad** [float or (float, float), default: 0.02] Padding or (horizontal padding, vertical padding) between axes, in inches.

**add\_all** [bool, default: True]

**share\_all** [bool, default: False]

**share\_x** [bool, default: True]

**share\_y** [bool, default: True]

**label\_mode** [{"L", "1", "all"}, default: "L"] Determines which axes will get tick labels:

- "L": All axes on the left column get vertical tick labels; all axes on the bottom row get horizontal tick labels.
- "1": Only the bottom left axes is labelled.
- "all": all axes are labelled.

**axes\_class** [a type that is a subclass of *matplotlib.axes.Axes*, default: None]

**mpl\_toolkits.axisartist.axes\_grid.ImageGrid**

```
class mpl_toolkits.axisartist.axes_grid.ImageGrid(fig, rect, nrows_ncols,
                                                  ngrids=None, direction='row',
                                                  axes_pad=0.02, add_all=True,
                                                  share_all=False, aspect=True,
                                                  label_mode='L', cbar_mode=None,
                                                  cbar_location='right',
                                                  cbar_pad=None, cbar_size='5%',
                                                  cbar_set_cax=True,
                                                  axes_class=None)
```

Bases: *mpl\_toolkits.axes\_grid1.axes\_grid.ImageGrid*

**Parameters**

**fig** [*Figure*] The parent figure.

**rect** [(float, float, float, float) or int] The axes position, as a (left, bottom, width, height) tuple or as a three-digit subplot position code (e.g., "121").

**direction** [{"row", "column"}, default: "row"]

**axes\_pad** [float or (float, float), default: 0.02] Padding or (horizontal padding, vertical padding) between axes, in inches.

**add\_all** [bool, default: True]

**share\_all** [bool, default: False]

**aspect** [bool, default: True]

**label\_mode** [{"L", "1", "all"}, default: "L"] Determines which axes will get tick labels:

- "L": All axes on the left column get vertical tick labels; all axes on the bottom row get horizontal tick labels.
- "1": Only the bottom left axes is labelled.
- "all": all axes are labelled.

**cbar\_mode** [{"each", "single", "edge", None }, default: None]

**cbar\_location** [{"left", "right", "bottom", "top"}, default: "right"]

**cbar\_pad** [float, default: None]

**cbar\_size** [size specification (see `Size.from_any`), default: "5%"]

**cbar\_set\_cax** [bool, default: True] If True, each axes in the grid has a *cax* attribute that is bound to associated *cbar\_axes*.

**axes\_class** [a type that is a subclass of `matplotlib.axes.Axes`, default: None]

`mpl_toolkits.axisartist.axes_rgb`

## Classes

`RGBAxes(*args[, pad, add_all])`

## Parameters

`mpl_toolkits.axisartist.axes_rgb.RGBAxes`

```
class mpl_toolkits.axisartist.axes_rgb.RGBAxes(*args, pad=0, add_all=True, **kwargs)
    Bases: mpl_toolkits.axes_grid1.axes_rgb.RGBAxesBase
```

## Parameters

**pad** [float] fraction of the axes height to put as padding. defaults to 0.0

**add\_all** [bool] True: Add the {rgb, r, g, b} axes to the figure defaults to True.

**axes\_class** [matplotlib.axes.Axes]

**\*args** Unpacked into `axes_class()` init for RGB

**\*\*kwargs** Unpacked into `axes_class()` init for RGB, R, G, B axes

### `mpl_toolkits.axisartist.axis_artist`

`axis_artist.py` module provides axis-related artists. They are

- axis line
- tick lines
- tick labels
- axis label
- grid lines

The main artist classes are *AxisArtist* and *GridlinesCollection*. While *GridlinesCollection* is responsible for drawing grid lines, *AxisArtist* is responsible for all other artists. *AxisArtist* has attributes that are associated with each type of artists:

- `line`: axis line
- `major_ticks`: major tick lines
- `major_ticklabels`: major tick labels
- `minor_ticks`: minor tick lines
- `minor_ticklabels`: minor tick labels
- `label`: axis label

Typically, the *AxisArtist* associated with an axes will be accessed with the *axis* dictionary of the axes, i.e., the *AxisArtist* for the bottom axis is

```
ax.axis["bottom"]
```

where *ax* is an instance of `mpl_toolkits.axislines.Axes`. Thus, `ax.axis["bottom"].line` is an artist associated with the axis line, and `ax.axis["bottom"].major_ticks` is an artist associated with the major tick lines.

You can change the colors, fonts, line widths, etc. of these artists by calling suitable `set` method. For example, to change the color of the major ticks of the bottom axis to red, use

```
ax.axis["bottom"].major_ticks.set_color("r")
```

However, things like the locations of ticks, and their ticklabels need to be changed from the side of the `grid_helper`.

### `axis_direction`

*AxisArtist*, *AxisLabel*, *TickLabels* have an *axis\_direction* attribute, which adjusts the location, angle, etc.,. The *axis\_direction* must be one of "left", "right", "bottom", "top", and follows the Matplotlib convention for rectangular axis.

For example, for the *bottom* axis (the left and right is relative to the direction of the increasing coordinate),

- ticklabels and axislabel are on the right

- ticklabels and axislabel have text angle of 0
- ticklabels are baseline, center-aligned
- axislabel is top, center-aligned

The text angles are actually relative to (90 + angle of the direction to the ticklabel), which gives 0 for bottom axis.

Parameter	left	bottom	right	top
ticklabels location	left	right	right	left
axislabel location	left	right	right	left
ticklabels angle	90	0	-90	180
axislabel angle	180	0	0	180
ticklabel va	center	baseline	center	baseline
axislabel va	center	top	center	bottom
ticklabel ha	right	center	right	center
axislabel ha	right	center	right	center

Ticks are by default direct opposite side of the ticklabels. To make ticks to the same side of the ticklabels,

```
ax.axis["bottom"].major_ticks.set_ticks_out(True)
```

The following attributes can be customized (use the set\_xxx methods):

- *Ticks*: ticksize, tick\_out
- *TickLabels*: pad
- *AxisLabel*: pad

**Classes**

<i>AttributeCopier</i> (ref_artist[, klass])	
<i>AxisArtist</i> (axes, helper[, offset, ...])	An artist which draws axis (a line along which the n-th axes coord is constant) line, ticks, ticklabels, and axis label.
<i>AxisLabel</i> (*args[, axis_direction, axis])	Axis Label.
<i>BezierPath</i> (path, *args, **kwargs)	
<i>GridlinesCollection</i> (*args[, which, axis])	<i>which</i> : "major" or "minor" axis : "both", "x" or "y"
<i>LabelBase</i> (*args, **kwargs)	A base class for AxisLabel and TickLabels.
<i>TickLabels</i> (*[, axis_direction])	Tick Labels.
<i>Ticks</i> (ticksize[, tick_out, axis])	Ticks are derived from Line2D, and note that ticks themselves are markers.

**mpl\_toolkits.axisartist.axis\_artist.AttributeCopier**

```
class mpl_toolkits.axisartist.axis_artist.AttributeCopier(ref_artist,
                                                         klass=<class
                                                         'matplotlib.artist.Artist'>)
    Bases: object
    get_attribute_from_ref_artist(self, attr_name, default_value)
```

```
get_ref_artist(self)
set_ref_artist(self, artist)
```

### `mpl_toolkits.axisartist.axis_artist.AxisArtist`

```
class mpl_toolkits.axisartist.axis_artist.AxisArtist(axes, helper, offset=None,
                                                    axis_direction='bottom',
                                                    **kwargs)
```

Bases: `matplotlib.artist.Artist`

An artist which draws axis (a line along which the n-th axes coord is constant) line, ticks, ticklabels, and axis label.

*axes* : axes *helper* : an AxisArtistHelper instance.

LABELPAD

ZORDER = 2.5

```
draw(self, renderer)
    Draw the axis lines, tick lines and labels
```

```
get_axisline_style(self)
    return the current axisline style.
```

```
get_helper(self)
    Return axis artist helper instance.
```

```
get_tightbbox(self, renderer)
    Like Artist.get_window_extent, but includes any clipping.
```

#### Parameters

**renderer** [`RendererBase` instance] renderer that will be used to draw the figures (i.e. `fig.canvas.get_renderer()`)

#### Returns

**bbox** [`BBox`] The enclosing bounding box (in figure pixel co-ordinates).

```
get_transform(self)
    Return the Transform instance used by this artist.
```

```
invert_ticklabel_direction(self)
```

```
set_axis_direction(self, axis_direction)
    Adjust the direction, text angle, text alignment of ticklabels, labels following the matplotlib convention for the rectangle axes.
```

The *axis\_direction* must be one of [left, right, bottom, top].

property	left	bottom	right	top
ticklabels location	"-"	"+"	"+"	"-"
axislabel location	"-"	"+"	"+"	"-"
ticklabels angle	90	0	-90	180
ticklabel va	center	baseline	center	baseline
ticklabel ha	right	center	right	center
axislabel angle	180	0	0	180
axislabel va	center	top	center	bottom
axislabel ha	right	center	right	center

Note that the direction "+" and "-" are relative to the direction of the increasing coordinate. Also, the text angles are actually relative to (90 + angle of the direction to the ticklabel), which gives 0 for bottom axis.

`set_axislabel_direction(self, label_direction)`  
Adjust the direction of the axislabel.

Note that the *label\_directions* '+' and '-' are relative to the direction of the increasing coordinate.

#### Parameters

**tick\_direction** [{"+", "-"}]

`set_axisline_style(self, axisline_style=None, **kwargs)`  
Set the axisline style.

**axisline\_style can be a string with axisline style name with optional** comma-separated attributes. Alternatively, the attrs can be provided as keywords.

`set_axisline_style("->,size=1.5")` `set_axisline_style("->", size=1.5)`

Old attrs simply are forgotten.

Without argument (or with `arrowstyle=None`), return available styles as a list of strings.

`set_label(self, s)`  
Set a label that will be displayed in the legend.

#### Parameters

**s** [object] *s* will be converted to a string by calling `str`.

`set_ticklabel_direction(self, tick_direction)`  
Adjust the direction of the ticklabel.

Note that the *label\_directions* '+' and '-' are relative to the direction of the increasing coordinate.

#### Parameters

**tick\_direction** [{"+", "-"}]

`toggle(self, all=None, ticks=None, ticklabels=None, label=None)`  
Toggle visibility of ticks, ticklabels, and (axis) label. To turn all off,

```
axis.toggle(all=False)
```

To turn all off but ticks on

```
axis.toggle(all=False, ticks=True)
```

To turn all on but (axis) label off

```
axis.toggle(all=True, label=False)
```

**mpl\_toolkits.axisartist.axis\_artist.AxisLabel**

```
class mpl_toolkits.axisartist.axis_artist.AxisLabel(*args, axis_direction='bottom',
                                                    axis=None, **kwargs)
```

Bases: `mpl_toolkits.axisartist.axis_artist.LabelBase`, `mpl_toolkits.axisartist.axis_artist.AttributeCopier`

Axis Label. Derived from Text. The position of the text is updated in the fly, so changing text position has no effect. Otherwise, the properties can be changed as a normal Text.

To change the pad between ticklabels and axis label, use `set_pad`.

`draw(self, renderer)`

Draws the *Text* object to the given *renderer*.

`get_color(self)`

Return the color of the text

`get_pad(self)`

return pad in points. See `set_pad` for more details.

`get_ref_artist(self)`

`get_text(self)`

Get the text as string

`get_window_extent(self, renderer)`

Return the Bbox bounding the text, in display units.

In addition to being used internally, this is useful for specifying clickable regions in a png file on a web page.

**Parameters**

**renderer** [Renderer, optional] A renderer is needed to compute the bounding box. If the artist has already been drawn, the renderer is cached; thus, it is only necessary to pass this argument when calling `get_window_extent` before the first `draw`. In practice, it is usually easier to trigger a draw first (e.g. by saving the figure).

**dpi** [float, optional] The dpi value for computing the bbox, defaults to `self.figure.dpi` (*not* the renderer dpi); should be set e.g. if to match regions with a figure saved with a custom dpi value.

`set_axis_direction(self, d)`

Adjust the text angle and text alignment of axis label according to the matplotlib convention.

property	left	bottom	right	top
axislabel angle	180	0	0	180
axislabel va	center	top	center	bottom
axislabel ha	right	center	right	center

Note that the text angles are actually relative to (90 + angle of the direction to the ticklabel), which gives 0 for bottom axis.

`set_default_alignment(self, d)`

`set_default_angle(self, d)`

`set_pad(self, pad)`

Set the pad in points. Note that the actual pad will be the sum of the internal pad and the external pad (that are set automatically by the `AxisArtist`), and it only set the internal pad

#### `mpl_toolkits.axisartist.axis_artist.BezierPath`

`class mpl_toolkits.axisartist.axis_artist.BezierPath(path, *args, **kwargs)`

Bases: `matplotlib.lines.Line2D`

`draw(self, renderer)`

Draw the Artist using the given renderer.

This method will be overridden in the Artist subclasses. Typically, it is implemented to not have any effect if the Artist is not visible (`Artist.get_visible` is `False`).

##### Parameters

**renderer** [`RendererBase` subclass.]

`recache(self)`

`set_path(self, path)`

#### `mpl_toolkits.axisartist.axis_artist.GridlinesCollection`

`class mpl_toolkits.axisartist.axis_artist.GridlinesCollection(*args, which='major', axis='both', **kwargs)`

Bases: `matplotlib.collections.LineCollection`

`which` : "major" or "minor" `axis` : "both", "x" or "y"

`draw(self, renderer)`

Draw the Artist using the given renderer.

This method will be overridden in the Artist subclasses. Typically, it is implemented to not have any effect if the Artist is not visible (`Artist.get_visible` is `False`).

##### Parameters

**renderer** [`RendererBase` subclass.]

`set_axis(self, axis)`

`set_grid_helper(self, grid_helper)`

`set_which(self, which)`

#### `mpl_toolkits.axisartist.axis_artist.LabelBase`

`class mpl_toolkits.axisartist.axis_artist.LabelBase(*args, **kwargs)`

Bases: `matplotlib.text.Text`

A base class for `AxisLabel` and `TickLabels`. The position and angle of the text are calculated by to `offset_ref_angle`, `text_ref_angle`, and `offset_radius` attributes.

`draw(self, renderer)`

Draws the `Text` object to the given `renderer`.

`get_window_extent(self, renderer)`

Return the `Bbox` bounding the text, in display units.

In addition to being used internally, this is useful for specifying clickable regions in a png file on a web page.

### Parameters

**renderer** [Renderer, optional] A renderer is needed to compute the bounding box. If the artist has already been drawn, the renderer is cached; thus, it is only necessary to pass this argument when calling `get_window_extent` before the first `draw`. In practice, it is usually easier to trigger a draw first (e.g. by saving the figure).

**dpi** [float, optional] The dpi value for computing the bbox, defaults to `self.figure.dpi` (*not* the renderer dpi); should be set e.g. if to match regions with a figure saved with a custom dpi value.

### `mpl_toolkits.axisartist.axis_artist.TickLabels`

```
class mpl_toolkits.axisartist.axis_artist.TickLabels(*, axis_direction='bottom',
                                                    **kwargs)
    Bases: mpl_toolkits.axisartist.axis_artist.AxisLabel, mpl_toolkits.axisartist.
           axis_artist.AttributeCopier
```

Tick Labels. While derived from `Text`, this single artist draws all ticklabels. As in `AxisLabel`, the position of the text is updated in the fly, so changing text position has no effect. Otherwise, the properties can be changed as a normal `Text`. Unlike the ticklabels of the mainline matplotlib, properties of single ticklabel alone cannot be modified.

To change the pad between ticks and ticklabels, use `set_pad`.

`draw(self, renderer)`

Draws the `Text` object to the given `renderer`.

`get_ref_artist(self)`

`get_texts_widths_heights_descents(self, renderer)`

return a list of width, height, descent for ticklabels.

`get_window_extents(self, renderer)`

`invert_axis_direction(self)`

`set_axis_direction(self, label_direction)`

Adjust the text angle and text alignment of ticklabels according to the matplotlib convention.

The `label_direction` must be one of [left, right, bottom, top].

property	left	bottom	right	top
ticklabels angle	90	0	-90	180
ticklabel va	center	baseline	center	baseline
ticklabel ha	right	center	right	center

Note that the text angles are actually relative to (90 + angle of the direction to the ticklabel), which gives 0 for bottom axis.

`set_locs_angles_labels(self, locs_angles_labels)`

**mpl\_toolkits.axisartist.axis\_artist.Ticks**

```
class mpl_toolkits.axisartist.axis_artist.Ticks(ticksizelike, tick_out=False, *,
        axis=None, **kwargs)
```

Bases: `matplotlib.lines.Line2D`, `mpl_toolkits.axisartist.axis_artist.AttributeCopier`

Ticks are derived from `Line2D`, and note that ticks themselves are markers. Thus, you should use `set_mec`, `set_mew`, etc.

To change the tick size (length), you need to use `set_ticksizelike`. To change the direction of the ticks (ticks are in opposite direction of ticklabels by default), use `set_tick_out(False)`.

`draw(self, renderer)`

Draw the Artist using the given renderer.

This method will be overridden in the Artist subclasses. Typically, it is implemented to not have any effect if the Artist is not visible (`Artist.get_visible` is `False`).

**Parameters**

**renderer** [`RendererBase` subclass.]

`get_color(self)`

Return the line color.

See also `set_color`.

`get_markeredgecolor(self)`

Return the marker edge color.

See also `set_markeredgecolor`.

`get_markeredgewidth(self)`

Return the marker edge width in points.

See also `set_markeredgewidth`.

`get_ref_artist(self)`

`get_tick_out(self)`

Return True if the tick will be rotated by 180 degree.

`get_ticksizelike(self)`

Return length of the ticks in points.

`set_locs_angles(self, locs_angles)`

`set_tick_out(self, b)`

set True if tick need to be rotated by 180 degree.

`set_ticksizelike(self, ticksizelike)`

set length of the ticks in points.

**mpl\_toolkits.axisartist.axisline\_style****Classes**

*AxislineStyle**AxislineStyle* is a container class which defines style classes for AxisArtists.**mpl\_toolkits.axisartist.axisline\_style.AxislineStyle**

```
class mpl_toolkits.axisartist.axisline_style.AxislineStyle
    Bases: matplotlib.patches._Style
```

*AxislineStyle* is a container class which defines style classes for AxisArtists.

An instance of any axisline style class is an callable object, whose call signature is

```
__call__(self, axis_artist, path, transform)
```

When called, this should return a mpl artist with following methods implemented.

```
def set_path(self, path):
    # set the path for axisline.

def set_line_mutation_scale(self, scale):
    # set the scale

def draw(self, renderer):
    # draw
```

return the instance of the subclass with the given style name.

```
class FilledArrow(size=1)
    Bases: mpl_toolkits.axisartist.axisline_style.SimpleArrow
```

**size** size of the arrow as a fraction of the ticklabel size.

```
ArrowAxisClass
    alias of _FancyAxislineStyle.FilledArrow
```

```
class SimpleArrow(size=1)
    Bases: mpl_toolkits.axisartist.axisline_style._Base
```

A simple arrow.

**size** size of the arrow as a fraction of the ticklabel size.

```
ArrowAxisClass
    alias of _FancyAxislineStyle.SimpleArrow
```

```
new_line(self, axis_artist, transform)
```

**mpl\_toolkits.axisartist.axislines**

Axislines includes modified implementation of the Axes class. The biggest difference is that the artists responsible for drawing the axis spine, ticks, ticklabels and axis labels are separated out from mpl's Axis class. Originally, this change was motivated to support curvilinear grid. Here are a few reasons that I came up with a new axes class:

- "top" and "bottom" x-axis (or "left" and "right" y-axis) can have different ticks (tick locations and labels). This is not possible with the current mpl, although some twin axes trick can help.

- Curvilinear grid.
- angled ticks.

In the new axes class, `xaxis` and `yaxis` is set to not visible by default, and new set of artist (`AxisArtist`) are defined to draw axis line, ticks, ticklabels and axis label. `Axes.axis` attribute serves as a dictionary of these artists, i.e., `ax.axis["left"]` is a `AxisArtist` instance responsible to draw left y-axis. The default `Axes.axis` contains "bottom", "left", "top" and "right".

`AxisArtist` can be considered as a container artist and has following children artists which will draw ticks, labels, etc.

- line
- major\_ticks, major\_ticklabels
- minor\_ticks, minor\_ticklabels
- offsetText
- label

Note that these are separate artists from `Axis` class of the original `mpl`, thus most of tick-related command in the original `mpl` won't work, although some effort has made to work with. For example, `color` and `markerwidth` of the `ax.axis["bottom"].major_ticks` will follow those of `Axes.xaxis` unless explicitly specified.

In addition to `AxisArtist`, the `Axes` will have `gridlines` attribute, which obviously draws grid lines. The `gridlines` needs to be separated from the axis as some gridlines can never pass any axis.

## Classes

<code>Axes(*args[, grid_helper])</code>	
<code>AxesZero(*args[, grid_helper])</code>	
<code>AxisArtistHelper</code>	<code>AxisArtistHelper</code> should define following method with given APIs.
<code>AxisArtistHelperRectilinear</code>	
<code>GridHelperBase()</code>	
<code>GridHelperRectilinear(axes)</code>	
<code>SimpleChainedObjects(**kwargs)</code>	<code>[Deprecated]</code>

### `mpl_toolkits.axisartist.axislines.Axes`

```
class mpl_toolkits.axisartist.axislines.Axes(*args, grid_helper=None, **kwargs)
    Bases: matplotlib.axes._axes.Axes
    class AxisDict(**kwargs)
        Bases: dict
        [Deprecated]
```

#### Notes

Deprecated since version 3.1:

**axis**

Convenience method to get or set some axis properties.

Call signatures:

```
xmin, xmax, ymin, ymax = axis()
xmin, xmax, ymin, ymax = axis([xmin, xmax, ymin, ymax])
xmin, xmax, ymin, ymax = axis(option)
xmin, xmax, ymin, ymax = axis(**kwargs)
```

**Parameters**

**xmin, xmax, ymin, ymax** [float, optional] The axis limits to be set. Either none or all of the limits must be given. This can also be achieved using

```
ax.set(xlim=(xmin, xmax), ylim=(ymin, ymax))
```

**option** [bool or str] If a bool, turns axis lines and labels on or off. If a string, possible values are:

Value	Description
'on'	Turn on axis lines and labels. Same as <code>True</code> .
'off'	Turn off axis lines and labels. Same as <code>False</code> .
'equal'	Set equal scaling (i.e., make circles circular) by changing axis limits.
'scaled'	Set equal scaling (i.e., make circles circular) by changing dimensions of the plot box.
'tight'	Set limits just large enough to show all data.
'auto'	Automatic scaling (fill plot box with data).
'normal'	Same as 'auto'; deprecated.
'image'	'scaled' with axis limits equal to data limits.
'square'	Square plot; similar to 'scaled', but initially forcing $x_{\max} - x_{\min} = y_{\max} - y_{\min}$ .

**emit** [bool, optional, default `True`] Whether observers are notified of the axis limit change. This option is passed on to `set_xlim` and `set_ylim`.

**Returns**

**xmin, xmax, ymin, ymax** [float] The axis limits.

**See also:**

`matplotlib.axes.Axes.set_xlim`

`matplotlib.axes.Axes.set_ylim`

`cla(self)`

Clear the current axes.

`get_children(self)`

Return a list of the child *Artists* of this *Artist*.

```

get_grid_helper(self)
grid(self, b=None, which='major', axis='both', **kwargs)
    Toggle the gridlines, and optionally set the properties of the lines.
invalidate_grid_helper(self)
new_fixed_axis(self, loc, offset=None)
new_floating_axis(self, nth_coord, value, axis_direction='bottom')
new_gridlines(self, grid_helper=None)
    Create and return a new GridlineCollection instance.
    which : "major" or "minor" axis : "both", "x" or "y"
toggle_axisline(self, b=None)

```

### `mpl_toolkits.axisartist.axislines.AxesZero`

```

class mpl_toolkits.axisartist.axislines.AxesZero(*args, grid_helper=None, **kwargs)
    Bases: mpl_toolkits.axisartist.axislines.Axes

```

### `mpl_toolkits.axisartist.axislines.AxisArtistHelper`

```

class mpl_toolkits.axisartist.axislines.AxisArtistHelper
    Bases: object

```

AxisArtistHelper should define following method with given APIs. Note that the first axes argument will be axes attribute of the caller artist.:

```

# LINE (spinal line?)

def get_line(self, axes):
    # path : Path
    return path

def get_line_transform(self, axes):
    # ...
    # trans : transform
    return trans

# LABEL

def get_label_pos(self, axes):
    # x, y : position
    return (x, y), trans

def get_label_offset_transform(self, axes,
    pad_points, fontprops, renderer,
    bboxes,
    ):
    # va : vertical alignment
    # ha : horizontal alignment
    # a : angle

```

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```

    return trans, va, ha, a

# TICK

def get_tick_transform(self, axes):
    return trans

def get_tick_iterators(self, axes):
    # iter : iterable object that yields (c, angle, l) where
    # c, angle, l is position, tick angle, and label

    return iter_major, iter_minor

```

```
class Fixed(loc, nth_coord=None)
```

```
    Bases: mpl_toolkits.axisartist.axislines._Base
```

Helper class for a fixed (in the axes coordinate) axis.

nth\_coord = along which coordinate value varies in 2d, nth\_coord = 0 -> x axis,  
nth\_coord = 1 -> y axis

```
    get_axislabel_pos_angle(self, axes)
```

label reference position in transAxes.

get\_label\_transform() returns a transform of (transAxes+offset)

```
    get_axislabel_transform(self, axes)
```

```
    get_line(self, axes)
```

```
    get_line_transform(self, axes)
```

```
    get_nth_coord(self)
```

```
    get_tick_transform(self, axes)
```

```
class Floating(nth_coord, value)
```

```
    Bases: mpl_toolkits.axisartist.axislines._Base
```

```
    get_line(self, axes)
```

```
    get_nth_coord(self)
```

### **mpl\_toolkits.axisartist.axislines.AxisArtistHelperRectlinear**

```
class mpl_toolkits.axisartist.axislines.AxisArtistHelperRectlinear
```

```
    Bases: object
```

```
    class Fixed(axes, loc, nth_coord=None)
```

```
        Bases: mpl_toolkits.axisartist.axislines.Fixed
```

nth\_coord = along which coordinate value varies in 2d, nth\_coord = 0 -> x axis,  
nth\_coord = 1 -> y axis

```
        get_tick_iterators(self, axes)
```

tick\_loc, tick\_angle, tick\_label

```
    class Floating(axes, nth_coord, passingthrough_point, axis_direction='bottom')
```

```
        Bases: mpl_toolkits.axisartist.axislines.Floating
```

```
get_axislabel_pos_angle(self, axes)  
    label reference position in transAxes.  
    get_label_transform() returns a transform of (transAxes+offset)  
get_axislabel_transform(self, axes)  
get_line(self, axes)  
get_line_transform(self, axes)  
get_tick_iterators(self, axes)  
    tick_loc, tick_angle, tick_label  
get_tick_transform(self, axes)
```

### **mpl\_toolkits.axisartist.axislines.GridHelperBase**

```
class mpl_toolkits.axisartist.axislines.GridHelperBase  
    Bases: object  
    get_gridlines(self, which, axis)  
        Return list of grid lines as a list of paths (list of points).  
        which : "major" or "minor" axis : "both", "x" or "y"  
    invalidate(self)  
    new_gridlines(self, ax)  
        Create and return a new GridlineCollection instance.  
        which : "major" or "minor" axis : "both", "x" or "y"  
    update_lim(self, axes)  
    valid(self)
```

### **mpl\_toolkits.axisartist.axislines.GridHelperRectlinear**

```
class mpl_toolkits.axisartist.axislines.GridHelperRectlinear(axes)  
    Bases: mpl_toolkits.axisartist.axislines.GridHelperBase  
    get_gridlines(self, which='major', axis='both')  
        return list of gridline coordinates in data coordinates.  
        which : "major" or "minor" axis : "both", "x" or "y"  
    new_fixed_axis(self, loc, nth_coord=None, axis_direction=None, offset=None,  
                  axes=None)  
    new_floating_axis(self, nth_coord, value, axis_direction='bottom', axes=None)
```

### **mpl\_toolkits.axisartist.axislines.SimpleChainedObjects**

```
class mpl_toolkits.axisartist.axislines.SimpleChainedObjects(**kwargs)  
    Bases: object  
    [Deprecated]
```

## Notes

Deprecated since version 3.1:

### `mpl_toolkits.axisartist.clip_path`

#### Functions

*atan2*(*dy*, *dx*)

---

*clip*(*xlines*, *yline*s, *x0*[, *clip*, *xdir*, *ydir*])

---

*clip\_line\_to\_rect*(*xline*, *yline*, *bbox*)

---

### `mpl_toolkits.axisartist.clip_path.atan2`

`mpl_toolkits.axisartist.clip_path.atan2(dy, dx)`

### `mpl_toolkits.axisartist.clip_path.clip`

`mpl_toolkits.axisartist.clip_path.clip(xlines, ylines, x0, clip='right', xdir=True, ydir=True)`

### `mpl_toolkits.axisartist.clip_path.clip_line_to_rect`

`mpl_toolkits.axisartist.clip_path.clip_line_to_rect(xline, yline, bbox)`

### `mpl_toolkits.axisartist.floating_axes`

An experimental support for curvilinear grid.

#### Classes

*ExtremeFinderFixed*(*extremes*)

---

*FixedAxisArtistHelper*(*grid\_helper*, *side*[, *nth\_coord* = along which coordinate value varies.

---

*FloatingAxes* alias of `mpl_toolkits.axisartist.floating_axes.Floating AxesHostAxes`

---

*FloatingAxesBase*(\*args, \*\*kwargs)

---

*FloatingAxisArtistHelper*(*grid\_helper*, ...[, *nth\_coord* = along which coordinate value varies.

---

*GridHelperCurveLinear*(*aux\_trans*, *extremes*[, ...]) *aux\_trans* : a transform from the source (curved) coordinate to target (rectilinear) coordinate.

---

**mpl\_toolkits.axisartist.floating\_axes.ExtremeFinderFixed**

```
class mpl_toolkits.axisartist.floating_axes.ExtremeFinderFixed(extremes)
    Bases: mpl_toolkits.axisartist.grid_finder.ExtremeFinderSimple
```

**mpl\_toolkits.axisartist.floating\_axes.FixedAxisArtistHelper**

```
class mpl_toolkits.axisartist.floating_axes.FixedAxisArtistHelper(grid_helper, side,
                                                                    nth_coord_ticks=None)
    Bases: mpl_toolkits.axisartist.grid_helper_curvelinear.FloatingAxisArtistHelper
    nth_coord = along which coordinate value varies. nth_coord = 0 -> x axis,
    nth_coord = 1 -> y axis
    get_axislabel_pos_angle(self, axes)
    get_line(self, axes)
    get_line_transform(self, axes)
    get_tick_iterators(self, axes)
    tick_loc, tick_angle, tick_label, (optionally) tick_label
    get_tick_transform(self, axes)
    update_lim(self, axes)
```

**mpl\_toolkits.axisartist.floating\_axes.FloatingAxes**

```
mpl_toolkits.axisartist.floating_axes.FloatingAxes
    alias of mpl_toolkits.axisartist.floating_axes.Floating AxesHostAxes
```

**mpl\_toolkits.axisartist.floating\_axes.FloatingAxesBase**

```
class mpl_toolkits.axisartist.floating_axes.FloatingAxesBase(*args, **kwargs)
    Bases: object
    adjust_axes_lim(self)
    cla(self)
```

**mpl\_toolkits.axisartist.floating\_axes.FloatingAxisArtistHelper**

```
class mpl_toolkits.axisartist.floating_axes.FloatingAxisArtistHelper(grid_helper,
                                                                    nth_coord,
                                                                    value,
                                                                    axis_direction=None)
    Bases: mpl_toolkits.axisartist.grid_helper_curvelinear.FloatingAxisArtistHelper
    nth_coord = along which coordinate value varies. nth_coord = 0 -> x axis,
    nth_coord = 1 -> y axis
```

**mpl\_toolkits.axisartist.floating\_axes.GridHelperCurveLinear**

```
class mpl_toolkits.axisartist.floating_axes.GridHelperCurveLinear(aux_trans,
                                                                extremes,
                                                                grid_locator1=None,
                                                                grid_locator2=None,
                                                                tick_formatter1=None,
                                                                tick_formatter2=None)
```

Bases: *mpl\_toolkits.axisartist.grid\_helper\_curvelinear.GridHelperCurveLinear*

*aux\_trans* : a transform from the source (curved) coordinate to target (rectilinear) coordinate. An instance of MPL's Transform (inverse transform should be defined) or a tuple of two callable objects which defines the transform and its inverse. The callables need take two arguments of array of source coordinates and should return two target coordinates: e.g.,  $x2, y2 = trans(x1, y1)$

*get\_boundary(self)*  
return Nx2 array of x,y coordinate of the boundary

*get\_data\_boundary(self, side)*  
return v= 0 , nth=1

*get\_gridlines(self, which='major', axis='both')*  
Return list of grid lines as a list of paths (list of points).  
*which* : "major" or "minor" *axis* : "both", "x" or "y"

*new\_fixed\_axis(self, loc, nth\_coord=None, axis\_direction=None, offset=None, axes=None)*

**Examples using `mpl_toolkits.axisartist.floating_axes.GridHelperCurveLinear`**

- sphx\_glr\_gallery\_axisartist\_demo\_floating\_axes.py

**mpl\_toolkits.axisartist.grid\_finder****Classes**

<i>DictFormatter</i> ( <i>format_dict</i> [, <i>formatter</i> ])	<i>format_dict</i> : dictionary for format strings to be used.
<i>ExtremeFinderSimple</i> ( <i>nx</i> , <i>ny</i> )	
<i>FixedLocator</i> ( <i>locs</i> )	
<i>FormatterPrettyPrint</i> ([ <i>useMathText</i> ])	
<i>GridFinder</i> ( <i>transform</i> [, <i>extreme_finder</i> , ...])	<i>transform</i> : transform from the image coordinate (which will be the <i>transData</i> of the axes to the world coordinate.
<i>GridFinderBase</i> ( <i>extreme_finder</i> , ...[, ...])	the <i>transData</i> of the axes to the world coordinate.
<i>MaxNLocator</i> ([ <i>nbins</i> , <i>steps</i> , <i>trim</i> , <i>integer</i> , ...])	

**mpl\_toolkits.axisartist.grid\_finder.DictFormatter**

```
class mpl_toolkits.axisartist.grid_finder.DictFormatter(format_dict,          format-  
                                                    ter=None)  
    Bases: object  
    format_dict : dictionary for format strings to be used. formatter : fall-back formatter
```

**Examples using mpl\_toolkits.axisartist.grid\_finder.DictFormatter**

- sphx\_glr\_gallery\_axisartist\_demo\_floating\_axes.py

**mpl\_toolkits.axisartist.grid\_finder.ExtremeFinderSimple**

```
class mpl_toolkits.axisartist.grid_finder.ExtremeFinderSimple(nx, ny)  
    Bases: object
```

**mpl\_toolkits.axisartist.grid\_finder.FixedLocator**

```
class mpl_toolkits.axisartist.grid_finder.FixedLocator(locs)  
    Bases: object  
    set_factor(self, f)
```

**Examples using mpl\_toolkits.axisartist.grid\_finder.FixedLocator**

- sphx\_glr\_gallery\_axisartist\_demo\_floating\_axes.py

**mpl\_toolkits.axisartist.grid\_finder.FormatterPrettyPrint**

```
class mpl_toolkits.axisartist.grid_finder.FormatterPrettyPrint(useMathText=True)  
    Bases: object
```

**mpl\_toolkits.axisartist.grid\_finder.GridFinder**

```
class mpl_toolkits.axisartist.grid_finder.GridFinder(transform,          ex-  
                                                    treme_finder=None,  
                                                    grid_locator1=None,  
                                                    grid_locator2=None,  
                                                    tick_formatter1=None,  
                                                    tick_formatter2=None)
```

Bases: *mpl\_toolkits.axisartist.grid\_finder.GridFinderBase*

*transform* : transform from the image coordinate (which will be the *transData* of the axes to the world coordinate.

or *transform* = (*transform\_xy*, *inv\_transform\_xy*)

*locator1*, *locator2* : grid locator for 1st and 2nd axis.

**mpl\_toolkits.axisartist.grid\_finder.GridFinderBase**

```
class mpl_toolkits.axisartist.grid_finder.GridFinderBase(extreme_finder,
                                                         grid_locator1, grid_locator2,
                                                         tick_formatter1=None,
                                                         tick_formatter2=None)
```

Bases: `object`

the `transData` of the axes to the world coordinate. `locator1`, `locator2` : grid locator for 1st and 2nd axis.

Derived must define "transform\_xy, inv\_transform\_xy" (may use `update_transform`)

```
get_grid_info(self, x1, y1, x2, y2)
```

**lon\_values, lat\_values** [list of grid values. if integer is given,] rough number of grids in each direction.

```
update(self, **kw)
```

```
update_transform(self, aux_trans)
```

**mpl\_toolkits.axisartist.grid\_finder.MaxNLocator**

```
class mpl_toolkits.axisartist.grid_finder.MaxNLocator(nbins=10,          steps=None,
                                                       trim=True, integer=False, sym-
                                                       metric=False, prune=None)
```

Bases: `matplotlib.ticker.MaxNLocator`

```
set_factor(self, f)
```

**Examples using `mpl_toolkits.axisartist.grid_finder.MaxNLocator`**

- `sphx_glr_gallery_axisartist_demo_axis_direction.py`
- `sphx_glr_gallery_axisartist_demo_curvilinear_grid2.py`
- `sphx_glr_gallery_axisartist_demo_floating_axes.py`
- `sphx_glr_gallery_axisartist_simple_axis_pad.py`

**mpl\_toolkits.axisartist.grid\_helper\_curvilinear**

An experimental support for curvilinear grid.

**Classes**

```
FixedAxisArtistHelper(grid_helper,   side[,   Helper class for a fixed axis.
...])
```

```
FloatingAxisArtistHelper(grid_helper,   ...[,   nth_coord = along which coordinate value
...])                                       varies.
```

---

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---

<code>GridHelperCurveLinear(aux_trans[, ...])</code>	<code>aux_trans</code> : a transform from the source (curved) coordinate to target (rectilinear) coordinate.
--	--

---

**`mpl_toolkits.axisartist.grid_helper_curvelinear.FixedAxisArtistHelper`**

```
class mpl_toolkits.axisartist.grid_helper_curvelinear.FixedAxisArtistHelper(grid_helper,
                                                                              side,
                                                                              nth_coord_ticks=None)
```

Bases: `mpl_toolkits.axisartist.axislines.Fixed`

Helper class for a fixed axis.

**`nth_coord = along which coordinate value varies.`** `nth_coord = 0` -> x axis,  
`nth_coord = 1` -> y axis

`change_tick_coord(self, coord_number=None)`

`get_tick_iterators(self, axes)`  
`tick_loc, tick_angle, tick_label`

`get_tick_transform(self, axes)`

`update_lim(self, axes)`

**`mpl_toolkits.axisartist.grid_helper_curvelinear.FloatingAxisArtistHelper`**

```
class mpl_toolkits.axisartist.grid_helper_curvelinear.FloatingAxisArtistHelper(grid_helper,
                                                                              nth_coord,
                                                                              value,
                                                                              axis_direction=None)
```

Bases: `mpl_toolkits.axisartist.axislines.Floating`

**`nth_coord = along which coordinate value varies.`** `nth_coord = 0` -> x axis,  
`nth_coord = 1` -> y axis

`get_axislabel_pos_angle(self, axes)`

`get_axislabel_transform(self, axes)`

`get_line(self, axes)`

`get_line_transform(self, axes)`

`get_tick_iterators(self, axes)`  
`tick_loc, tick_angle, tick_label, (optionally) tick_label`

`get_tick_transform(self, axes)`

`set_extremes(self, e1, e2)`

`update_lim(self, axes)`

`mpl_toolkits.axisartist.grid_helper_curvelinear.GridHelperCurveLinear`

```
class mpl_toolkits.axisartist.grid_helper_curvelinear.GridHelperCurveLinear(aux_trans,
                                                                              ex-
                                                                              treme_finder=None,
                                                                              grid_locator1=None,
                                                                              grid_locator2=None,
                                                                              tick_formatter1=None,
                                                                              tick_formatter2=None)
```

Bases: `mpl_toolkits.axisartist.axislines.GridHelperBase`

`aux_trans` : a transform from the source (curved) coordinate to target (rectilinear) coordinate. An instance of MPL's Transform (inverse transform should be defined) or a tuple of two callable objects which defines the transform and its inverse. The callables need take two arguments of array of source coordinates and should return two target coordinates.

e.g., `x2, y2 = trans(x1, y1)`

`get_gridlines(self, which='major', axis='both')`

Return list of grid lines as a list of paths (list of points).

`which` : "major" or "minor" axis : "both", "x" or "y"

`get_tick_iterator(self, nth_coord, axis_side, minor=False)`

`new_fixed_axis(self, loc, nth_coord=None, axis_direction=None, offset=None, axes=None)`

`new_floating_axis(self, nth_coord, value, axes=None, axis_direction='bottom')`

`update_grid_finder(self, aux_trans=None, **kw)`

`mpl_toolkits.axisartist.parasite_axes`

### 18.1.4 Matplotlib axes\_grid Toolkit

---

**Note:** AxesGrid toolkit has been a part of matplotlib since v 0.99. Originally, the toolkit had a single namespace of `axes_grid`. In more recent version, the toolkit has divided into two separate namespace (`axes_grid1` and `axisartist`). While `axes_grid` namespace is maintained for the backward compatibility, use of `axes_grid1` and `axisartist` is recommended. For the documentation on `axes_grid`, see the [previous version of the docs](#).

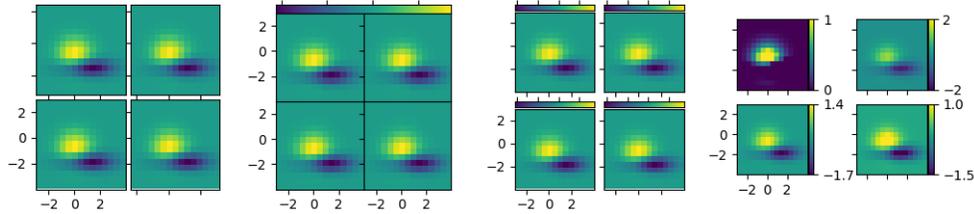
---

#### Matplotlib axes\_grid1 Toolkit

The matplotlib `mpl_toolkits.axes_grid1` toolkit is a collection of helper classes to ease displaying multiple images in matplotlib. While the `aspect` parameter in matplotlib adjust the position of the single axes, `axes_grid1` toolkit provides a framework to adjust the position of multiple axes according to their aspects.

See *What is axes\_grid1 toolkit?* for a guide on the usage of `axes_grid1`.

**The submodules of the axes\_grid1 API are:**

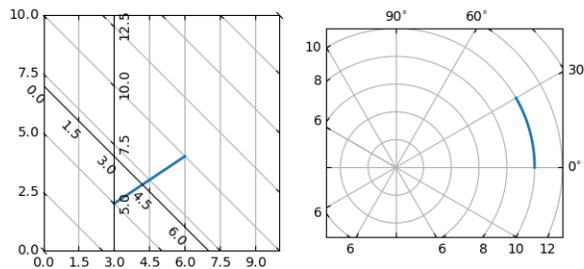


<code>axes_grid1.anchored_artists</code>	
<code>axes_grid1.axes_divider</code>	The <code>axes_divider</code> module provides helper classes to adjust the positions of multiple axes at drawing time.
<code>axes_grid1.axes_grid</code>	
<code>axes_grid1.axes_rgb</code>	
<code>axes_grid1.axes_size</code>	Provides classes of simple units that will be used with <code>AxesDivider</code> class (or others) to determine the size of each axes.
<code>axes_grid1.colorbar</code>	Colorbar toolkit with two classes and a function:
<code>axes_grid1.inset_locator</code>	A collection of functions and objects for creating or placing inset axes.
<code>axes_grid1.mpl_axes</code>	
<code>axes_grid1.parasite_axes</code>	

### Matplotlib axisartist Toolkit

The `axisartist` namespace includes a derived `Axis` implementation (`mpl_toolkits.axisartist.Axis`). The biggest difference is that the artists that are responsible for drawing axis lines, ticks, ticklabels, and axis labels are separated out from the `mpl`'s `Axis` class. This change was strongly motivated to support curvilinear grid.

You can find a tutorial describing usage of `axisartist` at the `axisartist` user guide.



### The submodules of the axisartist API are:

<code>axisartist.angle_helper</code>	
<code>axisartist.axes_divider</code>	
<code>axisartist.axes_grid</code>	
<code>axisartist.axes_rgb</code>	
<code>axisartist.axis_artist</code>	<code>axis_artist.py</code> module provides axis-related artists.
<code>axisartist.axisline_style</code>	
<code>axisartist.axislines</code>	<code>Axislines</code> includes modified implementation of the <code>Axis</code> class

Table 36 – continued from previous page

<code>axisartist.floating_axes</code>	An experimental support for curvilinear grid.
<code>axisartist.grid_finder</code>	
<code>axisartist.grid_helper_curvelinear</code>	An experimental support for curvilinear grid.
<code>axisartist.parasite_axes</code>	

## 18.2 mplot3d API

### Contents

- *mplot3d API*
  - *axes3d*
  - *axis3d*
  - *art3d*
  - *Art3D Utility Functions*
  - *proj3d*

### 18.2.1 axes3d

**Note:** Significant effort went into bringing axes3d to feature-parity with regular axes objects for version 1.1.0. However, more work remains. Please report any functions that do not behave as expected as a bug. In addition, help and patches would be greatly appreciated!

---

`axes3d.Axes3D(fig[, rect, azim, elev, ...])`      3D axes object.

---

#### `mpl_toolkits.mplot3d.axes3d.Axes3D`

```
class mpl_toolkits.mplot3d.axes3d.Axes3D(fig, rect=None, *args, azim=-60,
                                         elev=30, zscale=None, sharez=None,
                                         proj_type='persp', **kwargs)
```

Bases: `matplotlib.axes._axes.Axes`

3D axes object.

#### Parameters

**fig** [Figure] The parent figure.

**rect** [(float, float, float, float)] The (left, bottom, width, height) axes position.

**azim** [float, optional] Azimuthal viewing angle, defaults to -60.

- elev** [float, optional] Elevation viewing angle, defaults to 30.
- zscale** [['function' | 'functionlog' | 'linear' | 'log' | 'logit' | 'symlog'], optional] The z scale. Note that currently, only a linear scale is supported.
- sharez** [Axes3D, optional] Other axes to share z-limits with.
- proj\_type** [{'persp', 'ortho'}] The projection type, default 'persp'.

## Notes

New in version 1.2.1: The *sharez* parameter.

`add_collection3d(self, col, zs=0, zdir='z')`

Add a 3D collection object to the plot.

2D collection types are converted to a 3D version by modifying the object and adding z coordinate information.

### Supported are:

- PolyCollection
- LineCollection
- PatchCollection

`add_contour_set(self, cset, extend3d=False, stride=5, zdir='z', offset=None)`

`add_contourf_set(self, cset, zdir='z', offset=None)`

`auto_scale_xyz(self, X, Y, Z=None, had_data=None)`

`autoscale(self, enable=True, axis='both', tight=None)`

Convenience method for simple axis view autoscaling. See `matplotlib.axes.Axes.autoscale()` for full explanation. Note that this function behaves the same, but for all three axes. Therefore, 'z' can be passed for *axis*, and 'both' applies to all three axes.

New in version 1.1.0: This function was added, but not tested. Please report any bugs.

`autoscale_view(self, tight=None, scalex=True, scaley=True, scalez=True)`

Autoscale the view limits using the data limits. See `matplotlib.axes.Axes.autoscale_view()` for documentation. Note that this function applies to the 3D axes, and as such adds the *scalez* to the function arguments.

Changed in version 1.1.0: Function signature was changed to better match the 2D version. *tight* is now explicitly a kwarg and placed first.

Changed in version 1.2.1: This is now fully functional.

`bar(self, left, height, zs=0, zdir='z', *args, **kwargs)`

Add 2D bar(s).

### Parameters

**left** [1D array-like] The x coordinates of the left sides of the bars.

**height** [1D array-like] The height of the bars.

**zs** [scalar or 1D array-like] Z coordinate of bars; if a single value is specified, it will be used for all bars.

**zdir** [`{'x', 'y', 'z'}`] When plotting 2D data, the direction to use as z (`'x'`, `'y'` or `'z'`); defaults to `'z'`.

**\*\*kwargs** Other arguments are forwarded to `matplotlib.axes.Axes.bar`.

### Returns

**mpl\_toolkits.mplot3d.art3d.Patch3DCollection**

`bar3d(self, x, y, z, dx, dy, dz, color=None, zsort='average', shade=True, *args, **kwargs)`

Generate a 3D barplot.

This method creates three dimensional barplot where the width, depth, height, and color of the bars can all be uniquely set.

### Parameters

**x, y, z** [array-like] The coordinates of the anchor point of the bars.

**dx, dy, dz** [scalar or array-like] The width, depth, and height of the bars, respectively.

**color** [sequence of valid color specifications, optional] The color of the bars can be specified globally or individually. This parameter can be:

- A single color value, to color all bars the same color.
- An array of colors of length N bars, to color each bar independently.
- An array of colors of length 6, to color the faces of the bars similarly.
- An array of colors of length 6 \* N bars, to color each face independently.

When coloring the faces of the boxes specifically, this is the order of the coloring:

1. -Z (bottom of box)
2. +Z (top of box)
3. -Y
4. +Y
5. -X
6. +X

**zsort** [str, optional] The z-axis sorting scheme passed onto `Poly3DCollection`

**shade** [bool, optional (default = True)] When true, this shades the dark sides of the bars (relative to the plot's source of light).

**\*\*kwargs** Any additional keyword arguments are passed onto `Poly3DCollection`.

### Returns

**collection** [*Poly3DCollection*] A collection of three dimensional polygons representing the bars.

`can_pan(self)`

Return *True* if this axes supports the pan/zoom button functionality.

3D axes objects do not use the pan/zoom button.

`can_zoom(self)`

Return *True* if this axes supports the zoom box button functionality.

3D axes objects do not use the zoom box button.

`cla(self)`

Clear axes

`clabel(self, *args, **kwargs)`

This function is currently not implemented for 3D axes. Returns *None*.

`contour(self, X, Y, Z, *args, extend3d=False, stride=5, zdir='z', offset=None, **kwargs)`

Create a 3D contour plot.

#### Parameters

**X, Y, Z** [array-likes] Input data.

**extend3d** [bool] Whether to extend contour in 3D; defaults to *False*.

**stride** [int] Step size for extending contour.

**zdir** [{'x', 'y', 'z'}] The direction to use; defaults to 'z'.

**offset** [scalar] If specified, plot a projection of the contour lines at this position in a plane normal to *zdir*

**\*args, \*\*kwargs** Other arguments are forwarded to *matplotlib.axes.Axes.contour*.

#### Returns

**matplotlib.contour.QuadContourSet**

`contour3D(self, X, Y, Z, *args, extend3d=False, stride=5, zdir='z', offset=None, **kwargs)`

Create a 3D contour plot.

#### Parameters

**X, Y, Z** [array-likes] Input data.

**extend3d** [bool] Whether to extend contour in 3D; defaults to *False*.

**stride** [int] Step size for extending contour.

**zdir** [{'x', 'y', 'z'}] The direction to use; defaults to 'z'.

**offset** [scalar] If specified, plot a projection of the contour lines at this position in a plane normal to *zdir*

**\*args, \*\*kwargs** Other arguments are forwarded to *matplotlib.axes.Axes.contour*.

#### Returns

**matplotlib.contour.QuadContourSet**

`contourf(self, X, Y, Z, *args, zdir='z', offset=None, **kwargs)`  
 Create a 3D filled contour plot.

### Parameters

**X, Y, Z** [array-likes] Input data.

**zdir** [{'x', 'y', 'z'}] The direction to use; defaults to 'z'.

**offset** [scalar] If specified, plot a projection of the contour lines at this position in a plane normal to zdir

**\*args, \*\*kwargs** Other arguments are forwarded to `matplotlib.axes.Axes.contourf`.

### Returns

**matplotlib.contour.QuadContourSet**

### Notes

New in version 1.1.0: The `zdir` and `offset` parameters.

`contourf3D(self, X, Y, Z, *args, zdir='z', offset=None, **kwargs)`  
 Create a 3D filled contour plot.

### Parameters

**X, Y, Z** [array-likes] Input data.

**zdir** [{'x', 'y', 'z'}] The direction to use; defaults to 'z'.

**offset** [scalar] If specified, plot a projection of the contour lines at this position in a plane normal to zdir

**\*args, \*\*kwargs** Other arguments are forwarded to `matplotlib.axes.Axes.contourf`.

### Returns

**matplotlib.contour.QuadContourSet**

### Notes

New in version 1.1.0: The `zdir` and `offset` parameters.

`convert_zunits(self, z)`  
 For artists in an axes, if the zaxis has units support, convert z using zaxis unit type

New in version 1.2.1.

`disable_mouse_rotation(self)`  
 Disable mouse button callbacks.

`draw(self, renderer)`  
 Draw everything (plot lines, axes, labels)

`format_coord(self, xd, yd)`  
 Given the 2D view coordinates attempt to guess a 3D coordinate. Looks for the nearest edge to the point and then assumes that the point is at the same z location as the nearest point on the edge.

`format_zdata(self, z)`

Return *z* string formatted. This function will use the `fmt_zdata` attribute if it is callable, else will fall back on the `zaxis` major formatter

`get_autoscale_on(self)`

Get whether autoscaling is applied for all axes on plot commands

New in version 1.1.0: This function was added, but not tested. Please report any bugs.

`get_autoscalez_on(self)`

Get whether autoscaling for the z-axis is applied on plot commands

New in version 1.1.0: This function was added, but not tested. Please report any bugs.

`get_axis_position(self)`

`get_frame_on(self)`

Get whether the 3D axes panels are drawn.

New in version 1.1.0.

`get_proj(self)`

Create the projection matrix from the current viewing position.

`elev` stores the elevation angle in the z plane `azim` stores the azimuth angle in the x,y plane

`dist` is the distance of the eye viewing point from the object point.

`get_w_lims(self)`

Get 3D world limits.

`get_xlim(self)`

Return the x-axis view limits.

#### Returns

**left, right** [(float, float)] The current x-axis limits in data coordinates.

#### See also:

`set_xlim`

`set_xbound`, `get_xbound`

`invert_xaxis`, `xaxis_inverted`

#### Notes

The x-axis may be inverted, in which case the *left* value will be greater than the *right* value.

Changed in version 1.1.0: This function now correctly refers to the 3D x-limits

`get_xlim3d(self)`

Return the x-axis view limits.

#### Returns

**left, right** [(float, float)] The current x-axis limits in data coordinates.

#### See also:

`set_xlim`  
`set_xbound, get_xbound`  
`invert_xaxis, xaxis_inverted`

### Notes

The x-axis may be inverted, in which case the *left* value will be greater than the *right* value.

Changed in version 1.1.0: This function now correctly refers to the 3D x-limits

`get_ylim(self)`  
 Return the y-axis view limits.

### Returns

**bottom, top** [(float, float)] The current y-axis limits in data coordinates.

### See also:

`set_ylim`  
`set_ybound, get_ybound`  
`invert_yaxis, yaxis_inverted`

### Notes

The y-axis may be inverted, in which case the *bottom* value will be greater than the *top* value.

Changed in version 1.1.0: This function now correctly refers to the 3D y-limits.

`get_ylim3d(self)`  
 Return the y-axis view limits.

### Returns

**bottom, top** [(float, float)] The current y-axis limits in data coordinates.

### See also:

`set_ylim`  
`set_ybound, get_ybound`  
`invert_yaxis, yaxis_inverted`

### Notes

The y-axis may be inverted, in which case the *bottom* value will be greater than the *top* value.

Changed in version 1.1.0: This function now correctly refers to the 3D y-limits.

`get_zaxis(self)`  
Return the ZAxis (*Axis*) instance.

`get_zbound(self)`  
Returns the z-axis numerical bounds where:

<code>lowerBound &lt; upperBound</code>
---

New in version 1.1.0: This function was added, but not tested. Please report any bugs.

`get_zlabel(self)`  
Get the z-label text string.

New in version 1.1.0: This function was added, but not tested. Please report any bugs.

`get_zlim(self)`  
Get 3D z limits.

`get_zlim3d(self)`  
Get 3D z limits.

`get_zmajorticklabels(self)`  
Get the ztick labels as a list of Text instances  
New in version 1.1.0.

`get_zminorticklabels(self)`  
Get the ztick labels as a list of Text instances

---

**Note:** Minor ticks are not supported. This function was added only for completeness.

---

New in version 1.1.0.

`get_zscale(self)`  
`get_zticklabels(self, minor=False)`  
Get ztick labels as a list of Text instances. See `matplotlib.axes.Axes.get_yticklabels()` for more details.

---

**Note:** Minor ticks are not supported.

---

New in version 1.1.0.

`get_zticklines(self)`  
Get ztick lines as a list of Line2D instances. Note that this function is provided merely for completeness. These lines are re-calculated as the display changes.

New in version 1.1.0.

`get_zticks(self, minor=False)`  
Return the z ticks as a list of locations See `matplotlib.axes.Axes.get_yticks()` for more details.

---

**Note:** Minor ticks are not supported.

---

New in version 1.1.0.

`grid(self, b=True, **kwargs)`  
Set / unset 3D grid.

---

**Note:** Currently, this function does not behave the same as `matplotlib.axes.Axes.grid()`, but it is intended to eventually support that behavior.

---

Changed in version 1.1.0: This function was changed, but not tested. Please report any bugs.

`have_units(self)`  
Return `True` if units are set on the x, y, or z axes

`invert_zaxis(self)`  
Invert the z-axis.

New in version 1.1.0: This function was added, but not tested. Please report any bugs.

`locator_params(self, axis='both', tight=None, **kwargs)`  
Convenience method for controlling tick locators.

See `matplotlib.axes.Axes.locator_params()` for full documentation. Note that this is for Axes3D objects, therefore, setting `axis` to 'both' will result in the parameters being set for all three axes. Also, `axis` can also take a value of 'z' to apply parameters to the z axis.

New in version 1.1.0: This function was added, but not tested. Please report any bugs.

`margins(self, *margins, x=None, y=None, z=None, tight=True)`  
Convenience method to set or retrieve autoscaling margins.

**signatures::** `margins()`

returns `xmargin`, `ymargin`, `zmargin`

```
margins(margin)

margins(xmargin, ymargin, zmargin)

margins(x=xmargin, y=ymargin, z=zmargin)

margins(..., tight=False)
```

All forms above set the `xmargin`, `ymargin` and `zmargin` parameters. All keyword parameters are optional. A single positional argument specifies `xmargin`, `ymargin` and `zmargin`. Passing both positional and keyword arguments for `xmargin`, `ymargin`, and/or `zmargin` is invalid.

The `tight` parameter is passed to `autoscale_view()`, which is executed after a margin is changed; the default here is `True`, on the assumption that when margins are specified, no additional padding to match tick marks is usually desired. Setting `tight` to `None` will preserve the previous setting.

Specifying any margin changes only the autoscaling; for example, if `xmargin` is not `None`, then `xmargin` times the X data interval will be added to each end of that interval before it is used in autoscaling.

New in version 1.1.0: This function was added, but not tested. Please report any bugs.

```
mouse_init(self, rotate_btn=1, zoom_btn=3)
```

Initializes mouse button callbacks to enable 3D rotation of the axes. Also optionally sets the mouse buttons for 3D rotation and zooming.

#### Parameters

**rotate\_btn** [int or list of int] The mouse button or buttons to use for 3D rotation of the axes; defaults to 1.

**zoom\_btn** [int or list of int] The mouse button or buttons to use to zoom the 3D axes; defaults to 3.

```
name = '3d'
```

```
plot(self, xs, ys, *args, zdir='z', **kwargs)
```

Plot 2D or 3D data.

#### Parameters

**xs** [1D array-like] x coordinates of vertices.

**ys** [1D array-like] y coordinates of vertices.

**zs** [scalar or 1D array-like] z coordinates of vertices; either one for all points or one for each point.

**zdir** [{'x', 'y', 'z'}] When plotting 2D data, the direction to use as z ('x', 'y' or 'z'); defaults to 'z'.

**\*\*kwargs** Other arguments are forwarded to `matplotlib.axes.Axes.plot`.

```
plot3D(self, xs, ys, *args, zdir='z', **kwargs)
```

Plot 2D or 3D data.

#### Parameters

**xs** [1D array-like] x coordinates of vertices.

**ys** [1D array-like] y coordinates of vertices.

**zs** [scalar or 1D array-like] z coordinates of vertices; either one for all points or one for each point.

**zdir** [{'x', 'y', 'z'}] When plotting 2D data, the direction to use as z ('x', 'y' or 'z'); defaults to 'z'.

**\*\*kwargs** Other arguments are forwarded to `matplotlib.axes.Axes.plot`.

```
plot_surface(self, X, Y, Z, *args, norm=None, vmin=None, vmax=None, light-  
source=None, **kwargs)
```

Create a surface plot.

By default it will be colored in shades of a solid color, but it also supports color mapping by supplying the `cmap` argument.

---

**Note:** The `rcount` and `ccount` kwargs, which both default to 50, determine the maximum number of samples used in each direction. If the input data is larger, it will be downsampled (by slicing) to these numbers of points.

---

**Parameters**

**X, Y, Z** [2d arrays] Data values.

**rcount, ccount** [int] Maximum number of samples used in each direction. If the input data is larger, it will be downsampled (by slicing) to these numbers of points. Defaults to 50.

New in version 2.0.

**rstride, cstride** [int] Downsampling stride in each direction. These arguments are mutually exclusive with *rcount* and *ccount*. If only one of *rstride* or *cstride* is set, the other defaults to 10.

'classic' mode uses a default of *rstride* = *cstride* = 10 instead of the new default of *rcount* = *ccount* = 50.

**color** [color-like] Color of the surface patches.

**cmap** [Colormap] Colormap of the surface patches.

**facecolors** [array-like of colors.] Colors of each individual patch.

**norm** [Normalize] Normalization for the colormap.

**vmin, vmax** [float] Bounds for the normalization.

**shade** [bool] Whether to shade the facecolors. Defaults to True. Shading is always disabled when *cmap* is specified.

**lightsource** [*LightSource*] The lightsource to use when *shade* is True.

**\*\*kwargs** Other arguments are forwarded to *Poly3DCollection*.

```
plot_trisurf(self, *args, color=None, norm=None, vmin=None, vmax=None, light-
             source=None, **kwargs)
```

Plot a triangulated surface.

The (optional) triangulation can be specified in one of two ways; either:

```
plot_trisurf(triangulation, ...)
```

where *triangulation* is a *Triangulation* object, or:

```
plot_trisurf(X, Y, ...)
plot_trisurf(X, Y, triangles, ...)
plot_trisurf(X, Y, triangles=triangles, ...)
```

in which case a *Triangulation* object will be created. See *Triangulation* for a explanation of these possibilities.

The remaining arguments are:

```
plot_trisurf(..., Z)
```

where *Z* is the array of values to contour, one per point in the triangulation.

**Parameters**

**X, Y, Z** [array-like] Data values as 1D arrays.

**color** Color of the surface patches.

**cmap** A colormap for the surface patches.

**norm** [Normalize] An instance of Normalize to map values to colors.

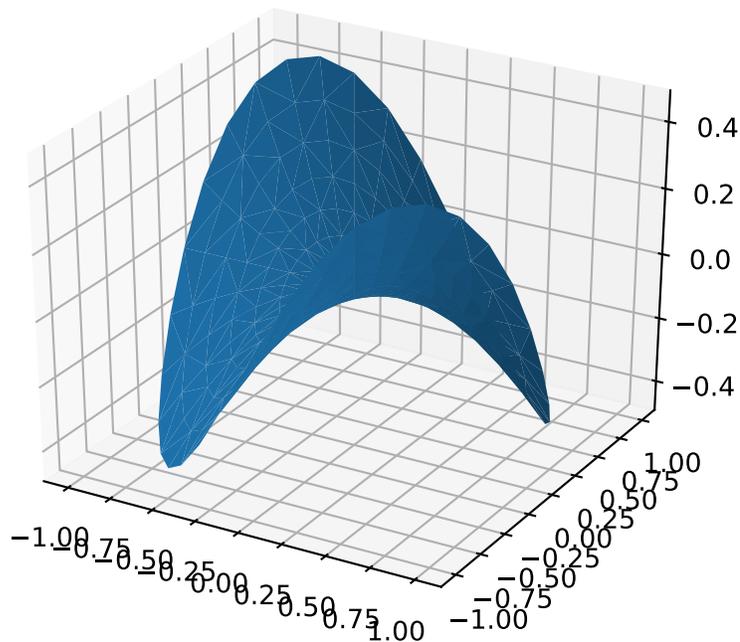
**vmin, vmax** [scalar, optional, default: None] Minimum and maximum value to map.

**shade** [bool] Whether to shade the facecolors. Defaults to True. Shading is always disabled when *cmap* is specified.

**lightsource** [*LightSource*] The lightsource to use when *shade* is True.

**\*\*kwargs** All other arguments are passed on to *Poly3DCollection*

## Examples



New in version 1.2.0: This plotting function was added for the v1.2.0 release.

```
plot_wireframe(self, X, Y, Z, *args, **kwargs)
```

Plot a 3D wireframe.

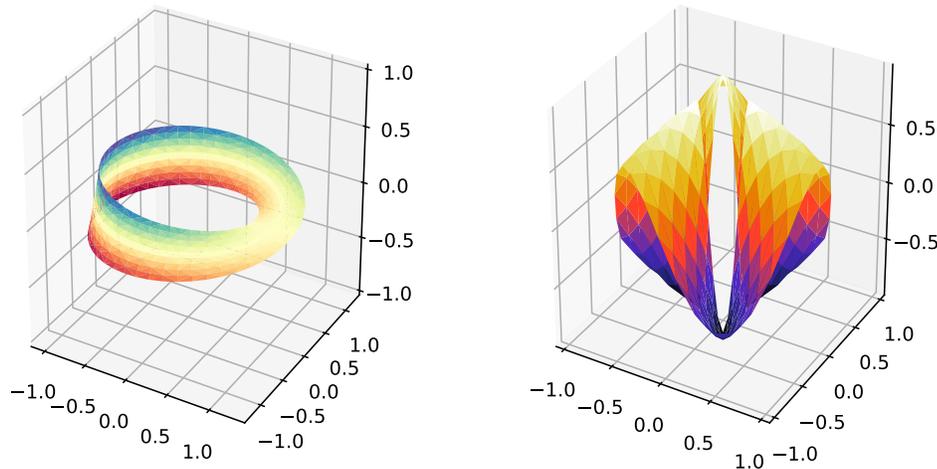
---

**Note:** The *rcount* and *ccount* kwargs, which both default to 50, determine the maximum number of samples used in each direction. If the input data is larger, it will be downsampled (by slicing) to these numbers of points.

---

## Parameters

**X, Y, Z** [2d arrays] Data values.



**rcount, ccount** [int] Maximum number of samples used in each direction. If the input data is larger, it will be downsampled (by slicing) to these numbers of points. Setting a count to zero causes the data to be not sampled in the corresponding direction, producing a 3D line plot rather than a wireframe plot. Defaults to 50.

New in version 2.0.

**rstride, cstride** [int] Downsampling stride in each direction. These arguments are mutually exclusive with *rcount* and *ccount*. If only one of *rstride* or *cstride* is set, the other defaults to 1. Setting a stride to zero causes the data to be not sampled in the corresponding direction, producing a 3D line plot rather than a wireframe plot.

'classic' mode uses a default of *rstride* = *cstride* = 1 instead of the new default of *rcount* = *ccount* = 50.

**\*\*kwargs** Other arguments are forwarded to *Line3DCollection*.

`quiver(X, Y, Z, U, V, W, /, length=1, arrow_length_ratio=.3, pivot='tail', normalize=False, **kwargs)`  
Plot a 3D field of arrows.

The arguments could be array-like or scalars, so long as they can be broadcast together. The arguments can also be masked arrays. If an element in any of argument is masked, then that corresponding quiver element will not be plotted.

### Parameters

**X, Y, Z** [array-like] The x, y and z coordinates of the arrow locations (default is tail of arrow; see *pivot* kwarg)

**U, V, W** [array-like] The x, y and z components of the arrow vectors

**length** [float] The length of each quiver, default to 1.0, the unit is the same with the axes

**arrow\_length\_ratio** [float] The ratio of the arrow head with respect to the quiver, default to 0.3

**pivot** [{'tail', 'middle', 'tip'}] The part of the arrow that is at the grid point; the arrow rotates about this point, hence the name *pivot*. Default is 'tail'

**normalize** [bool] When True, all of the arrows will be the same length. This defaults to False, where the arrows will be different lengths depending on the values of u,v,w.

**\*\*kwargs** Any additional keyword arguments are delegated to *LineCollection*

```
quiver3D(X, Y, Z, U, V, W, /, length=1, arrow_length_ratio=.3, pivot='tail', normalize=False, **kwargs)
```

Plot a 3D field of arrows.

The arguments could be array-like or scalars, so long as they they can be broadcast together. The arguments can also be masked arrays. If an element in any of argument is masked, then that corresponding quiver element will not be plotted.

### Parameters

**X, Y, Z** [array-like] The x, y and z coordinates of the arrow locations (default is tail of arrow; see *pivot* kwarg)

**U, V, W** [array-like] The x, y and z components of the arrow vectors

**length** [float] The length of each quiver, default to 1.0, the unit is the same with the axes

**arrow\_length\_ratio** [float] The ratio of the arrow head with respect to the quiver, default to 0.3

**pivot** [{'tail', 'middle', 'tip'}] The part of the arrow that is at the grid point; the arrow rotates about this point, hence the name *pivot*. Default is 'tail'

**normalize** [bool] When True, all of the arrows will be the same length. This defaults to False, where the arrows will be different lengths depending on the values of u,v,w.

**\*\*kwargs** Any additional keyword arguments are delegated to *LineCollection*

```
scatter(self, xs, ys, zs=0, zdir='z', s=20, c=None, depthshade=True, *args, **kwargs)
```

Create a scatter plot.

### Parameters

**xs, ys** [array-like] The data positions.

**zs** [float or array-like, optional, default: 0] The z-positions. Either an array of the same length as xs and ys or a single value to place all points in the same plane.

**zdir** [{'x', 'y', 'z', '-x', '-y', '-z'}, optional, default: 'z'] The axis direction for the zs. This is useful when plotting 2D data on a 3D Axes. The data must be passed as xs, ys. Setting *zdir* to 'y' then plots the data to the x-z-plane.

See also [/gallery/mplot3d/2dcollections3d](#).

**s** [scalar or array-like, optional, default: 20] The marker size in points\*\*2. Either an array of the same length as *xs* and *ys* or a single value to make all markers the same size.

**c** [color, sequence, or sequence of color, optional] The marker color. Possible values:

- A single color format string.
- A sequence of color specifications of length *n*.
- A sequence of *n* numbers to be mapped to colors using *cmap* and *norm*.
- A 2-D array in which the rows are RGB or RGBA.

For more details see the *c* argument of *scatter*.

**depthshade** [bool, optional, default: True] Whether to shade the scatter markers to give the appearance of depth.

**\*\*kwargs** All other arguments are passed on to *scatter*.

### Returns

**paths** [*PathCollection*]

```
scatter3D(self, xs, ys, zs=0, zdir='z', s=20, c=None, depthshade=True, *args,
          **kwargs)
```

Create a scatter plot.

### Parameters

**xs, ys** [array-like] The data positions.

**zs** [float or array-like, optional, default: 0] The z-positions. Either an array of the same length as *xs* and *ys* or a single value to place all points in the same plane.

**zdir** [{'x', 'y', 'z', '-x', '-y', '-z'}], optional, default: 'z'] The axis direction for the *zs*. This is useful when plotting 2D data on a 3D Axes. The data must be passed as *xs*, *ys*. Setting *zdir* to 'y' then plots the data to the x-z-plane.

See also [/gallery/mplot3d/2dcollections3d](#).

**s** [scalar or array-like, optional, default: 20] The marker size in points\*\*2. Either an array of the same length as *xs* and *ys* or a single value to make all markers the same size.

**c** [color, sequence, or sequence of color, optional] The marker color. Possible values:

- A single color format string.
- A sequence of color specifications of length *n*.
- A sequence of *n* numbers to be mapped to colors using *cmap* and *norm*.
- A 2-D array in which the rows are RGB or RGBA.

For more details see the *c* argument of *scatter*.

**depthshade** [bool, optional, default: True] Whether to shade the scatter markers to give the appearance of depth.

**\*\*kwargs** All other arguments are passed on to *scatter*.

### Returns

**paths** [*PathCollection*]

`set_autoscale_on(self, b)`

Set whether autoscaling is applied on plot commands

New in version 1.1.0: This function was added, but not tested. Please report any bugs.

### Parameters

**b** [bool]

`set_autoscalez_on(self, b)`

Set whether autoscaling for the z-axis is applied on plot commands

New in version 1.1.0: This function was added, but not tested. Please report any bugs.

### Parameters

**b** [bool]

`set_axis_off(self)`

Turn the x- and y-axis off.

This affects the axis lines, ticks, ticklabels, grid and axis labels.

`set_axis_on(self)`

Turn the x- and y-axis on.

This affects the axis lines, ticks, ticklabels, grid and axis labels.

`set_frame_on(self, b)`

Set whether the 3D axes panels are drawn.

New in version 1.1.0.

### Parameters

**b** [bool]

`set_proj_type(self, proj_type)`

Set the projection type.

### Parameters

**proj\_type** [str] Type of projection, accepts 'persp' and 'ortho'.

`set_title(self, label, fontdict=None, loc='center', **kwargs)`

Set a title for the axes.

Set one of the three available axes titles. The available titles are positioned above the axes in the center, flush with the left edge, and flush with the right edge.

### Parameters

**label** [str] Text to use for the title

**fontdict** [dict] A dictionary controlling the appearance of the title text, the default fontdict is:

```
{'fontsize': rcParams['axes.titlesize'],
 'fontweight' : rcParams['axes.titleweight'],
 'verticalalignment': 'baseline',
 'horizontalalignment': loc}
```

**loc** [{'center', 'left', 'right'}, str, optional] Which title to set, defaults to 'center'

**pad** [float] The offset of the title from the top of the axes, in points. Default is None to use rcParams['axes.titlepad'].

### Returns

**text** [*Text*] The matplotlib text instance representing the title

### Other Parameters

**\*\*kwargs** [*Text* properties] Other keyword arguments are text properties, see *Text* for a list of valid text properties.

`set_top_view(self)`

`set_xlim(self, left=None, right=None, emit=True, auto=False, *, xmin=None, xmax=None)`  
Set 3D x limits.

See `matplotlib.axes.Axes.set_xlim()` for full documentation.

`set_xlim3d(self, left=None, right=None, emit=True, auto=False, *, xmin=None, xmax=None)`  
Set 3D x limits.

See `matplotlib.axes.Axes.set_xlim()` for full documentation.

`set_xscale(self, value, **kwargs)`  
Set the x-axis scale.

### Parameters

**value** [{"linear", "log", "symlog", "logit", ...}] The axis scale type to apply.

**\*\*kwargs** Different keyword arguments are accepted, depending on the scale. See the respective class keyword arguments:

- `matplotlib.scale.LinearScale`
- `matplotlib.scale.LogScale`
- `matplotlib.scale.SymmetricalLogScale`
- `matplotlib.scale.LogitScale`

### Notes

By default, Matplotlib supports the above mentioned scales. Additionally, custom scales may be registered using `matplotlib.scale.register_scale`. These scales can then also be used here.

New in version 1.1.0: This function was added, but not tested. Please report any bugs.

`set_ylim(self, bottom=None, top=None, emit=True, auto=False, *, ymin=None, ymax=None)`  
Set 3D y limits.

See `matplotlib.axes.Axes.set_ylim()` for full documentation.

`set_ylim3d(self, bottom=None, top=None, emit=True, auto=False, *, ymin=None, ymax=None)`  
Set 3D y limits.

See `matplotlib.axes.Axes.set_ylim()` for full documentation.

`set_yscale(self, value, **kwargs)`  
Set the y-axis scale.

### Parameters

**value** [{"linear", "log", "symlog", "logit", ...}] The axis scale type to apply.

**\*\*kwargs** Different keyword arguments are accepted, depending on the scale. See the respective class keyword arguments:

- `matplotlib.scale.LinearScale`
- `matplotlib.scale.LogScale`
- `matplotlib.scale.SymmetricalLogScale`
- `matplotlib.scale.LogitScale`

### Notes

By default, Matplotlib supports the above mentioned scales. Additionally, custom scales may be registered using `matplotlib.scale.register_scale`. These scales can then also be used here.

New in version 1.1.0: This function was added, but not tested. Please report any bugs.

`set_zbound(self, lower=None, upper=None)`  
Set the lower and upper numerical bounds of the z-axis. This method will honor axes inversion regardless of parameter order. It will not change the `_autoscaleZon` attribute.

New in version 1.1.0: This function was added, but not tested. Please report any bugs.

`set_zlabel(self, zlabel, fontdict=None, labelpad=None, **kwargs)`  
Set zlabel. See doc for `set_ylabel()` for description.

`set_zlim(self, bottom=None, top=None, emit=True, auto=False, *, zmin=None, zmax=None)`  
Set 3D z limits.

See `matplotlib.axes.Axes.set_ylim()` for full documentation

`set_zlim3d(self, bottom=None, top=None, emit=True, auto=False, *, zmin=None, zmax=None)`  
Set 3D z limits.

See `matplotlib.axes.Axes.set_ylim()` for full documentation

`set_zmargin(self, m)`

Set padding of Z data limits prior to autoscaling.

*m* times the data interval will be added to each end of that interval before it is used in autoscaling.

accepts: float in range 0 to 1

New in version 1.1.0: This function was added, but not tested. Please report any bugs.

`set_zscale(self, value, **kwargs)`

Set the z-axis scale.

### Parameters

**value** [{"linear", "log", "symlog", "logit", ...}] The axis scale type to apply.

**\*\*kwargs** Different keyword arguments are accepted, depending on the scale. See the respective class keyword arguments:

- `matplotlib.scale.LinearScale`
- `matplotlib.scale.LogScale`
- `matplotlib.scale.SymmetricalLogScale`
- `matplotlib.scale.LogitScale`

### Notes

Currently, Axes3D objects only supports linear scales. Other scales may or may not work, and support for these is improving with each release.

By default, Matplotlib supports the above mentioned scales. Additionally, custom scales may be registered using `matplotlib.scale.register_scale`. These scales may then also be used here as support is added.

`set_zticklabels(self, *args, **kwargs)`

Set z-axis tick labels. See `matplotlib.axes.Axes.set_yticklabels()` for more details.

---

**Note:** Minor ticks are not supported by Axes3D objects.

---

New in version 1.1.0.

`set_zticks(self, *args, **kwargs)`

Set z-axis tick locations. See `matplotlib.axes.Axes.set_yticks()` for more details.

---

**Note:** Minor ticks are not supported.

---

New in version 1.1.0.

`text(self, x, y, z, s, zdir=None, **kwargs)`

Add text to the plot. `kwargs` will be passed on to `Axes.text`, except for the `zdir` keyword, which sets the direction to be used as the z direction.

`text2D(self, x, y, s, fontdict=None, withdash=<deprecated parameter>, **kwargs)`  
Add text to the axes.

Add the text *s* to the axes at location *x*, *y* in data coordinates.

### Parameters

**x, y** [scalars] The position to place the text. By default, this is in data coordinates. The coordinate system can be changed using the *transform* parameter.

**s** [str] The text.

**fontdict** [dictionary, optional, default: None] A dictionary to override the default text properties. If fontdict is None, the defaults are determined by your rc parameters.

**withdash** [boolean, optional, default: False] Creates a *TextWithDash* instance instead of a *Text* instance.

### Returns

**text** [*Text*] The created *Text* instance.

### Other Parameters

**\*\*kwargs** [*Text* properties.] Other miscellaneous text parameters.

### Examples

Individual keyword arguments can be used to override any given parameter:

```
>>> text(x, y, s, fontsize=12)
```

The default transform specifies that text is in data coords, alternatively, you can specify text in axis coords (0,0 is lower-left and 1,1 is upper-right). The example below places text in the center of the axes:

```
>>> text(0.5, 0.5, 'matplotlib', horizontalalignment='center',
...      verticalalignment='center', transform=ax.transAxes)
```

You can put a rectangular box around the text instance (e.g., to set a background color) by using the keyword `bbox`. `bbox` is a dictionary of *Rectangle* properties. For example:

```
>>> text(x, y, s, bbox=dict(facecolor='red', alpha=0.5))
```

`text3D(self, x, y, z, s, zdir=None, **kwargs)`

Add text to the plot. `kwargs` will be passed on to `Axes.text`, except for the `zdir` keyword, which sets the direction to be used as the z direction.

`tick_params(self, axis='both', **kwargs)`

Convenience method for changing the appearance of ticks and tick labels.

See `matplotlib.axes.Axes.tick_params()` for more complete documentation.

The only difference is that setting `axis` to 'both' will mean that the settings are applied to all three axes. Also, the `axis` parameter also accepts a value of 'z', which would mean to apply to only the z-axis.

Also, because of how Axes3D objects are drawn very differently from regular 2D axes, some of these settings may have ambiguous meaning. For simplicity, the 'z' axis will accept settings as if it was like the 'y' axis.

---

**Note:** While this function is currently implemented, the core part of the Axes3D object may ignore some of these settings. Future releases will fix this. Priority will be given to those who file bugs.

---

New in version 1.1.0: This function was added, but not tested. Please report any bugs.

`ticklabel_format(self, *, style="", scilimits=None, useOffset=None, axis='both')`  
 Convenience method for manipulating the ScalarFormatter used by default for linear axes in Axes3D objects.

See `matplotlib.axes.Axes.ticklabel_format()` for full documentation. Note that this version applies to all three axes of the Axes3D object. Therefore, the `axis` argument will also accept a value of 'z' and the value of 'both' will apply to all three axes.

New in version 1.1.0: This function was added, but not tested. Please report any bugs.

`tricontour(self, *args, extend3d=False, stride=5, zdir='z', offset=None, **kwargs)`  
 Create a 3D contour plot.

Changed in version 1.3.0: Added support for custom triangulations

---

**Note:** This method currently produces incorrect output due to a longstanding bug in 3D PolyCollection rendering.

---

### Parameters

**X, Y, Z** [array-likes] Input data.

**extend3d** [bool] Whether to extend contour in 3D; defaults to False.

**stride** [int] Step size for extending contour.

**zdir** [{'x', 'y', 'z'}] The direction to use; defaults to 'z'.

**offset** [scalar] If specified, plot a projection of the contour lines at this position in a plane normal to zdir

**\*args, \*\*kwargs** Other arguments are forwarded to `matplotlib.axes.Axes.tricontour`.

### Returns

**matplotlib.tri.tricontour.TriContourSet**

`tricontourf(self, *args, zdir='z', offset=None, **kwargs)`  
 Create a 3D filled contour plot.

---

**Note:** This method currently produces incorrect output due to a longstanding bug in 3D PolyCollection rendering.

---

**Parameters**

**X, Y, Z** [array-likes] Input data.

**zdir** [{'x', 'y', 'z'}] The direction to use; defaults to 'z'.

**offset** [scalar] If specified, plot a projection of the contour lines at this position in a plane normal to **zdir**

**\*args, \*\*kwargs** Other arguments are forwarded to `matplotlib.axes.Axes.tricontourf`.

**Returns**

**matplotlib.tri.tricontour.TriContourSet**

**Notes**

New in version 1.1.0: The *zdir* and *offset* parameters.

Changed in version 1.3.0: Added support for custom triangulations

`tunit_cube(self, vals=None, M=None)`

`tunit_edges(self, vals=None, M=None)`

`unit_cube(self, vals=None)`

`update_dataLim(self, xys, **kwargs)`

Extend the `dataLim` BBox to include the given points.

If no data is set currently, the BBox will ignore its limits and set the bound to be the bounds of the xydata (*xys*). Otherwise, it will compute the bounds of the union of its current data and the data in *xys*.

**Parameters**

**xys** [2D array-like] The points to include in the data limits BBox. This can be either a list of (x, y) tuples or a Nx2 array.

**updatex, updatey** [bool, optional, default *True*] Whether to update the x/y limits.

`view_init(self, elev=None, azim=None)`

Set the elevation and azimuth of the axes in degrees (not radians).

This can be used to rotate the axes programmatically.

'*elev*' stores the elevation angle in the z plane (in degrees). '*azim*' stores the azimuth angle in the x,y plane (in degrees).

if *elev* or *azim* are None (default), then the initial value is used which was specified in the `Axes3D` constructor.

`voxels([x, y, z], /, filled, facecolors=None, edgecolors=None, **kwargs)`

Plot a set of filled voxels

All voxels are plotted as 1x1x1 cubes on the axis, with filled[0,0,0] placed with its lower corner at the origin. Occluded faces are not plotted.

New in version 2.1.

**Parameters**

**filled** [3D np.array of bool] A 3d array of values, with truthy values indicating which voxels to fill

**x, y, z** [3D np.array, optional] The coordinates of the corners of the voxels. This should broadcast to a shape one larger in every dimension than the shape of `filled`. These can be used to plot non-cubic voxels.

If not specified, defaults to increasing integers along each axis, like those returned by `indices()`. As indicated by the / in the function signature, these arguments can only be passed positionally.

**facecolors, edgecolors** [array\_like, optional] The color to draw the faces and edges of the voxels. Can only be passed as keyword arguments. This parameter can be:

- A single color value, to color all voxels the same color. This can be either a string, or a 1D rgb/rgba array
- `None`, the default, to use a single color for the faces, and the style default for the edges.
- A 3D ndarray of color names, with each item the color for the corresponding voxel. The size must match the voxels.
- A 4D ndarray of rgb/rgba data, with the components along the last axis.

**shade** [bool] Whether to shade the facecolors. Defaults to `True`. Shading is always disabled when `cmap` is specified.

New in version 3.1.

**lightsource** [*LightSource*] The lightsource to use when `shade` is `True`.

New in version 3.1.

**\*\*kwargs** Additional keyword arguments to pass onto `Poly3DCollection()`

## Returns

**faces** [dict] A dictionary indexed by coordinate, where `faces[i,j,k]` is a `Poly3DCollection` of the faces drawn for the voxel `filled[i,j,k]`. If no faces were drawn for a given voxel, either because it was not asked to be drawn, or it is fully occluded, then `(i,j,k)` not in `faces`.

## Examples

```
zaxis_date(self, tz=None)
```

Sets up z-axis ticks and labels that treat the z data as dates.

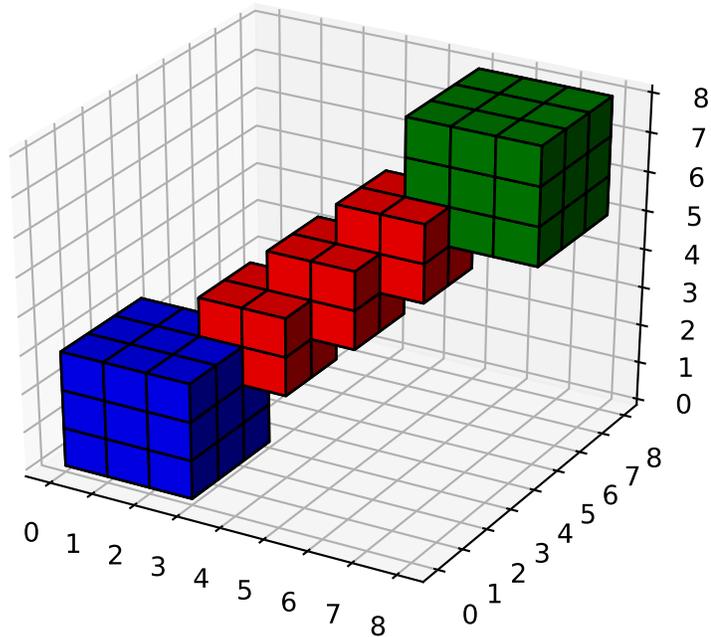
`tz` is a timezone string or `tzinfo` instance. Defaults to rc value.

---

**Note:** This function is merely provided for completeness. `Axes3D` objects do not officially support dates for ticks, and so this may or may not work as expected.

---

New in version 1.1.0: This function was added, but not tested. Please report any bugs.



`zaxis_inverted(self)`

Returns True if the z-axis is inverted.

New in version 1.1.0: This function was added, but not tested. Please report any bugs.

## 18.2.2 axis3d

---

**Note:** See `mpl_toolkits.mplot3d.axis3d._axinfo` for a dictionary containing constants that may be modified for controlling the look and feel of mplot3d axes (e.g., label spacing, font colors and panel colors). Historically, axis3d has suffered from having hard-coded constants that precluded user adjustments, and this dictionary was implemented in version 1.1 as a stop-gap measure.

---

`axis3d.Axis(adir, v_intervalx, d_intervalx, ...)` An Axis class for the 3D plots.

---

### `mpl_toolkits.mplot3d.axis3d.Axis`

`class mpl_toolkits.mplot3d.axis3d.Axis(adir, v_intervalx, d_intervalx, axes, *args, rotate_label=None, **kwargs)`

Bases: `matplotlib.axis.XAxis`

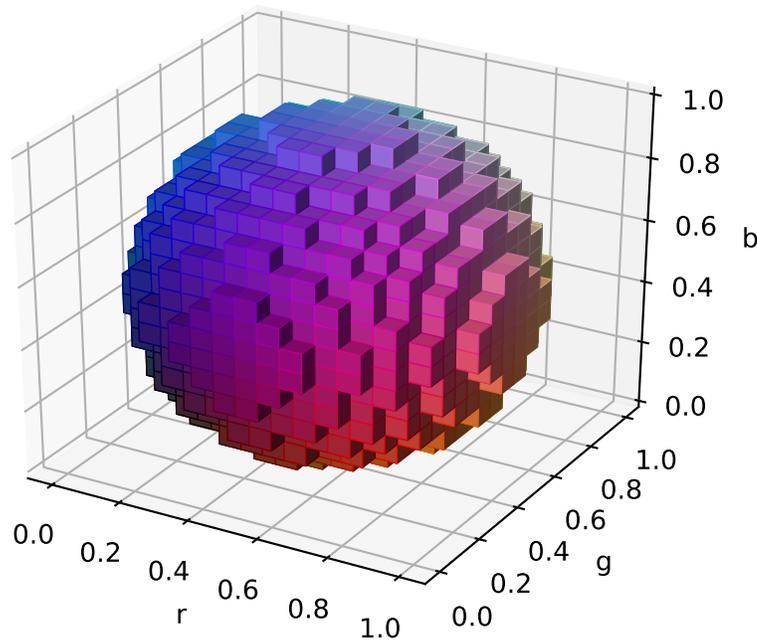
An Axis class for the 3D plots.

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`d_interval`

`draw(self, renderer)`

Draw the axis lines, grid lines, tick lines and labels



`set_rotate_label(self, val)`

Whether to rotate the axis label: True, False or None. If set to None the label will be rotated if longer than 4 chars.

`v_interval`

### 18.2.3 art3d

<code>art3d.Line3D(xs, ys, zs, *args, **kwargs)</code>	3D line object.
<code>art3d.Line3DCollection(segments[, ...])</code>	A collection of 3D lines.
<code>art3d.Patch3D(*args[, zs, zdir])</code>	3D patch object.
<code>art3d.Patch3DCollection(*args[, zs, zdir, ...])</code>	A collection of 3D patches.
<code>art3d.Path3DCollection(*args[, zs, zdir, ...])</code>	A collection of 3D paths.
<code>art3d.PathPatch3D(path, *[, zs, zdir])</code>	3D PathPatch object.
<code>art3d.Poly3DCollection(verts, *args[, zsort])</code>	A collection of 3D polygons.
<code>art3d.Text3D([x, y, z, text, zdir])</code>	Text object with 3D position and direction.

#### `mpl_toolkits.mplot3d.art3d.Line3D`

`class mpl_toolkits.mplot3d.art3d.Line3D(xs, ys, zs, *args, **kwargs)`

Bases: `matplotlib.lines.Line2D`

3D line object.

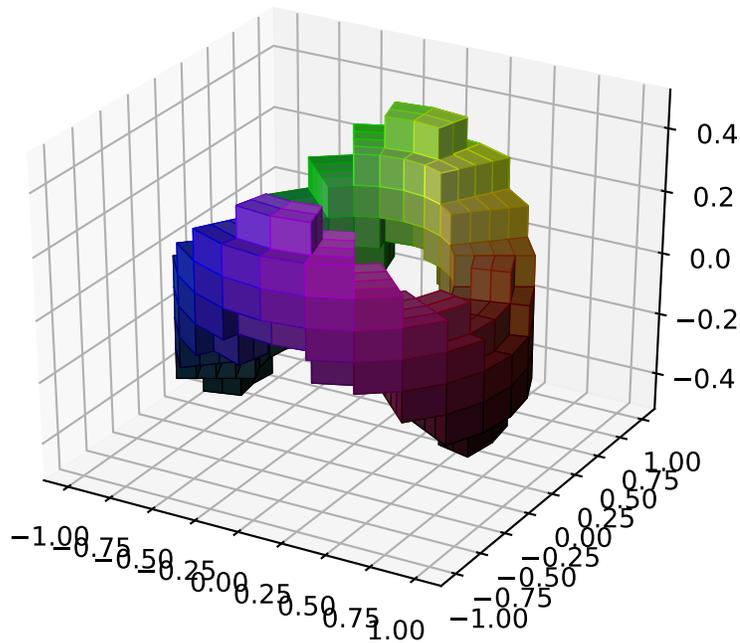
Keyword arguments are passed onto `Line2D()`.

`draw(self, renderer)`

18.2. `mpl_toolkits.mplot3d.art3d` The Artist using the given renderer.

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This method will be overridden in the Artist subclasses. Typically, it is implemented to not have any effect if the Artist is not visible (`Artist.get_visible` is `False`).



### Notes

Accepts  $x$ ,  $y$ ,  $z$  arguments or a single array\_like ( $x$ ,  $y$ ,  $z$ )

### `mpl_toolkits.mplot3d.art3d.Line3DCollection`

```
class mpl_toolkits.mplot3d.art3d.Line3DCollection(segments, linewidths=None, colors=None, antialiaseds=None,
                                                  linestyles='solid', offsets=None,
                                                  transOffset=None, norm=None,
                                                  cmap=None, pickradius=5,
                                                  zorder=2, facecolors='none',
                                                  **kwargs)
```

Bases: `matplotlib.collections.LineCollection`

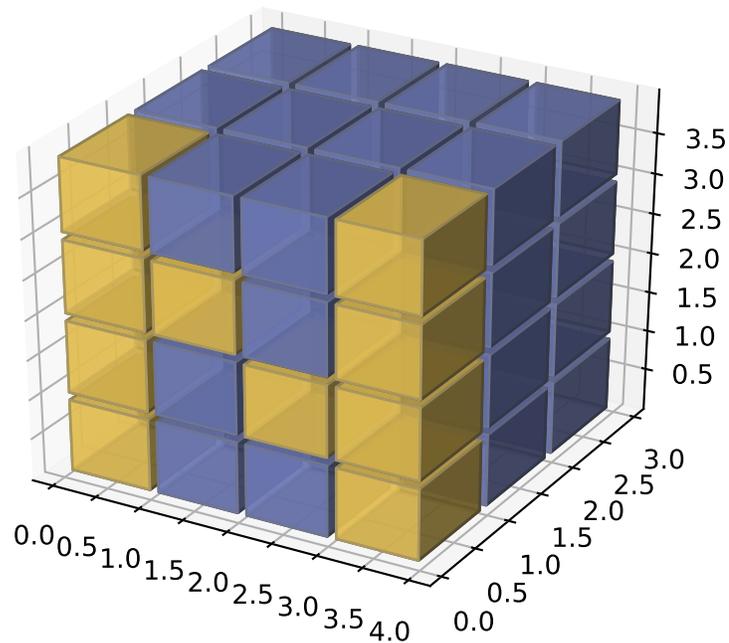
A collection of 3D lines.

### Parameters

**segments** A sequence of (*line0*, *line1*, *line2*), where:

```
linen = (x0, y0), (x1, y1), ... (xm, ym)
```

or the equivalent numpy array with two columns. Each line can be a different length.



**colors** [sequence, optional] A sequence of RGBA tuples (e.g., arbitrary color strings, etc, not allowed).

**antialiaseds** [sequence, optional] A sequence of ones or zeros.

**linestyles** [string, tuple, optional] Either one of [ 'solid' | 'dashed' | 'dash-dot' | 'dotted' ], or a dash tuple. The dash tuple is:

```
(offset, onoffseq)
```

where *onoffseq* is an even length tuple of on and off ink in points.

**norm** [Normalize, optional] *Normalize* instance.

**cmap** [string or Colormap, optional] Colormap name or *Colormap* instance.

**pickradius** [float, optional] The tolerance in points for mouse clicks picking a line. Default is 5 pt.

**zorder** [int, optional] zorder of the LineCollection. Default is 2.

**facecolors** [optional] The facecolors of the LineCollection. Default is 'none'. Setting to a value other than 'none' will lead to a filled polygon being drawn between points on each line.

## Notes

If *linewidths*, *colors*, or *antialiaseds* is None, they default to their rcParams setting, in sequence form.

If *offsets* and *transOffset* are not None, then *offsets* are transformed by *transOffset* and applied after the segments have been transformed to display coordinates.

If *offsets* is not None but *transOffset* is None, then the *offsets* are added to the segments before any transformation. In this case, a single offset can be specified as:

```
offsets=(x0,y0)
```

and this value will be added cumulatively to each successive segment, so as to produce a set of successively offset curves.

The use of *ScalarMappable* is optional. If the *ScalarMappable* array *\_A* is not None (i.e., a call to *set\_array()* has been made), at draw time a call to scalar mappable will be made to set the colors.

*do\_3d\_projection(self, renderer)*

Project the points according to renderer matrix.

*draw(self, renderer, project=False)*

Draw the Artist using the given renderer.

This method will be overridden in the Artist subclasses. Typically, it is implemented to not have any effect if the Artist is not visible (*Artist.get\_visible* is *False*).

## Parameters

**renderer** [*RendererBase* subclass.]

*set\_segments(self, segments)*

Set 3D segments.

*set\_sort\_zpos(self, val)*

Set the position to use for z-sorting.

## `mpl_toolkits.mplot3d.art3d.Patch3D`

```
class mpl_toolkits.mplot3d.art3d.Patch3D(*args, zs=(), zdir='z', **kwargs)
```

Bases: *matplotlib.patches.Patch*

3D patch object.

*do\_3d\_projection(self, renderer)*

*get\_facecolor(self)*

Return the face color of the Patch.

*get\_path(self)*

Return the path of this patch

*set\_3d\_properties(self, verts, zs=0, zdir='z')*

**mpl\_toolkits.mplot3d.art3d.Patch3DCollection**

```
class mpl_toolkits.mplot3d.art3d.Patch3DCollection(*args, zs=0, zdir='z',
                                                  depthshade=True, **kwargs)
```

Bases: *matplotlib.collections.PatchCollection*

A collection of 3D patches.

Create a collection of flat 3D patches with its normal vector pointed in *zdir* direction, and located at *zs* on the *zdir* axis. 'zs' can be a scalar or an array-like of the same length as the number of patches in the collection.

Constructor arguments are the same as for *PatchCollection*. In addition, keywords *zs=0* and *zdir='z'* are available.

Also, the keyword argument "depthshade" is available to indicate whether or not to shade the patches in order to give the appearance of depth (default is *True*). This is typically desired in scatter plots.

```
do_3d_projection(self, renderer)
```

```
set_3d_properties(self, zs, zdir)
```

```
set_sort_zpos(self, val)
```

Set the position to use for z-sorting.

**mpl\_toolkits.mplot3d.art3d.Path3DCollection**

```
class mpl_toolkits.mplot3d.art3d.Path3DCollection(*args, zs=0, zdir='z',
                                                  depthshade=True, **kwargs)
```

Bases: *matplotlib.collections.PathCollection*

A collection of 3D paths.

Create a collection of flat 3D paths with its normal vector pointed in *zdir* direction, and located at *zs* on the *zdir* axis. 'zs' can be a scalar or an array-like of the same length as the number of paths in the collection.

Constructor arguments are the same as for *PathCollection*. In addition, keywords *zs=0* and *zdir='z'* are available.

Also, the keyword argument "depthshade" is available to indicate whether or not to shade the patches in order to give the appearance of depth (default is *True*). This is typically desired in scatter plots.

```
do_3d_projection(self, renderer)
```

```
set_3d_properties(self, zs, zdir)
```

```
set_sort_zpos(self, val)
```

Set the position to use for z-sorting.

**mpl\_toolkits.mplot3d.art3d.PathPatch3D**

```
class mpl_toolkits.mplot3d.art3d.PathPatch3D(path, *, zs=(), zdir='z', **kwargs)
```

Bases: *mpl\_toolkits.mplot3d.art3d.Patch3D*

3D PathPatch object.

```
do_3d_projection(self, renderer)
```

```
set_3d_properties(self, path, zs=0, zdir='z')
```

### `mpl_toolkits.mplot3d.art3d.Poly3DCollection`

```
class mpl_toolkits.mplot3d.art3d.Poly3DCollection(verts, *args, zsort='average',  
                                                **kwargs)
```

Bases: `matplotlib.collections.PolyCollection`

A collection of 3D polygons.

Create a `Poly3DCollection`.

`verts` should contain 3D coordinates.

Keyword arguments: `zsort`, see `set_zsort` for options.

Note that this class does a bit of magic with the `_facecolors` and `_edgecolors` properties.

```
do_3d_projection(self, renderer)  
    Perform the 3D projection for this object.
```

```
get_edgecolor(self)
```

```
get_facecolor(self)
```

```
get_vector(self, segments3d)  
    Optimize points for projection.
```

```
set_3d_properties(self)
```

```
set_alpha(self, alpha)  
    Set the alpha transparencies of the collection.
```

#### **Parameters**

**alpha** [float or None]

```
set_edgecolor(self, colors)  
    Set the edgecolor(s) of the collection.
```

#### **Parameters**

**c** [color or sequence of colors or 'face'] The collection edgecolor(s).  
If a sequence, the patches cycle through it. If 'face', match the facecolor.

```
set_facecolor(self, colors)  
    Set the facecolor(s) of the collection. c can be a matplotlib color spec (all patches  
have same color), or a sequence of specs; if it is a sequence the patches will cycle  
through the sequence.
```

If *c* is 'none', the patch will not be filled.

#### **Parameters**

**c** [color or sequence of colors]

```
set_sort_zpos(self, val)  
    Set the position to use for z-sorting.
```

```
set_verts(self, verts, closed=True)  
    Set 3D vertices.
```

`set_verts_and_codes(self, verts, codes)`  
Sets 3D vertices with path codes.

`set_zsort(self, zsort)`  
Sets the calculation method for the z-order.

### Parameters

**zsort** [{'average', 'min', 'max'}] The function applied on the z-coordinates of the vertices in the viewer's coordinate system, to determine the z-order. *True* is deprecated and equivalent to 'average'.

## `mpl_toolkits.mplot3d.art3d.Text3D`

`class mpl_toolkits.mplot3d.art3d.Text3D(x=0, y=0, z=0, text="", zdir='z', **kwargs)`  
Bases: `matplotlib.text.Text`

Text object with 3D position and direction.

### Parameters

**x, y, z** The position of the text.

**text** [str] The text string to display.

**zdir** [{'x', 'y', 'z', None, 3-tuple}] The direction of the text. See `get_dir_vector` for a description of the values.

### Other Parameters

**\*\*kwargs** All other parameters are passed on to `Text`.

`draw(self, renderer)`  
Draws the `Text` object to the given `renderer`.

`get_tightbbox(self, renderer)`  
Like `Artist.get_window_extent`, but includes any clipping.

### Parameters

**renderer** [`RendererBase` instance] renderer that will be used to draw the figures (i.e. `fig.canvas.get_renderer()`)

### Returns

**bbbox** [`BBox`] The enclosing bounding box (in figure pixel co-ordinates).

`set_3d_properties(self, z=0, zdir='z')`

## 18.2.4 Art3D Utility Functions

<code>art3d.get_colors(c, num)</code>	[ <i>Deprecated</i> ] Stretch the color argument to provide the required number <i>num</i> .
<code>art3d.get_dir_vector(zdir)</code>	Return a direction vector.
<code>art3d.get_patch_verts(patch)</code>	[ <i>Deprecated</i> ] Return a list of vertices for the path of a patch.

Continued on next page

Table 40 – continued from previous page

<code>art3d.juggle_axes(xs, ys, zs, zdir)</code>	Reorder coordinates so that 2D <code>xs</code> , <code>ys</code> can be plotted in the plane orthogonal to <code>zdir</code> .
<code>art3d.line_2d_to_3d(line[, zs, zdir])</code>	Convert a 2D line to 3D.
<code>art3d.line_collection_2d_to_3d(col[, zs, zdir])</code>	Convert a <code>LineCollection</code> to a <code>Line3DCollection</code> object.
<code>art3d.norm_angle(a)</code>	<i>[Deprecated]</i> Return the given angle normalized to $-180 < a \leq 180$ degrees.
<code>art3d.norm_text_angle(a)</code>	<i>[Deprecated]</i> Return the given angle normalized to $-90 < a \leq 90$ degrees.
<code>art3d.patch_2d_to_3d(patch[, z, zdir])</code>	Convert a <code>Patch</code> to a <code>Patch3D</code> object.
<code>art3d.patch_collection_2d_to_3d(col[, zs, ...])</code>	Convert a <code>PatchCollection</code> into a <code>Patch3DCollection</code> object (or a <code>PathCollection</code> into a <code>Path3DCollection</code> object).
<code>art3d.path_to_3d_segment(path[, zs, zdir])</code>	<i>[Deprecated]</i> Convert a path to a 3D segment.
<code>art3d.path_to_3d_segment_with_codes(path[, ...])</code>	<i>[Deprecated]</i> Convert a path to a 3D segment with path codes.
<code>art3d.pathpatch_2d_to_3d(pathpatch[, z, zdir])</code>	Convert a <code>PathPatch</code> to a <code>PathPatch3D</code> object.
<code>art3d.paths_to_3d_segments(paths[, zs, zdir])</code>	<i>[Deprecated]</i> Convert paths from a collection object to 3D segments.
<code>art3d.paths_to_3d_segments_with_codes(paths)</code>	<i>[Deprecated]</i> Convert paths from a collection object to 3D segments with path codes.
<code>art3d.poly_collection_2d_to_3d(col[, zs, zdir])</code>	Convert a <code>PolyCollection</code> to a <code>Poly3DCollection</code> object.
<code>art3d.rotate_axes(xs, ys, zs, zdir)</code>	Reorder coordinates so that the axes are rotated with <code>zdir</code> along the original <code>z</code> axis.
<code>art3d.text_2d_to_3d(obj[, z, zdir])</code>	Convert a <code>Text</code> to a <code>Text3D</code> object.
<code>art3d.zalpha(colors, zs)</code>	<i>[Deprecated]</i> Modify the alphas of the color list according to depth.

**mpl\_toolkits.mplot3d.art3d.get\_colors**

`mpl_toolkits.mplot3d.art3d.get_colors(c, num)`  
*[Deprecated]* Stretch the color argument to provide the required number `num`.

**Notes**

Deprecated since version 3.1.

**mpl\_toolkits.mplot3d.art3d.get\_dir\_vector**

`mpl_toolkits.mplot3d.art3d.get_dir_vector(zdir)`  
 Return a direction vector.

**Parameters**

**zdir** [{`'x'`, `'y'`, `'z'`, `None`, 3-tuple}] The direction. Possible values are: - `'x'`: equivalent to (1, 0, 0) - `'y'`: equivalent to (0, 1, 0) - `'z'`: equivalent to

(0, 0, 1) - *None*: equivalent to (0, 0, 0) - an iterable (x, y, z) is returned unchanged.

### Returns

**x, y, z** [array-like] The direction vector. This is either a `numpy.array` or `zdir` itself if `zdir` is already a length-3 iterable.

#### `mpl_toolkits.mplot3d.art3d.get_patch_verts`

`mpl_toolkits.mplot3d.art3d.get_patch_verts(patch)`  
*[Deprecated]* Return a list of vertices for the path of a patch.

### Notes

Deprecated since version 3.1.

#### `mpl_toolkits.mplot3d.art3d.juggle_axes`

`mpl_toolkits.mplot3d.art3d.juggle_axes(xs, ys, zs, zdir)`  
 Reorder coordinates so that 2D `xs`, `ys` can be plotted in the plane orthogonal to `zdir`. `zdir` is normally `x`, `y` or `z`. However, if `zdir` starts with a '-' it is interpreted as a compensation for `rotate_axes`.

#### `mpl_toolkits.mplot3d.art3d.line_2d_to_3d`

`mpl_toolkits.mplot3d.art3d.line_2d_to_3d(line, zs=0, zdir='z')`  
 Convert a 2D line to 3D.

#### `mpl_toolkits.mplot3d.art3d.line_collection_2d_to_3d`

`mpl_toolkits.mplot3d.art3d.line_collection_2d_to_3d(col, zs=0, zdir='z')`  
 Convert a `LineCollection` to a `Line3DCollection` object.

#### `mpl_toolkits.mplot3d.art3d.norm_angle`

`mpl_toolkits.mplot3d.art3d.norm_angle(a)`  
*[Deprecated]* Return the given angle normalized to  $-180 < a \leq 180$  degrees.

### Notes

Deprecated since version 3.1.

#### `mpl_toolkits.mplot3d.art3d.norm_text_angle`

`mpl_toolkits.mplot3d.art3d.norm_text_angle(a)`  
*[Deprecated]* Return the given angle normalized to  $-90 < a \leq 90$  degrees.

### Notes

Deprecated since version 3.1.

#### `mpl_toolkits.mplot3d.art3d.patch_2d_to_3d`

`mpl_toolkits.mplot3d.art3d.patch_2d_to_3d(patch, z=0, zdir='z')`  
Convert a `Patch` to a `Patch3D` object.

#### `mpl_toolkits.mplot3d.art3d.patch_collection_2d_to_3d`

`mpl_toolkits.mplot3d.art3d.patch_collection_2d_to_3d(col, zs=0, zdir='z', depthshade=True)`  
Convert a `PatchCollection` into a `Patch3DCollection` object (or a `PathCollection` into a `Path3DCollection` object).

### Parameters

**za** The location or locations to place the patches in the collection along the `zdir` axis. Default: 0.

**zdir** The axis in which to place the patches. Default: "z".

**depthshade** Whether to shade the patches to give a sense of depth. Default: `True`.

#### `mpl_toolkits.mplot3d.art3d.path_to_3d_segment`

`mpl_toolkits.mplot3d.art3d.path_to_3d_segment(path, zs=0, zdir='z')`  
*[Deprecated]* Convert a path to a 3D segment.

### Notes

Deprecated since version 3.1.

#### `mpl_toolkits.mplot3d.art3d.path_to_3d_segment_with_codes`

`mpl_toolkits.mplot3d.art3d.path_to_3d_segment_with_codes(path, zs=0, zdir='z')`  
*[Deprecated]* Convert a path to a 3D segment with path codes.

### Notes

Deprecated since version 3.1.

#### `mpl_toolkits.mplot3d.art3d.pathpatch_2d_to_3d`

`mpl_toolkits.mplot3d.art3d.pathpatch_2d_to_3d(pathpatch, z=0, zdir='z')`  
Convert a `PathPatch` to a `PathPatch3D` object.

Examples using `mpl_toolkits.mplot3d.art3d.pathpatch_2d_to_3d`

- `sphx_glr_gallery_mplot3d_pathpatch3d.py`

`mpl_toolkits.mplot3d.art3d.paths_to_3d_segments`

`mpl_toolkits.mplot3d.art3d.paths_to_3d_segments(paths, zs=0, zdir='z')`  
 [Deprecated] Convert paths from a collection object to 3D segments.

#### Notes

Deprecated since version 3.1.

`mpl_toolkits.mplot3d.art3d.paths_to_3d_segments_with_codes`

`mpl_toolkits.mplot3d.art3d.paths_to_3d_segments_with_codes(paths, zs=0, zdir='z')`  
 [Deprecated] Convert paths from a collection object to 3D segments with path codes.

#### Notes

Deprecated since version 3.1.

`mpl_toolkits.mplot3d.art3d.poly_collection_2d_to_3d`

`mpl_toolkits.mplot3d.art3d.poly_collection_2d_to_3d(col, zs=0, zdir='z')`  
 Convert a PolyCollection to a Poly3DCollection object.

`mpl_toolkits.mplot3d.art3d.rotate_axes`

`mpl_toolkits.mplot3d.art3d.rotate_axes(xs, ys, zs, zdir)`  
 Reorder coordinates so that the axes are rotated with `zdir` along the original `z` axis. Prepending the axis with a '-' does the inverse transform, so `zdir` can be `x`, `-x`, `y`, `-y`, `z` or `-z`.

`mpl_toolkits.mplot3d.art3d.text_2d_to_3d`

`mpl_toolkits.mplot3d.art3d.text_2d_to_3d(obj, z=0, zdir='z')`  
 Convert a Text to a Text3D object.

`mpl_toolkits.mplot3d.art3d.zalpha`

`mpl_toolkits.mplot3d.art3d.zalpha(colors, zs)`  
 [Deprecated] Modify the alphas of the color list according to depth.

## Notes

Deprecated since version 3.1.

## 18.2.5 proj3d

<code>proj3d.inv_transform(xs, ys, zs, M)</code>	
<code>proj3d.line2d(p0, p1)</code>	[ <i>Deprecated</i> ] Return 2D equation of line in the form $ax+by+c = 0$
<code>proj3d.line2d_dist(l, p)</code>	[ <i>Deprecated</i> ] Distance from line to point line is a tuple of coefficients a, b, c
<code>proj3d.line2d_seg_dist(p1, p2, p0)</code>	[ <i>Deprecated</i> ] distance(s) from line defined by p1 - p2 to point(s) p0
<code>proj3d.mod(v)</code>	[ <i>Deprecated</i> ] 3d vector length
<code>proj3d.persp_transformation(zfront, zback)</code>	
<code>proj3d.proj_points(points, M)</code>	
<code>proj3d.proj_trans_clip_points(points, M)</code>	[ <i>Deprecated</i> ]
<code>proj3d.proj_trans_points(points, M)</code>	
<code>proj3d.proj_transform(xs, ys, zs, M)</code>	Transform the points by the projection matrix
<code>proj3d.proj_transform_clip(xs, ys, zs, M)</code>	Transform the points by the projection matrix and return the clipping result returns txs,tys,tzs,tis
<code>proj3d.proj_transform_vec(vec, M)</code>	[ <i>Deprecated</i> ]
<code>proj3d.proj_transform_vec_clip(vec, M)</code>	[ <i>Deprecated</i> ]
<code>proj3d.rot_x(V, alpha)</code>	
<code>proj3d.transform(xs, ys, zs, M)</code>	Transform the points by the projection matrix
<code>proj3d.vec_pad_ones(xs, ys, zs)</code>	[ <i>Deprecated</i> ]
<code>proj3d.view_transformation(E, R, V)</code>	
<code>proj3d.world_transformation(xmin, xmax, ...)</code>	

**mpl\_toolkits.mplot3d.proj3d.inv\_transform**

`mpl_toolkits.mplot3d.proj3d.inv_transform(xs, ys, zs, M)`

**mpl\_toolkits.mplot3d.proj3d.line2d**

`mpl_toolkits.mplot3d.proj3d.line2d(p0, p1)`

[*Deprecated*] Return 2D equation of line in the form  $ax+by+c = 0$

## Notes

Deprecated since version 3.1.

**mpl\_toolkits.mplot3d.proj3d.line2d\_dist**

`mpl_toolkits.mplot3d.proj3d.line2d_dist(l, p)`  
 [*Deprecated*] Distance from line to point line is a tuple of coefficients a, b, c

**Notes**

Deprecated since version 3.1.

**mpl\_toolkits.mplot3d.proj3d.line2d\_seg\_dist**

`mpl_toolkits.mplot3d.proj3d.line2d_seg_dist(p1, p2, p0)`  
 [*Deprecated*] distance(s) from line defined by p1 - p2 to point(s) p0  
 $p0[0] = x(s)$   $p0[1] = y(s)$   
 intersection point  $p = p1 + u*(p2-p1)$  and intersection point lies within segment if u is between 0 and 1

**Notes**

Deprecated since version 3.1.

**mpl\_toolkits.mplot3d.proj3d.mod**

`mpl_toolkits.mplot3d.proj3d.mod(v)`  
 [*Deprecated*] 3d vector length

**Notes**

Deprecated since version 3.1.

**mpl\_toolkits.mplot3d.proj3d.persp\_transformation**

`mpl_toolkits.mplot3d.proj3d.persp_transformation(zfront, zback)`

**mpl\_toolkits.mplot3d.proj3d.proj\_points**

`mpl_toolkits.mplot3d.proj3d.proj_points(points, M)`

**mpl\_toolkits.mplot3d.proj3d.proj\_trans\_clip\_points**

`mpl_toolkits.mplot3d.proj3d.proj_trans_clip_points(points, M)`  
 [*Deprecated*]

### Notes

Deprecated since version 3.1:

#### `mpl_toolkits.mplot3d.proj3d.proj_trans_points`

`mpl_toolkits.mplot3d.proj3d.proj_trans_points(points, M)`

#### `mpl_toolkits.mplot3d.proj3d.proj_transform`

`mpl_toolkits.mplot3d.proj3d.proj_transform(xs, ys, zs, M)`  
Transform the points by the projection matrix

#### `mpl_toolkits.mplot3d.proj3d.proj_transform_clip`

`mpl_toolkits.mplot3d.proj3d.proj_transform_clip(xs, ys, zs, M)`  
Transform the points by the projection matrix and return the clipping result returns  
`txs,tys,tzs,tis`

#### `mpl_toolkits.mplot3d.proj3d.proj_transform_vec`

`mpl_toolkits.mplot3d.proj3d.proj_transform_vec(vec, M)`  
*[Deprecated]*

### Notes

Deprecated since version 3.1:

#### `mpl_toolkits.mplot3d.proj3d.proj_transform_vec_clip`

`mpl_toolkits.mplot3d.proj3d.proj_transform_vec_clip(vec, M)`  
*[Deprecated]*

### Notes

Deprecated since version 3.1:

#### `mpl_toolkits.mplot3d.proj3d.rot_x`

`mpl_toolkits.mplot3d.proj3d.rot_x(V, alpha)`

#### `mpl_toolkits.mplot3d.proj3d.transform`

`mpl_toolkits.mplot3d.proj3d.transform(xs, ys, zs, M)`  
Transform the points by the projection matrix

`mpl_toolkits.mplot3d.proj3d.vec_pad_ones`

`mpl_toolkits.mplot3d.proj3d.vec_pad_ones(xS, yS, zS)`  
[*Deprecated*]

#### Notes

Deprecated since version 3.1:

`mpl_toolkits.mplot3d.proj3d.view_transformation`

`mpl_toolkits.mplot3d.proj3d.view_transformation(E, R, V)`

`mpl_toolkits.mplot3d.proj3d.world_transformation`

`mpl_toolkits.mplot3d.proj3d.world_transformation(xmin, xmax, ymin, ymax, zmin, zmax)`

## 18.3 Matplotlib axes\_grid Toolkit

---

**Note:** AxesGrid toolkit has been a part of matplotlib since v 0.99. Originally, the toolkit had a single namespace of *axes\_grid*. In more recent version, the toolkit has divided into two separate namespace (*axes\_grid1* and *axisartist*). While *axes\_grid* namespace is maintained for the backward compatibility, use of *axes\_grid1* and *axisartist* is recommended. For the documentation on *axes\_grid*, see the [previous version of the docs](#).

---



**Part IV**

**External Resources**



## BOOKS, CHAPTERS AND ARTICLES

- [Mastering matplotlib](#) by Duncan M. McGregor
- [Interactive Applications Using Matplotlib](#) by Benjamin Root
- [Matplotlib for Python Developers](#) by Sandro Tosi
- [Matplotlib chapter](#) by John Hunter and Michael Droettboom in *The Architecture of Open Source Applications*
- [Ten Simple Rules for Better Figures](#) by Nicolas P. Rougier, Michael Droettboom and Philip E. Bourne
- [Learning Scientific Programming with Python chapter 7](#) by Christian Hill



**VIDEOS**

- [Plotting with matplotlib](#) by Mike Müller
- [Introduction to NumPy and Matplotlib](#) by Eric Jones
- [Anatomy of Matplotlib](#) by Benjamin Root
- [Data Visualization Basics with Python \(O'Reilly\)](#) by Randal S. Olson



## TUTORIALS

- [Matplotlib tutorial](#) by Nicolas P. Rougier
- [Anatomy of Matplotlib - IPython Notebooks](#) by Benjamin Root



## **Part V**

# **Third party packages**



Several external packages that extend or build on Matplotlib functionality are listed below. They are maintained and distributed separately from Matplotlib and thus need to be installed individually.

Please submit an issue or pull request on Github if you have created a package that you would like to have included. We are also happy to host third party packages within the [Matplotlib Github Organization](#).

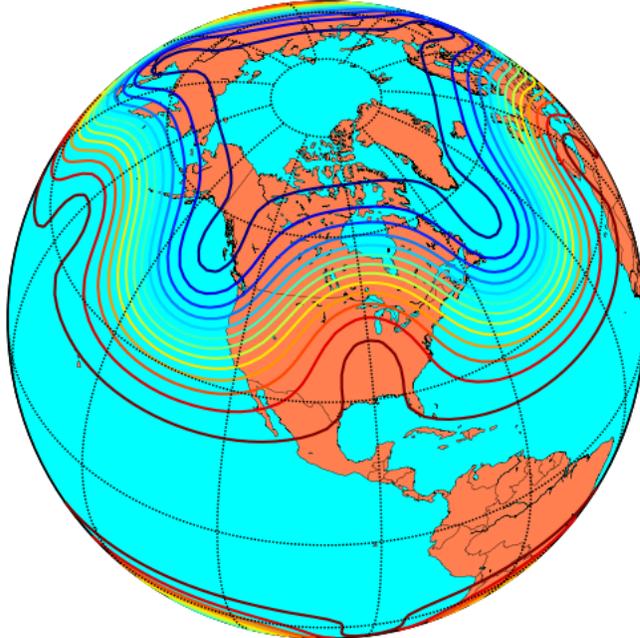


## MAPPING TOOLKITS

### 22.1 Basemap

Basemap plots data on map projections, with continental and political boundaries.

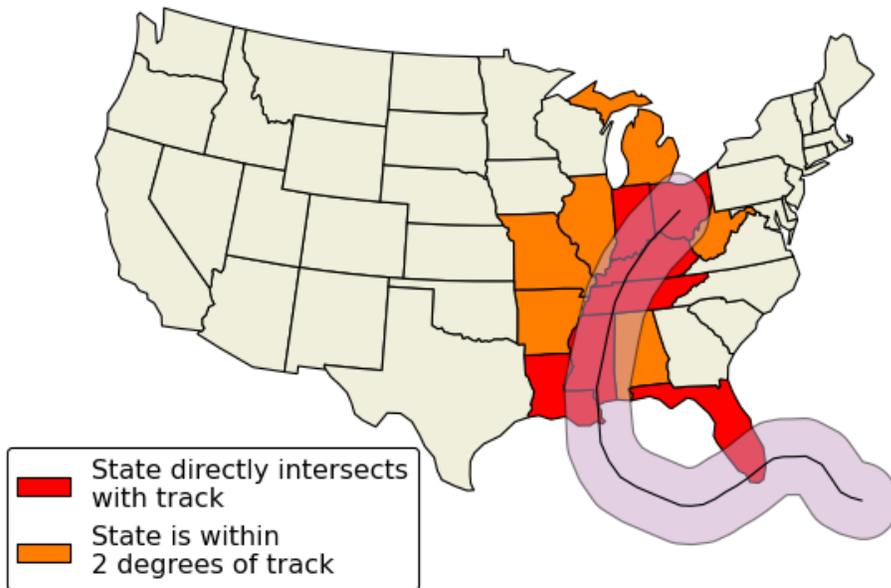
contour lines over filled continent background



### 22.2 Cartopy

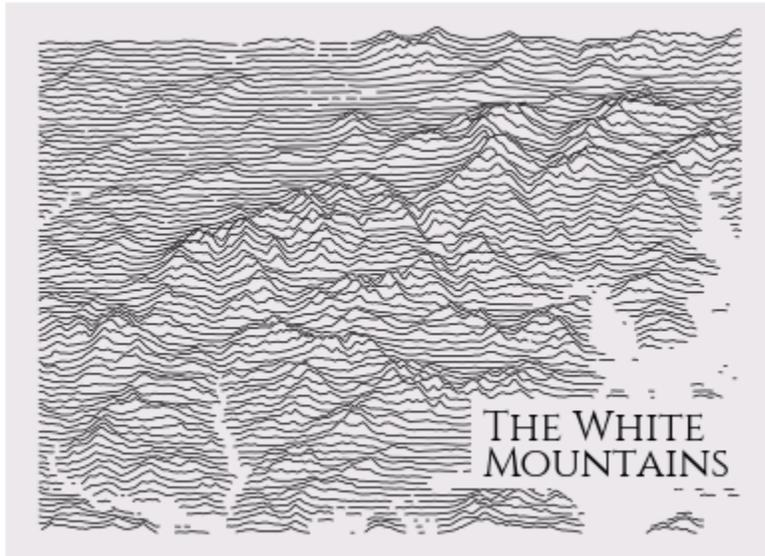
[Cartopy](#) builds on top of Matplotlib to provide object oriented map projection definitions and close integration with Shapely for powerful yet easy-to-use vector data processing tools. An example plot from the [Cartopy gallery](#):

US States which intersect the track of Hurricane Katrina (2005)



## 22.3 Ridge Map

`ridge_map` uses Matplotlib, SRTM.py, NumPy, and scikit-image to make ridge plots of your favorite ridges.

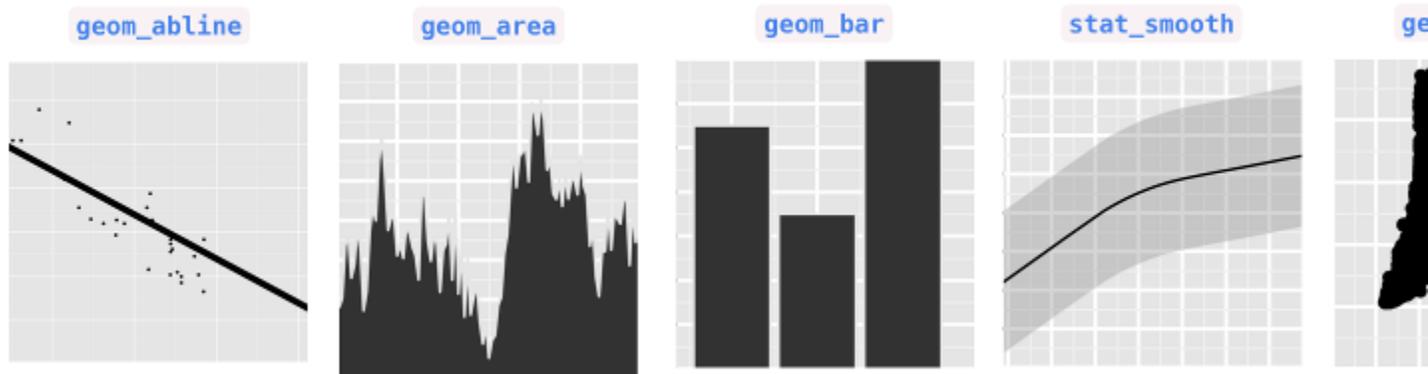




## DECLARATIVE LIBRARIES

### 23.1 ggplot

`ggplot` is a port of the R `ggplot2` package to python based on Matplotlib.

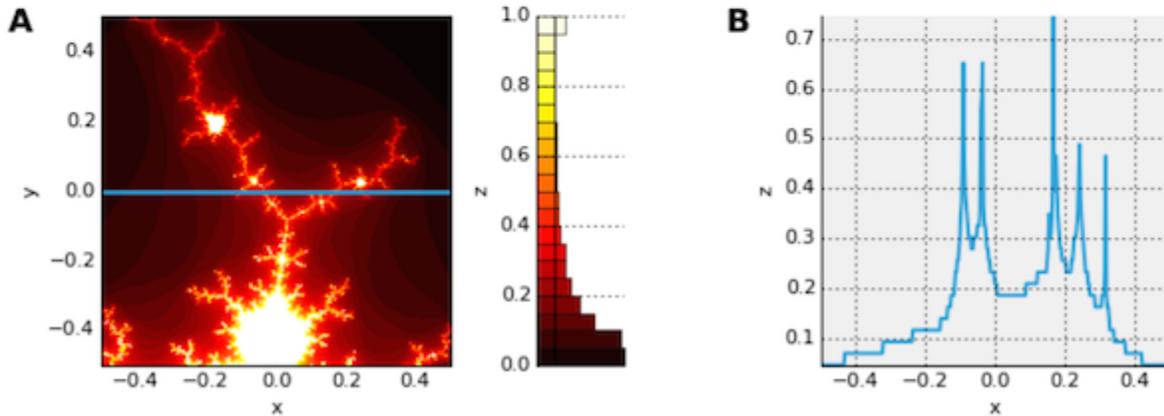


### 23.2 holoviews

`holoviews` makes it easier to visualize data interactively, especially in a [Jupyter notebook](#), by providing a set of declarative plotting objects that store your data and associated metadata. Your data is then immediately visualizable alongside or overlaid with other data, either statically or with automatically provided widgets for parameter exploration.

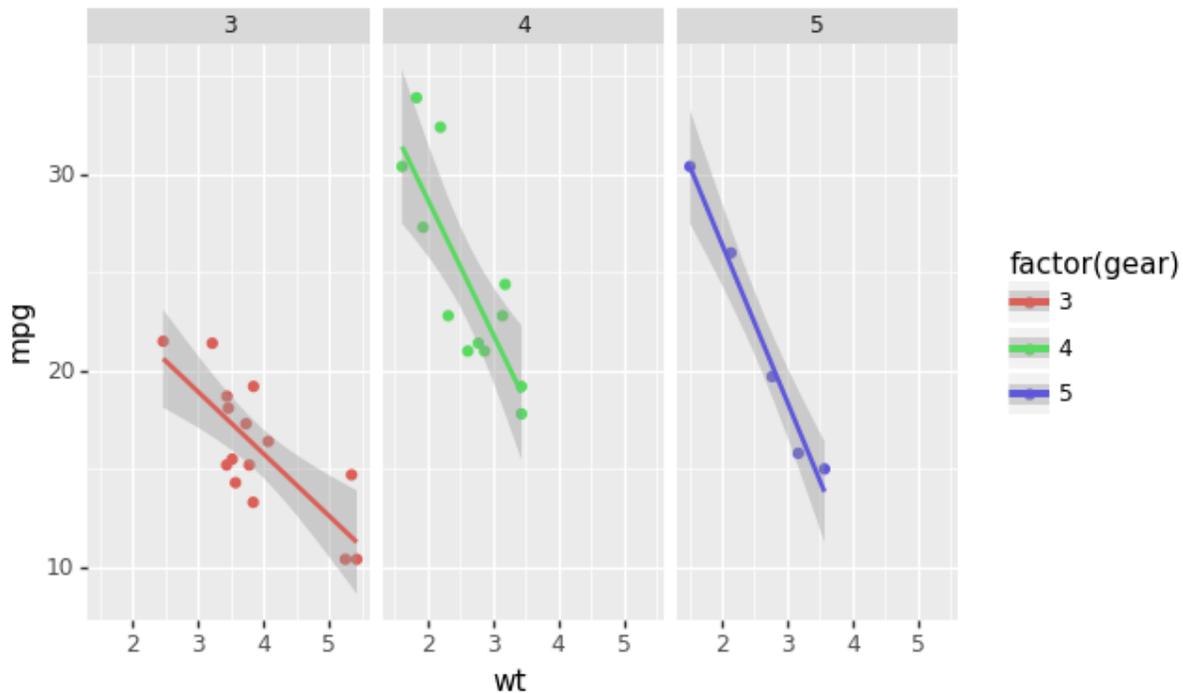
```
import numpy as np
import holoviews as hv
hv.notebook_extension('matplotlib')
fractal = hv.Image(np.load('mandelbrot.npy'))

((fractal * hv.HLine(y=0)).hist() + fractal.sample(y=0))
```



### 23.3 plotnine

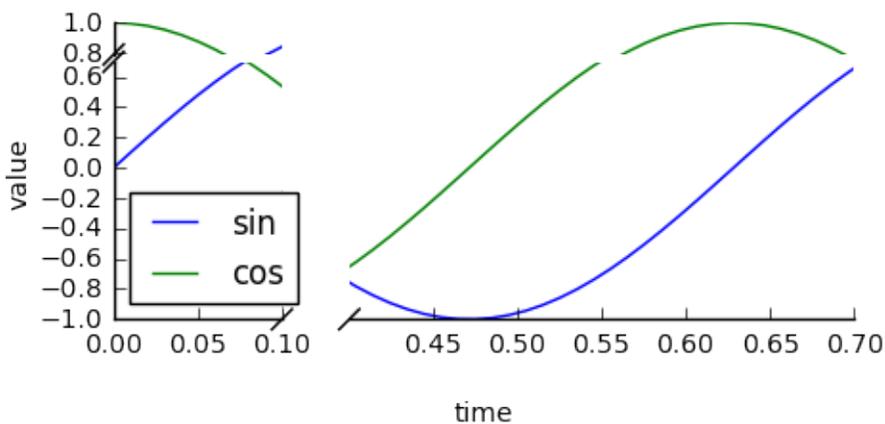
`plotnine` implements a grammar of graphics, similar to R's `ggplot2`. The grammar allows users to compose plots by explicitly mapping data to the visual objects that make up the plot.



## SPECIALTY PLOTS

### 24.1 Broken Axes

`brokenaxes` supplies an axes class that can have a visual break to indicate a discontinuous range.



### 24.2 DeCiDa

`DeCiDa` is a library of functions and classes for electron device characterization, electronic circuit design and general data visualization and analysis.

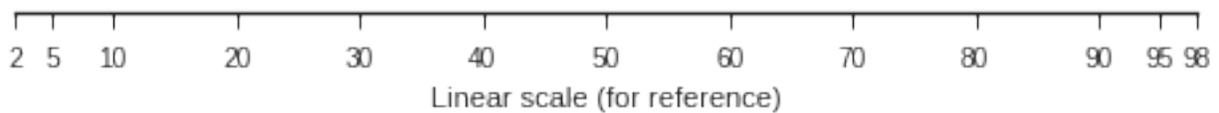
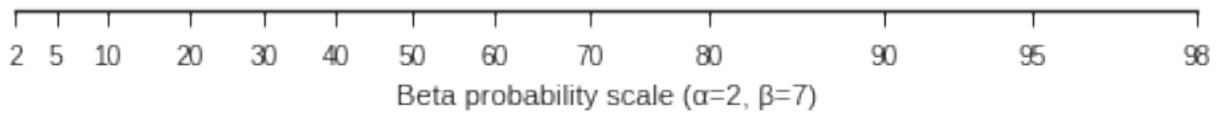
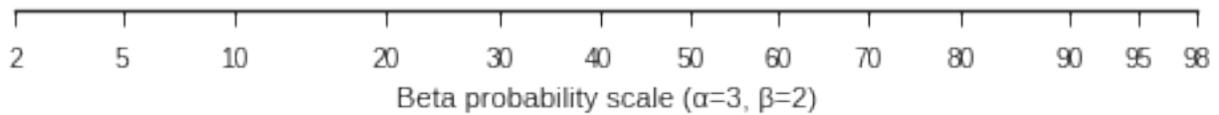
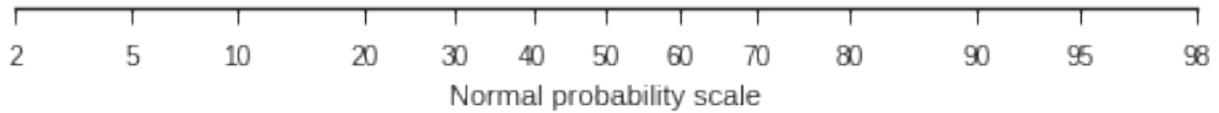
### 24.3 Matplotlib-Venn

`Matplotlib-Venn` provides a set of functions for plotting 2- and 3-set area-weighted (or un-weighted) Venn diagrams.

### 24.4 mpl-probscale

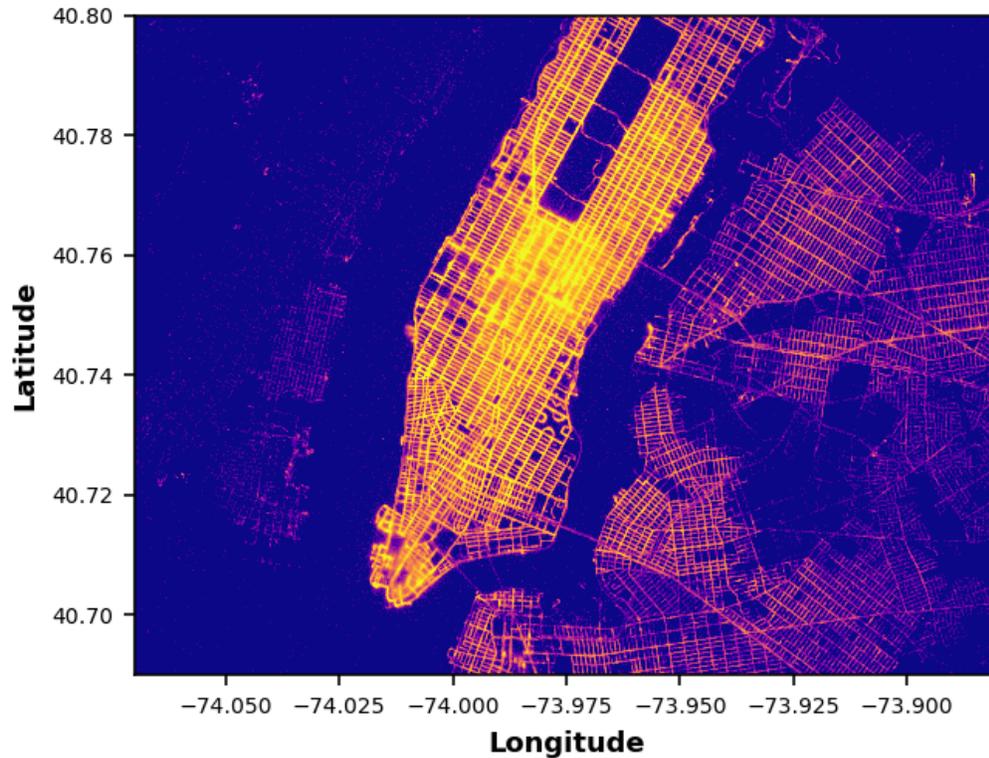
`mpl-probscale` is a small extension that allows Matplotlib users to specify probability scales.

Simply importing the `probscale` module registers the scale with Matplotlib, making it accessible via e.g., `ax.set_xscale('prob')` or `plt.yscale('prob')`.



## 24.5 `mpl-scatter-density`

`mpl-scatter-density` is a small package that makes it easy to make scatter plots of large numbers of points using a density map. The following example contains around 13 million points and the plotting (excluding reading in the data) took less than a second on an average laptop:



When used in interactive mode, the density map is downsampled on-the-fly while panning/zooming in order to provide a smooth interactive experience.

## 24.6 mplstereonet

`mplstereonet` provides stereonets for plotting and analyzing orientation data in Matplotlib.

## 24.7 Natgrid

`mpl_toolkits.natgrid` is an interface to the `natgrid` C library for gridding irregularly spaced data.

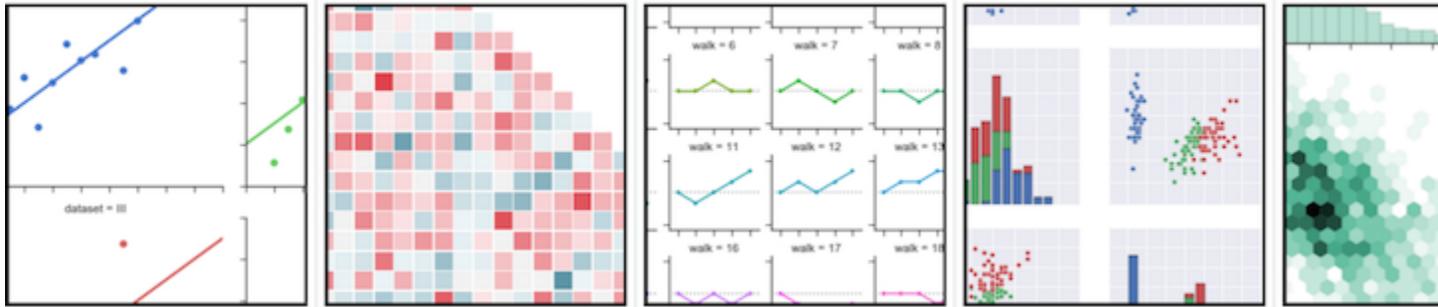
## 24.8 pyUpSet

`pyUpSet` is a static Python implementation of the `UpSet` suite by Lex et al. to explore complex intersections of sets and data frames.

## 24.9 seaborn

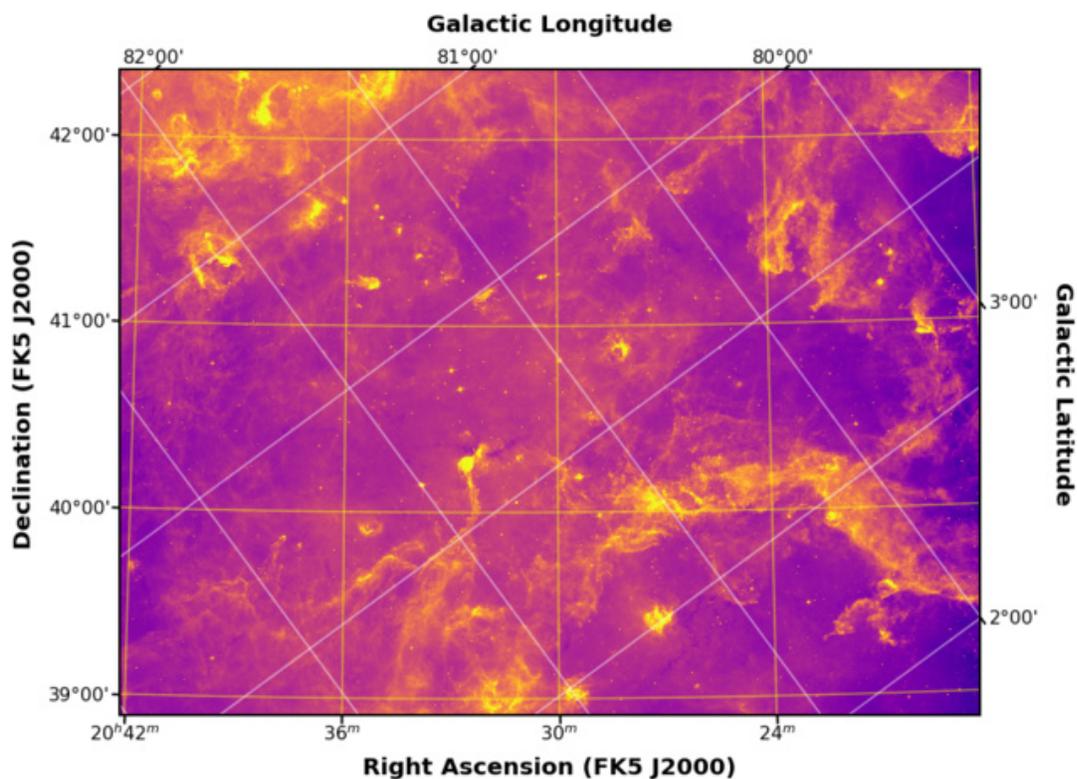
`seaborn` is a high level interface for drawing statistical graphics with Matplotlib. It aims to

make visualization a central part of exploring and understanding complex datasets.



## 24.10 WCSAxes

The *Astropy* core package includes a submodule called `WCSAxes` (available at [astropy.visualization.wcsaxes](https://astropy.org/visualization/wcsaxes)) which adds Matplotlib projections for Astronomical image data. The following is an example of a plot made with `WCSAxes` which includes the original coordinate system of the image and an overlay of a different coordinate system:

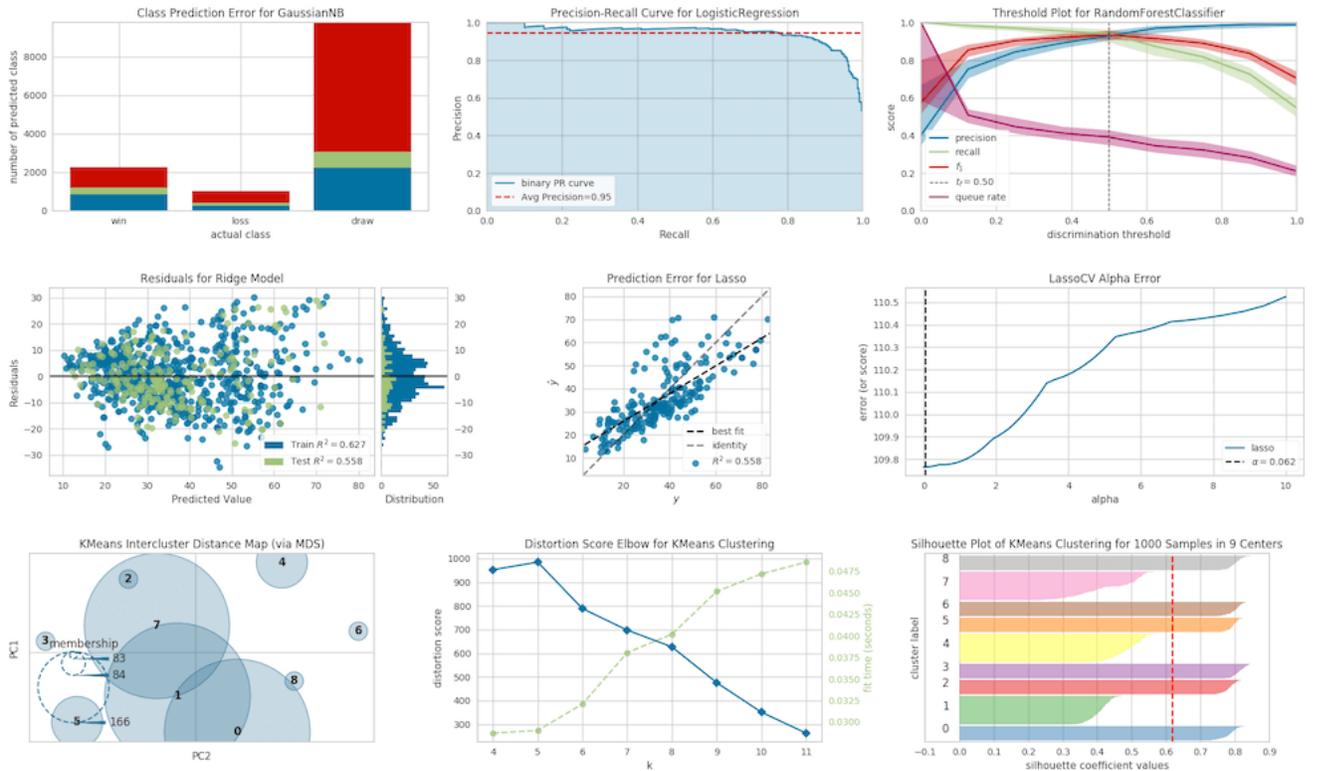


## 24.11 Windrose

*Windrose* is a Python Matplotlib, Numpy library to manage wind data, draw windroses (also known as polar rose plots), draw probability density functions and fit Weibull distributions.

## 24.12 Yellowbrick

**Yellowbrick** is a suite of visual diagnostic tools for machine learning that enables human steering of the model selection process. Yellowbrick combines scikit-learn with matplotlib using an estimator-based API called the *Visualizer*, which wraps both sklearn models and matplotlib Axes. *Visualizer* objects fit neatly into the machine learning workflow allowing data scientists to integrate visual diagnostic and model interpretation tools into experimentation without extra steps.





## INTERACTIVITY

### 25.1 `mplcursors`

`mplcursors` provides interactive data cursors for Matplotlib.

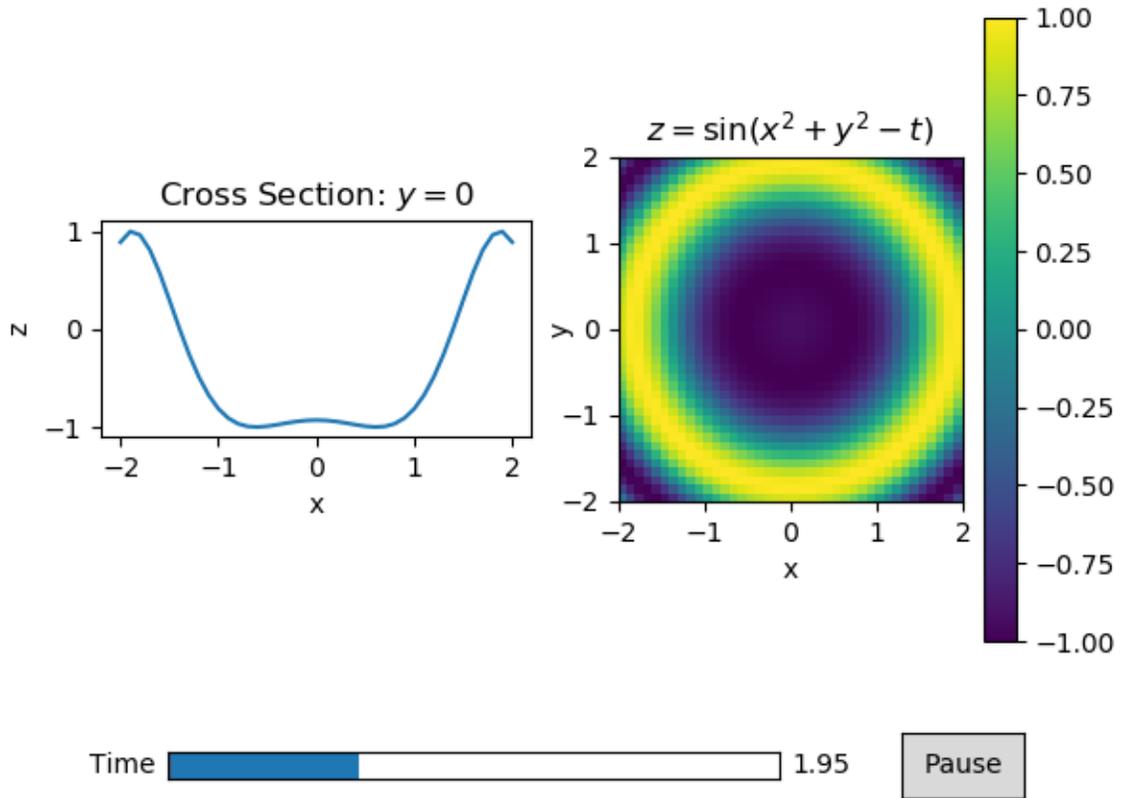
### 25.2 `MplDataCursor`

`MplDataCursor` is a toolkit written by Joe Kington to provide interactive “data cursors” (clickable annotation boxes) for Matplotlib.

### 25.3 `animatplot`

`animatplot` is a library for producing interactive animated plots with the goal of making production of animated plots almost as easy as static ones.

### Animatplot

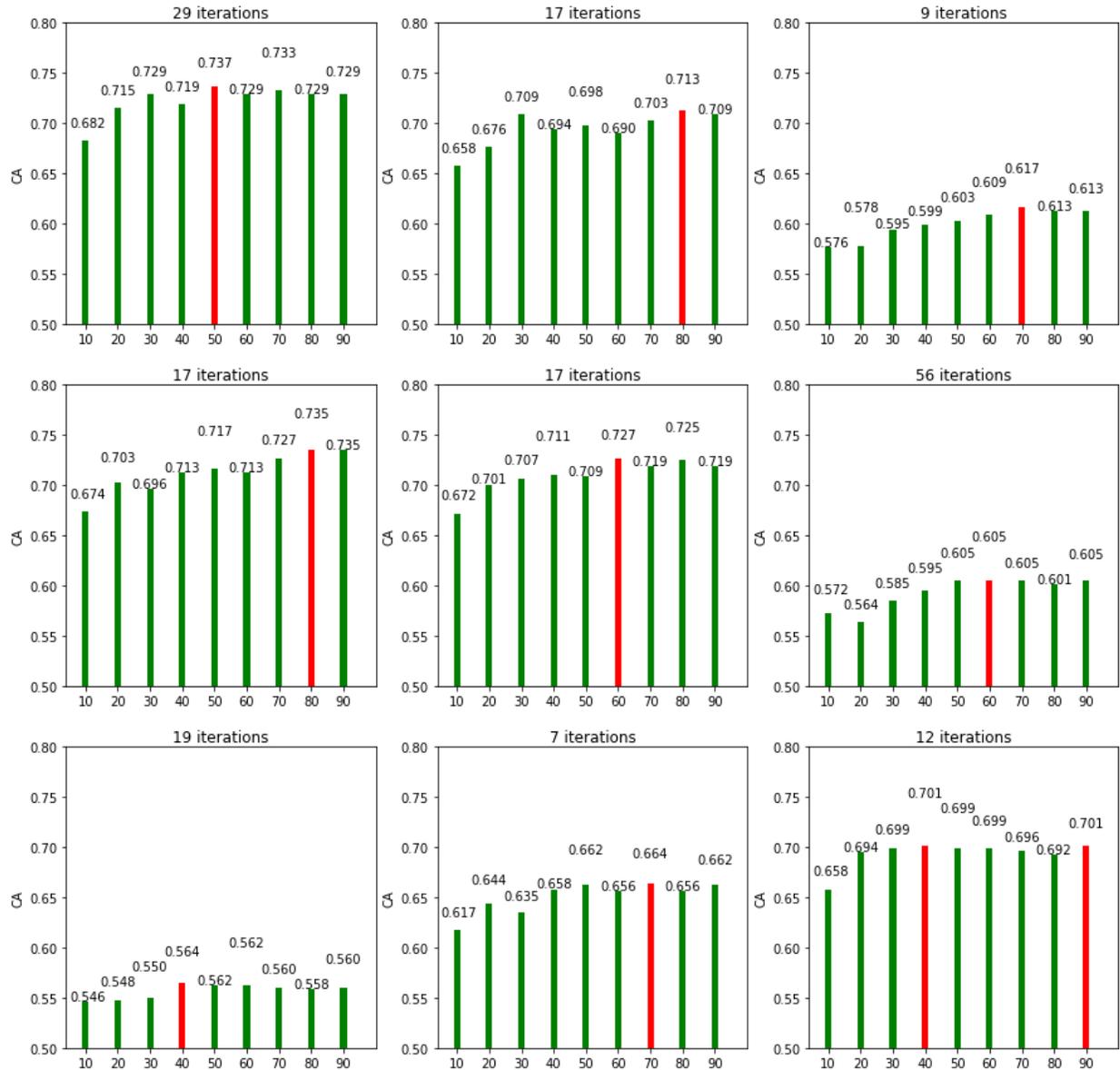


For an animated version of the above picture and more examples, see the [animatplot gallery](#).

## MISCELLANEOUS

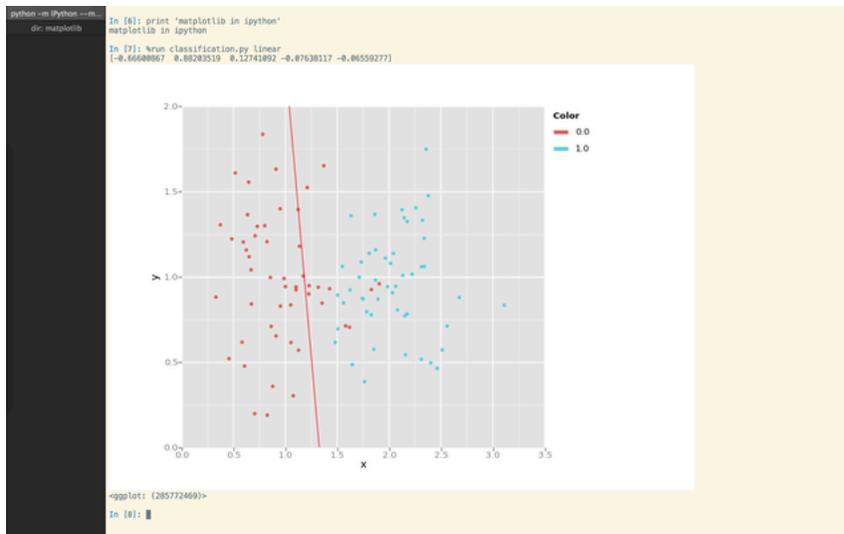
### 26.1 `adjustText`

`adjustText` is a small library for automatically adjusting text position in Matplotlib plots to minimize overlaps between them, specified points and other objects.



## 26.2 iTerm2 terminal backend

`matplotlib_itterm2` is an external Matplotlib backend using the iTerm2 nightly build inline image display feature.

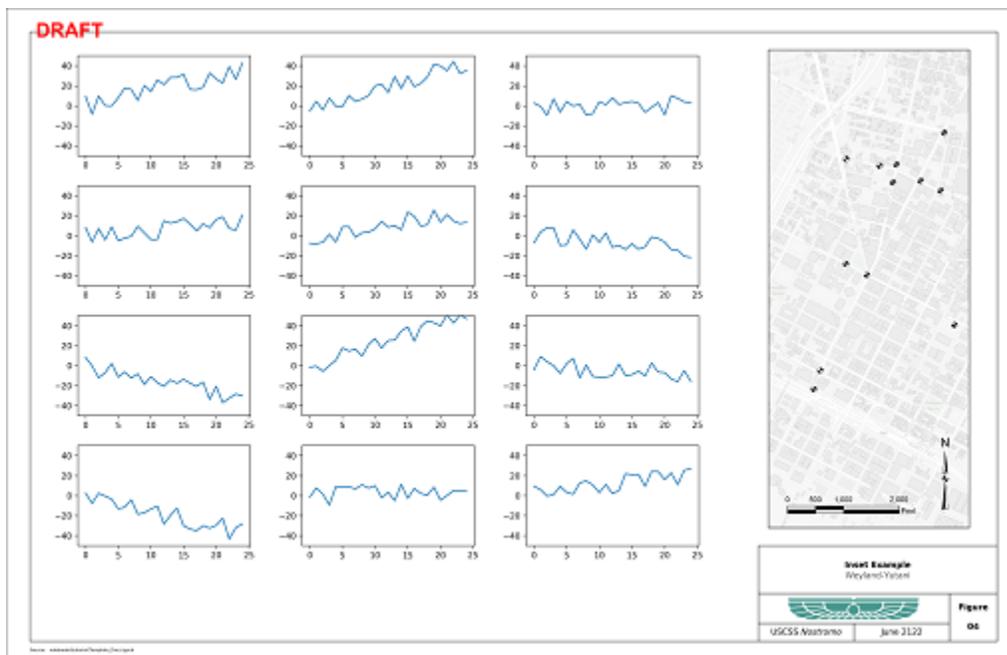


## 26.3 mplcairo

`mplcairo` is a cairo backend for Matplotlib, with faster and more accurate marker drawing, support for a wider selection of font formats and complex text layout, and various other features.

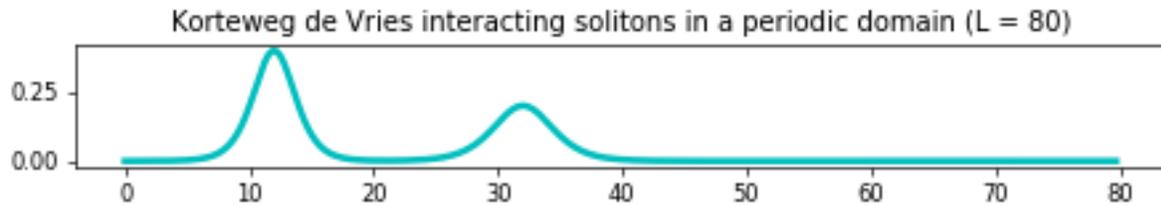
## 26.4 mpl-template

`mpl-template` provides a customizable way to add engineering figure elements such as a title block, border, and logo.



## 26.5 numpngw

`numpngw` provides functions for writing NumPy arrays to PNG and animated PNG files. It also includes the class `AnimatedPNGWriter` that can be used to save a Matplotlib animation as an animated PNG file. See the example on the PyPI page or at the `numpngw` [github repository](#).



## **Part VI**

# **The Matplotlib Developers' Guide**



## CONTRIBUTING

This project is a community effort, and everyone is welcome to contribute.

The project is hosted on <https://github.com/matplotlib/matplotlib>

### 27.1 Submitting a bug report

If you find a bug in the code or documentation, do not hesitate to submit a ticket to the [Bug Tracker](#). You are also welcome to post feature requests or pull requests.

If you are reporting a bug, please do your best to include the following:

1. A short, top-level summary of the bug. In most cases, this should be 1-2 sentences.
2. A short, self-contained code snippet to reproduce the bug, ideally allowing a simple copy and paste to reproduce. Please do your best to reduce the code snippet to the minimum required.
3. The actual outcome of the code snippet.
4. The expected outcome of the code snippet.
5. The Matplotlib version, Python version and platform that you are using. You can grab the version with the following commands:

```
>>> import matplotlib
>>> matplotlib.__version__
'1.5.3'
>>> import platform
>>> platform.python_version()
'2.7.12'
```

We have preloaded the issue creation page with a Markdown template that you can use to organize this information.

Thank you for your help in keeping bug reports complete, targeted and descriptive.

### 27.2 Retrieving and installing the latest version of the code

When developing Matplotlib, sources must be downloaded, built, and installed into a local environment on your machine.

Follow the instructions detailed *here* to set up your environment to build Matplotlib from source.

**Warning:** When working on Matplotlib sources, having multiple versions installed by different methods into the same environment may not always work as expected.

To work on Matplotlib sources, it is strongly recommended to set up an alternative development environment, using the something like [virtual environments in python](#), or a [conda environment](#).

If you choose to use an already existing environment, and not a clean virtual or conda environment, uninstall the current version of Matplotlib in that environment using the same method used to install it.

If working on Matplotlib documentation only, the above steps are *not* absolutely necessary.

We use [Git](#) for version control and [GitHub](#) for hosting our main repository.

You can check out the latest sources with the command (see *Set up your fork* for more details):

```
git clone https://github.com/matplotlib/matplotlib.git
```

and navigate to the `matplotlib` directory. If you have the proper privileges, you can use `git@` instead of `https://`, which works through the ssh protocol and might be easier to use if you are using 2-factor authentication.

### 27.2.1 Building Matplotlib for image comparison tests

Matplotlib's test suite makes heavy use of image comparison tests, meaning the result of a plot is compared against a known good result. Unfortunately, different versions of FreeType produce differently formed characters, causing these image comparisons to fail. To make them reproducible, Matplotlib can be built with a special local copy of FreeType. This is recommended for all Matplotlib developers.

Copy `setup.cfg.template` to `setup.cfg` and edit it to contain:

```
[test]
local_freetype = True
tests = True
```

or set the `MPLLOCALFREETYPE` environmental variable to any true value.

### 27.2.2 Installing Matplotlib in developer mode

To install Matplotlib (and compile the C-extensions) run the following command from the top-level directory

```
python -mpip install -ve .
```

This installs Matplotlib in 'editable/develop mode', i.e., builds everything and places the correct link entries in the install directory so that python will be able to import Matplotlib from the source directory. Thus, any changes to the `*.py` files will be reflected the next time you

import the library. If you change the C-extension source (which might happen if you change branches) you will need to run

```
python setup.py build
```

or re-run `python -mpip install -ve ..`

Alternatively, if you do

```
python -mpip install -v .
```

all of the files will be copied to the installation directory however, you will have to rerun this command every time the source is changed. Additionally you will need to copy `setup.cfg.template` to `setup.cfg` and edit it to contain

```
[test]
local_freetype = True
tests = True
```

In either case you can then run the tests to check your work environment is set up properly:

```
pytest
```

---

**Note: Additional dependencies for testing:** [pytest](#) (version 3.6 or later), [Ghostscript](#), [Inkscape](#)

---

### See also:

- *Developer's tips for testing*

## 27.3 Contributing code

### 27.3.1 How to contribute

The preferred way to contribute to Matplotlib is to fork the [main repository](#) on GitHub, then submit a "pull request" (PR).

The best practices for using GitHub to make PRs to Matplotlib are documented in the *Development workflow* section.

A brief overview is:

1. [Create an account](#) on GitHub if you do not already have one.
2. Fork the [project repository](#): click on the 'Fork' button near the top of the page. This creates a copy of the code under your account on the GitHub server.
3. Clone this copy to your local disk:

```
$ git clone https://github.com/YourLogin/matplotlib.git
```

4. Create a branch to hold your changes:

```
$ git checkout -b my-feature origin/master
```

and start making changes. Never work in the master branch!

5. Work on this copy, on your computer, using Git to do the version control. When you're done editing e.g., `lib/matplotlib/collections.py`, do:

```
$ git add lib/matplotlib/collections.py
$ git commit
```

to record your changes in Git, then push them to GitHub with:

```
$ git push -u origin my-feature
```

Finally, go to the web page of your fork of the Matplotlib repo, and click 'Pull request' to send your changes to the maintainers for review. You may want to consider sending an email to the mailing list for more visibility.

**See also:**

- [Git documentation](#)
- [Git-Contributing to a Project](#)
- [Introduction to Github](#)
- *Development workflow.*
- *Working with Matplotlib source code*

### 27.3.2 Contributing pull requests

It is recommended to check that your contribution complies with the following rules before submitting a pull request:

- If your pull request addresses an issue, please use the title to describe the issue and mention the issue number in the pull request description to ensure that a link is created to the original issue.
- All public methods should have informative docstrings with sample usage when appropriate. Use the [numpy docstring standard](#).
- Formatting should follow the recommendations of [PEP8](#). You should consider installing/enabling automatic PEP8 checking in your editor. Part of the test suite is checking PEP8 compliance, things go smoother if the code is mostly PEP8 compliant to begin with.
- Each high-level plotting function should have a simple example in the `Example` section of the docstring. This should be as simple as possible to demonstrate the method. More complex examples should go in the `examples` tree.
- Changes (both new features and bugfixes) should be tested. See *Developer's tips for testing* for more details.
- Import the following modules using the standard scipy conventions:

```
import numpy as np
import numpy.ma as ma
import matplotlib as mpl
import matplotlib.pyplot as plt
```

(continues on next page)

(continued from previous page)

```
import matplotlib.cbook as cbook
import matplotlib.patches as mpatches
```

- If your change is a major new feature, add an entry to the What's new section by adding a new file in `doc/users/next_whats_new` (see `doc/users/next_whats_new/README.rst` for more information).
- If you change the API in a backward-incompatible way, please document it in `doc/api/api_changes`, by adding a new file describing your changes (see `doc/api/api_changes/README.rst` for more information)
- See below for additional points about *Keyword argument processing*, if applicable for your pull request.

In addition, you can check for common programming errors with the following tools:

- Code with a good unittest coverage (at least 70%, better 100%), check with:

```
python -mpip install coverage
pytest --cov=matplotlib --showlocals -v
```

- No pyflakes warnings, check with:

```
python -mpip install pyflakes
pyflakes path/to/module.py
```

---

**Note:** The current state of the Matplotlib code base is not compliant with all of those guidelines, but we expect that enforcing those constraints on all new contributions will move the overall code base quality in the right direction.

---

#### See also:

- *Coding guidelines*
- *Developer's tips for testing*
- *Writing documentation*

### 27.3.3 Issues for New Contributors

New contributors should look for the following tags when looking for issues. We strongly recommend that new contributors tackle issues labeled [good first issue](#) as they are easy, well documented issues, that do not require an understanding of the different submodules of Matplotlib. This helps the contributor become familiar with the contribution workflow, and for the core devs to become acquainted with the contributor; besides which, we frequently underestimate how easy an issue is to solve!

## 27.4 Other ways to contribute

Code is not the only way to contribute to Matplotlib. For instance, documentation is also a very important part of the project and often doesn't get as much attention as it deserves. If you find a typo in the documentation, or have made improvements, do not hesitate to send an

email to the mailing list or submit a GitHub pull request. Full documentation can be found under the `doc/` directory.

It also helps us if you spread the word: reference the project from your blog and articles or link to it from your website!

## 27.5 Coding guidelines

### 27.5.1 New modules and files: installation

- If you have added new files or directories, or reorganized existing ones, make sure the new files are included in the match patterns in `MANIFEST.in`, and/or in `package_data` in `setup.py`.

### 27.5.2 C/C++ extensions

- Extensions may be written in C or C++.
- Code style should conform to PEP7 (understanding that PEP7 doesn't address C++, but most of its admonitions still apply).
- Python/C interface code should be kept separate from the core C/C++ code. The interface code should be named `FOO_wrap.cpp` or `FOO_wrapper.cpp`.
- Header file documentation (aka docstrings) should be in Numpydoc format. We don't plan on using automated tools for these docstrings, and the Numpydoc format is well understood in the scientific Python community.

### 27.5.3 Keyword argument processing

Matplotlib makes extensive use of `**kwargs` for pass-through customizations from one function to another. A typical example is in `matplotlib.pyplot.text()`. The definition of the `pylab` `text` function is a simple pass-through to `matplotlib.axes.Axes.text()`:

```
# in pylab.py
def text(*args, **kwargs):
    ret = gca().text(*args, **kwargs)
    draw_if_interactive()
    return ret
```

`text()` in simplified form looks like this, i.e., it just passes all `args` and `kwargs` on to `matplotlib.text.Text.__init__()`:

```
# in axes/_axes.py
def text(self, x, y, s, fontdict=None, withdash=False, **kwargs):
    t = Text(x=x, y=y, text=s, **kwargs)
```

and `__init__()` (again with liberties for illustration) just passes them on to the `matplotlib.artist.Artist.update()` method:

```
# in text.py
def __init__(self, x=0, y=0, text='', **kwargs):
    Artist.__init__(self)
    self.update(kwargs)
```

update does the work looking for methods named like `set_property` if `property` is a keyword argument. i.e., no one looks at the keywords, they just get passed through the API to the artist constructor which looks for suitably named methods and calls them with the value.

As a general rule, the use of `**kwargs` should be reserved for pass-through keyword arguments, as in the example above. If all the keyword args are to be used in the function, and not passed on, use the key/value keyword args in the function definition rather than the `**kwargs` idiom.

In some cases, you may want to consume some keys in the local function, and let others pass through. Instead of popping arguments to use off `**kwargs`, specify them as keyword-only arguments to the local function. This makes it obvious at a glance which arguments will be consumed in the function. For example, in `plot()`, `scalex` and `scaley` are local arguments and the rest are passed on as `Line2D()` keyword arguments:

```
# in axes/_axes.py
def plot(self, *args, scalex=True, scaley=True, **kwargs):
    lines = []
    for line in self._get_lines(*args, **kwargs):
        self.add_line(line)
        lines.append(line)
```

#### 27.5.4 Using logging for debug messages

Matplotlib uses the standard python `logging` library to write verbose warnings, information, and debug messages. Please use it! In all those places you write `print()` statements to do your debugging, try using `log.debug()` instead!

To include `logging` in your module, at the top of the module, you need to `import logging`. Then calls in your code like:

```
_log = logging.getLogger(__name__) # right after the imports

# code
# more code
_log.info('Here is some information')
_log.debug('Here is some more detailed information')
```

will log to a logger named `matplotlib.yourmodulename`.

If an end-user of Matplotlib sets up `logging` to display at levels more verbose than `logger.WARNING` in their code with the Matplotlib-provided helper:

```
plt.set_loglevel("debug")
```

or manually with

```
import logging
logging.basicConfig(level=logging.DEBUG)
import matplotlib.pyplot as plt
```

Then they will receive messages like:

```
DEBUG:matplotlib.backends:backend MacOSX version unknown
DEBUG:matplotlib.yourmodulename:Here is some information
DEBUG:matplotlib.yourmodulename:Here is some more detailed information
```

### Which logging level to use?

There are five levels at which you can emit messages.

- `logging.critical` and `logging.error` are really only there for errors that will end the use of the library but not kill the interpreter.
- `logging.warning` and `cbook._warn_external` are used to warn the user, see below.
- `logging.info` is for information that the user may want to know if the program behaves oddly. They are not displayed by default. For instance, if an object isn't drawn because its position is NaN, that can usually be ignored, but a mystified user could call `logging.basicConfig(level=logging.INFO)` and get an error message that says why.
- `logging.debug` is the least likely to be displayed, and hence can be the most verbose. "Expected" code paths (e.g., reporting normal intermediate steps of layouting or rendering) should only log at this level.

By default, `logging` displays all log messages at levels higher than `logging.WARNING` to `sys.stderr`.

The [logging tutorial](#) suggests that the difference between `logging.warning` and `cbook._warn_external` (which uses `warnings.warn`) is that `cbook._warn_external` should be used for things the user must change to stop the warning (typically in the source), whereas `logging.warning` can be more persistent. Moreover, note that `cbook._warn_external` will by default only emit a given warning *once* for each line of user code, whereas `logging.warning` will display the message every time it is called.

By default, `warnings.warn` displays the line of code that has the warn call. This usually isn't more informative than the warning message itself. Therefore, Matplotlib uses `cbook._warn_external` which uses `warnings.warn`, but goes up the stack and displays the first line of code outside of Matplotlib. For example, for the module:

```
# in my_matplotlib_module.py
import warnings

def set_range(bottom, top):
    if bottom == top:
        warnings.warn('Attempting to set identical bottom==top')
```

running the script:

```
from matplotlib import my_matplotlib_module
my_matplotlib_module.set_range(0, 0) #set range
```

will display:

```
UserWarning: Attempting to set identical bottom==top
warnings.warn('Attempting to set identical bottom==top')
```

Modifying the module to use `cbook._warn_external`:

```

from matplotlib import cbook

def set_range(bottom, top):
    if bottom == top:
        cbook._warn_external('Attempting to set identical bottom==top')

```

and running the same script will display:

```

UserWarning: Attempting to set identical bottom==top
my_matplotlib_module.set_range(0, 0) #set range

```

### 27.5.5 Developing a new backend

If you are working on a custom backend, the *backend* setting in `matplotlibrc` (*Customizing Matplotlib with style sheets and rcParams*) supports an external backend via the `module` directive. If `my_backend.py` is a Matplotlib backend in your `PYTHONPATH`, you can set it on one of several ways

- in `matplotlibrc`:

```
backend : module://my_backend
```

- with the `MPLBACKEND` environment variable:

```

> export MPLBACKEND="module://my_backend"
> python simple_plot.py

```

- with the `use` directive in your script:

```

import matplotlib
matplotlib.use('module://my_backend')

```

### 27.5.6 Writing examples

We have hundreds of examples in subdirectories of `matplotlib/examples`, and these are automatically generated when the website is built to show up in the `examples` section of the website.

Any sample data that the example uses should be kept small and distributed with Matplotlib in the `lib/matplotlib/mpl-data/sample_data/` directory. Then in your example code you can load it into a file handle with:

```

import matplotlib.cbook as cbook
fh = cbook.get_sample_data('mydata.dat')

```



## DEVELOPER'S TIPS FOR TESTING

Matplotlib's testing infrastructure depends on `pytest`. The tests are in `lib/matplotlib/tests`, and customizations to the `pytest` testing infrastructure are in `matplotlib.testing`.

### 28.1 Requirements

Install the latest version of Matplotlib as documented in *Retrieving and installing the latest version of the code*. In particular, follow the instructions to use a local FreeType build.

The following software is required to run the tests:

- `pytest` ( $\geq 3.6$ )
- `Ghostscript` ( $\geq 9.0$ , to render PDF files)
- `Inkscape` (to render SVG files)

Optionally you can install:

- `pytest-cov` ( $\geq 2.3.1$ ) to collect coverage information
- `pytest-pep8` to test coding standards
- `pytest-timeout` to limit runtime in case of stuck tests
- `pytest-xdist` to run tests in parallel

### 28.2 Running the tests

Running the tests is simple. Make sure you have `pytest` installed and run:

```
pytest
```

or:

```
pytest .
```

in the root directory of the distribution. The script takes a set of commands, such as:

<code>--pep8</code>	Perform pep8 checks (requires <code>pytest-pep8</code> )
<code>-m "not network"</code>	Disable tests that require network access

Additional arguments are passed on to pytest. See the pytest documentation for [supported arguments](#). Some of the more important ones are given here:

<code>--verbose</code>	Be more verbose
<code>--n NUM</code>	Run tests in parallel over NUM processes (requires <a href="#">pytest-xdist</a> )
<code>--timeout=SECONDS</code>	Set timeout for results from each test process (requires <a href="#">pytest-timeout</a> )
<code>--capture=no</code> or <code>-s</code>	Do not capture stdout

To run a single test from the command line, you can provide a file path, optionally followed by the function separated by two colons, e.g., (tests do not need to be installed, but Matplotlib should be):

```
pytest lib/matplotlib/tests/test_simplification.py::test_clipping
```

or, if tests are installed, a dot-separated path to the module, optionally followed by the function separated by two colons, such as:

```
pytest --pyargs matplotlib.tests.test_simplification::test_clipping
```

If you want to run the full test suite, but want to save wall time try running the tests in parallel:

```
pytest --verbose -n 5
```

Depending on your version of Python and `pytest-xdist`, you may need to set `PYTHONHASHSEED` to a fixed value when running in parallel:

```
PYTHONHASHSEED=0 pytest --verbose -n 5
```

An alternative implementation that does not look at command line arguments and works from within Python is to run the tests from the Matplotlib library function `matplotlib.test()`:

```
import matplotlib
matplotlib.test()
```

## 28.3 Writing a simple test

Many elements of Matplotlib can be tested using standard tests. For example, here is a test from `matplotlib.tests.test_basic`:

```
def test_simple():
    """
    very simple example test
    """
    assert 1 + 1 == 2
```

Pytest determines which functions are tests by searching for files whose names begin with "test\_" and then within those files for functions beginning with "test" or classes beginning with "Test".

Some tests have internal side effects that need to be cleaned up after their execution (such as created figures or modified rc params). The pytest fixture `mpl_test_settings()` will automatically clean these up; there is no need to do anything further.

## 28.4 Random data in tests

Random data is a very convenient way to generate data for examples, however the randomness is problematic for testing (as the tests must be deterministic!). To work around this set the seed in each test. For numpy use:

```
import numpy as np
np.random.seed(19680801)
```

and Python's random number generator:

```
import random
random.seed(19680801)
```

The seed is John Hunter's birthday.

## 28.5 Writing an image comparison test

Writing an image-based test is only slightly more difficult than a simple test. The main consideration is that you must specify the "baseline", or expected, images in the *image\_comparison* decorator. For example, this test generates a single image and automatically tests it:

```
from matplotlib.testing.decorators import image_comparison
import matplotlib.pyplot as plt

@image_comparison(baseline_images=['line_dashes'], remove_text=True,
                  extensions=['png'])
def test_line_dashes():
    fig, ax = plt.subplots()
    ax.plot(range(10), linestyle=(0, (3, 3)), lw=5)
```

The first time this test is run, there will be no baseline image to compare against, so the test will fail. Copy the output images (in this case `result_images/test_lines/test_line_dashes.png`) to the correct subdirectory of `baseline_images` tree in the source directory (in this case `lib/matplotlib/tests/baseline_images/test_lines`). Put this new file under source code revision control (with `git add`). When rerunning the tests, they should now pass.

Baseline images take a lot of space in the Matplotlib repository. An alternative approach for image comparison tests is to use the *check\_figures\_equal* decorator, which should be used to decorate a function taking two `Figure` parameters and draws the same images on the figures using two different methods (the tested method and the baseline method). The decorator will arrange for setting up the figures and then collect the drawn results and compare them.

See the documentation of *image\_comparison* and *check\_figures\_equal* for additional information about their use.

## 28.6 Known failing tests

If you're writing a test, you may mark it as a known failing test with the `pytest.mark.xfail()` decorator. This allows the test to be added to the test suite and run on the buildbots without

causing undue alarm. For example, although the following test will fail, it is an expected failure:

```
import pytest

@pytest.mark.xfail
def test_simple_fail():
    '''very simple example test that should fail'''
    assert 1 + 1 == 3
```

Note that the first argument to the `xfail()` decorator is a fail condition, which can be a value such as `True`, `False`, or may be a dynamically evaluated expression. If a condition is supplied, then a reason must also be supplied with the `reason='message'` keyword argument.

## 28.7 Creating a new module in `matplotlib.tests`

We try to keep the tests categorized by the primary module they are testing. For example, the tests related to the `mathtext.py` module are in `test_mathtext.py`.

## 28.8 Using Travis CI

Travis CI is a hosted CI system “in the cloud”.

Travis is configured to receive notifications of new commits to GitHub repos (via GitHub “service hooks”) and to run builds or tests when it sees these new commits. It looks for a YAML file called `.travis.yml` in the root of the repository to see how to test the project.

Travis CI is already enabled for the [main matplotlib GitHub repository](#) - for example, see its [Travis page](#).

If you want to enable Travis CI for your personal Matplotlib GitHub repo, simply enable the repo to use Travis CI in either the Travis CI UI or the GitHub UI (Admin | Service Hooks). For details, see [the Travis CI Getting Started page](#). This generally isn’t necessary, since any pull request submitted against the main Matplotlib repository will be tested.

Once this is configured, you can see the Travis CI results at [https://travis-ci.org/your\\_GitHub\\_user\\_name/matplotlib](https://travis-ci.org/your_GitHub_user_name/matplotlib) - [here’s an example](#).

## 28.9 Using tox

Tox is a tool for running tests against multiple Python environments, including multiple versions of Python (e.g., 3.6, 3.7) and even different Python implementations altogether (e.g., CPython, PyPy, Jython, etc.), as long as all these versions are available on your system’s `$PATH` (consider using your system package manager, e.g. `apt-get`, `yum`, or Homebrew, to install them).

tox makes it easy to determine if your working copy introduced any regressions before submitting a pull request. Here’s how to use it:

```
$ pip install tox
$ tox
```

You can also run tox on a subset of environments:

```
$ tox -e py36,py37
```

Tox processes everything serially so it can take a long time to test several environments. To speed it up, you might try using a new, parallelized version of tox called `detox`. Give this a try:

```
$ pip install -U -i http://pypi.testrun.org detox
$ detox
```

Tox is configured using a file called `tox.ini`. You may need to edit this file if you want to add new environments to test (e.g., `py33`) or if you want to tweak the dependencies or the way the tests are run. For more info on the `tox.ini` file, see the [Tox Configuration Specification](#).

## 28.10 Building old versions of Matplotlib

When running a `git bisect` to see which commit introduced a certain bug, you may (rarely) need to build very old versions of Matplotlib. The following constraints need to be taken into account:

- Matplotlib 1.3 (or earlier) requires numpy 1.8 (or earlier).



## WRITING DOCUMENTATION

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## 29.1 Getting started

### 29.1.1 General file structure

All documentation is built from the `doc/` directory. This directory contains both reStructuredText (ReST; `.rst`) files that contain pages in the documentation and configuration files for Sphinx.

The `.rst` files are kept in `doc/users`, `doc/devel`, `doc/api` and `doc/faq`. The main entry point is `doc/index.rst`, which pulls in the `index.rst` file for the users guide, developers guide, api reference, and FAQs. The documentation suite is built as a single document in order to make the most effective use of cross referencing.

Sphinx also creates `.rst` files that are staged in `doc/api` from the docstrings of the classes in the Matplotlib library. Except for `doc/api/api_changes/`, these `.rst` files are created when the documentation is built.

Similarly, the contents of `doc/gallery` and `doc/tutorials` are generated by the [Sphinx Gallery](#) from the sources in `examples` and `tutorials`. These sources consist of python scripts that have ReST documentation built into their comments. Don't directly edit the `.rst` files in `doc/gallery` and `doc/tutorials` as they are regenerated when the documentation are built.

### 29.1.2 Installing dependencies

The documentation for Matplotlib is generated from reStructuredText (ReST) using the Sphinx documentation generation tool. There are several extra requirements that are needed to build the documentation. They are listed in `doc-requirements.txt`, which is shown below:

```
# Requirements for building docs
#
# You will first need a matching Matplotlib installation
# e.g (from the Matplotlib root directory)
#     pip install -e .
#
# Install the documentation requirements with:
#     pip install -r requirements/doc/doc-requirements.txt
#
sphinx>=1.3,!1.5.0,!1.6.4,!1.7.3,!1.8.0,<2.0.0
colorspacious
```

(continues on next page)

(continued from previous page)

```
ipython
ipywidgets
numpydoc>=0.8
pillow>=3.4,!5.4.0
sphinx-gallery>=0.2
sphinx-copybutton
```

**Note:**

- You'll need a minimal working LaTeX distribution for many examples to run.
- [Graphviz](#) is not a Python package, and needs to be installed separately.

### 29.1.3 Building the docs

The documentation sources are found in the `doc/` directory in the trunk. The configuration file for Sphinx is `doc/conf.py`. It controls which directories Sphinx parses, how the docs are built, and how the extensions are used. To build the documentation in html format, `cd` into `doc/` and run:

```
make html
```

Other useful invocations include

```
# Delete built files. May help if you get errors about missing paths or
# broken links.
make clean

# Build pdf docs.
make latexpdf
```

The `SPHINXOPTS` variable is set to `-w` by default to turn warnings into errors. To unset it, use

```
make SPHINXOPTS= html
```

You can use the `O` variable to set additional options:

- `make O=-j4 html` runs a parallel build with 4 processes.
- `make O=-Dplot_formats=png:100 html` saves figures in low resolution.
- `make O=-Dplot_gallery=0 html` skips the gallery build.

Multiple options can be combined using e.g. `make O='-j4 -Dplot_gallery=0' html`.

On Windows, options needs to be set as environment variables, e.g. `set O=-W -j4 & make html`.

## 29.2 Writing ReST pages

Most documentation is either in the docstring of individual classes and methods, in explicit `.rst` files, or in examples and tutorials. All of these use the [ReST](#) syntax. Users should look

at the [ReST](#) documentation for a full description. But some specific hints and conventions Matplotlib uses are useful for creating documentation.

### 29.2.1 Formatting and style conventions

It is useful to strive for consistency in the Matplotlib documentation. Here are some formatting and style conventions that are used.

#### Section name formatting

For everything but top-level chapters, use Upper lower for section titles, e.g., Possible hangups rather than Possible Hangups

#### Function arguments

Function arguments and keywords within docstrings should be referred to using the *\*emphasis\** role. This will keep Matplotlib's documentation consistent with Python's documentation:

```
Here is a description of *argument*
```

Do not use the ``default`` role:

```
Do not describe `argument` like this. As per the next section, this syntax will (unsuccessfully) attempt to resolve the argument as a link to a class or method in the library.
```

nor the ```literal``` role:

```
Do not describe ``argument`` like this.
```

### 29.2.2 Referring to other documents and sections

[Sphinx](#) allows internal [references](#) between documents.

Documents can be linked with the `:doc:` directive:

```
See the :doc:`/faq/installing_faq`  
See the tutorial :doc:`/tutorials/introductory/sample_plots`  
See the example :doc:`/gallery/lines_bars_and_markers/simple_plot`
```

will render as:

See the *Installation*

See the tutorial *Sample plots in Matplotlib*

See the example `/gallery/lines_bars_and_markers/simple_plot`

Sections can also be given reference names. For instance from the *Installation* link:

```
.. _clean-install:
```

```
How to completely remove Matplotlib
```

```
=====
```

```
Occasionally, problems with Matplotlib can be solved with a clean...
```

and refer to it using the standard reference syntax:

```
See :ref:`clean-install`
```

will give the following link: *How to completely remove Matplotlib*

To maximize internal consistency in section labeling and references, use hyphen separated, descriptive labels for section references. Keep in mind that contents may be reorganized later, so avoid top level names in references like `user` or `devel` or `faq` unless necessary, because for example the FAQ "what is a backend?" could later become part of the users guide, so the label:

```
.. _what-is-a-backend:
```

is better than:

```
.. _faq-backend:
```

In addition, since underscores are widely used by Sphinx itself, use hyphens to separate words.

### 29.2.3 Referring to other code

To link to other methods, classes, or modules in Matplotlib you can use back ticks, for example:

```
`matplotlib.collections.LineCollection`
```

generates a link like this: *matplotlib.collections.LineCollection*.

*Note:* We use the sphinx setting `default_role = 'obj'` so that you don't have to use qualifiers like `:class:`, `:func:`, `:meth:` and the likes.

Often, you don't want to show the full package and module name. As long as the target is unambiguous you can simply leave them out:

```
`LineCollection`
```

and the link still works: *LineCollection*.

If there are multiple code elements with the same name (e.g. `plot()` is a method in multiple classes), you'll have to extend the definition:

```
`pyplot.plot` or `Axes.plot`
```

These will show up as *pyplot.plot* or *Axes.plot*. To still show only the last segment you can add a tilde as prefix:

```
`~.pyplot.plot` or `~.Axes.plot`
```

will render as *plot* or *plot*.

Other packages can also be linked via [intersphinx](#):

```
`numpy.mean`
```

will return this link: [numpy.mean](#). This works for Python, Numpy, Scipy, and Pandas (full list is in `doc/conf.py`). Sometimes it is tricky to get external Sphinx linking to work; to check that something exists to link to the following shell command outputs a list of all objects that can be referenced (in this case for Numpy):

```
python -m sphinx.ext.intersphinx 'https://docs.scipy.org/doc/numpy/objects.inv'
```

### 29.2.4 Including figures and files

Image files can directly included in pages with the `image::` directive. e.g., `users/navigation_toolbar.rst` displays the toolbar icons with a call to a static image:

```
.. image:: ../_static/toolbar.png
```

as rendered on the page: *Interactive navigation*.

Files can be included verbatim. For instance the `matplotlibrc` file is important for customizing Matplotlib, and is included verbatim in the tutorial in *Customizing Matplotlib with style sheets and rcParams*:

```
.. literalinclude:: ../../_static/matplotlibrc
```

This is rendered at the bottom of *Customizing Matplotlib with style sheets and rcParams*. Note that this is in a tutorial; see *Writing examples and tutorials* below.

The examples directory is also copied to `doc/gallery` by `sphinx-gallery`, so plots from the examples directory can be included using

```
.. plot:: gallery/lines_bars_and_markers/simple_plot.py
```

Note that the python script that generates the plot is referred to, rather than any plot that is created. `Sphinx-gallery` will provide the correct reference when the documentation is built.

## 29.3 Writing docstrings

Most of the API documentation is written in docstrings. These are comment blocks in source code that explain how the code works.

---

**Note:** Some parts of the documentation do not yet conform to the current documentation style. If in doubt, follow the rules given here and not what you may see in the source code. Pull requests updating docstrings to the current style are very welcome.

---

All new or edited docstrings should conform to the [numpydoc docstring guide](#). Much of the ReST syntax discussed above (*Writing ReST pages*) can be used for links and references. These docstrings eventually populate the `doc/api` directory and form the reference documentation for the library.

### 29.3.1 Example docstring

An example docstring looks like:

```
def hlines(self, y, xmin, xmax, colors='k', linestyle='solid',
           label='', **kwargs):
    """
    Plot horizontal lines at each *y* from *xmin* to *xmax*.

    Parameters
    -----
    y : float or array-like
        y-indices where to plot the lines.

    xmin, xmax : float or array-like
        Respective beginning and end of each line. If scalars are
        provided, all lines will have the same length.

    colors : array-like of colors, optional, default: 'k'

    linestyle : {'solid', 'dashed', 'dashdot', 'dotted'}, optional

    label : string, optional, default: ''

    Returns
    -----
    lines : ~matplotlib.collections.LineCollection`

    Other Parameters
    -----
    **kwargs : ~matplotlib.collections.LineCollection` properties.

    See also
    -----
    vlines : vertical lines
    axhline: horizontal line across the axes
    """
```

See the `hlines` documentation for how this renders.

The [Sphinx](#) website also contains plenty of [documentation](#) concerning ReST markup and working with Sphinx in general.

### 29.3.2 Formatting conventions

The basic docstring conventions are covered in the [numpydoc docstring guide](#) and the [Sphinx](#) documentation. Some Matplotlib-specific formatting conventions to keep in mind:

### Function arguments

Function arguments and keywords within docstrings should be referred to using the *\*emphasis\** role. This will keep Matplotlib's documentation consistent with Python's documentation:

```
If *linestyles* is *None*, the 'solid' is used.
```

Do not use the ``default`` role or the ```literal``` role:

```
Neither `argument` nor ``argument`` should be used.
```

### Quotes for strings

Matplotlib does not have a convention whether to use single-quotes or double-quotes. There is a mixture of both in the current code.

Use simple single or double quotes when giving string values, e.g.

```
If 'tight', try to figure out the tight bbox of the figure.
```

### Parameter type descriptions

The main goal for parameter type descriptions is to be readable and understandable by humans. If the possible types are too complex use a simplification for the type description and explain the type more precisely in the text.

Generally, the [numpydoc docstring guide](#) conventions apply. The following rules expand on them where the numpydoc conventions are not specific.

Use `float` for a type that can be any number.

Use `(float, float)` to describe a 2D position.

Use `array-like` for homogeneous numeric sequences, which could typically be a `numpy.array`. Dimensionality may be specified using `2D`, `3D`, `n-dimensional`. If you need to have variables denoting the sizes of the dimensions, use capital letters in brackets (`array-like (M, N)`). When referring to them in the text they are easier read and no special formatting is needed.

`float` is the implicit default dtype for array-likes. For other dtypes use `array-like of int`.

Some possible uses:

```
2D array-like
array-like (N)
array-like (M, N)
array-like (M, N, 3)
array-like of int
```

Non-numeric homogeneous sequences are described as lists, e.g.:

```
list of str
list of .Artist`
```

## Referencing types

Generally, the rules from *referring-to-other-code* apply. More specifically:

Use full references `~matplotlib.colors.Normalize`` with an abbreviation tilde in parameter types. While the full name helps the reader of plain text docstrings, the HTML does not need to show the full name as it links to it. Hence, the `--shortening` keeps it more readable.

Use abbreviated links `.Normalize`` in the text.

```
norm : `~matplotlib.colors.Normalize`, optional
      A .Normalize` instance is used to scale luminance data to 0, 1.
```

## See also sections

Sphinx automatically links code elements in the definition blocks of See also sections. No need to use backticks there:

```
See also
-----
vlines : vertical lines
axhline: horizontal line across the axes
```

## Wrapping parameter lists

Long parameter lists should be wrapped using a `\` for continuation and starting on the new line without any indent (no indent because pydoc will parse the docstring and strip the line continuation so that indent would result in a lot of whitespace within the line):

```
def add_axes(self, *args, **kwargs):
    """
    ...

    Parameters
    -----
    projection : {'aitoff', 'hammer', 'lambert', 'mollweide', 'polar', \
'rectilinear'}, optional
        The projection type of the axes.

    ...
    """
```

Alternatively, you can describe the valid parameter values in a dedicated section of the docstring.

## rcParams

rcParams can be referenced with the custom `:rc:` role: `:rc:`foo`` yields `rcParams["foo"]`. Use `= [default-val]` to indicate the default value of the parameter. The default value should be literal, i.e. enclosed in double backticks. For simplicity these may be omitted for string default values.

```
If not provided, defaults to :rc:`figure.(figsize` = ``[6.4, 4.8]``.
If not provided, defaults to :rc:`figure.facecolor` = 'w'.
```

### 29.3.3 Deprecated formatting conventions

Formerly, we have used square brackets for explicit parameter lists ['solid' | 'dashed' | 'dotted']. With numpydoc we have switched to their standard using curly braces {'solid', 'dashed', 'dotted'}.

### 29.3.4 Setters and getters

Artist properties are implemented using setter and getter methods (because Matplotlib pre-dates the introductions of the `property` decorator in Python). By convention, these setters and getters are named `set_PROPERTYNAME` and `get_PROPERTYNAME`; the list of properties thusly defined on an artist and their values can be listed by the `setp` and `getp` functions.

**Note:** ACCEPTS blocks have recently become optional. You may now use a numpydoc Parameters block because the accepted values can now be read from the type description of the first parameter.

Property setter methods should indicate the values they accept using a (legacy) special block in the docstring, starting with ACCEPTS, as follows:

```
# in lines.py
def set_linestyle(self, linestyle):
    """
    Set the linestyle of the line

    ACCEPTS: [ '-' | '--' | '-.' | ':' | 'steps' | 'None' | ' ' | '' ]
    """
```

The ACCEPTS block is used to render a table of all properties and their acceptable values in the docs; it can also be displayed using, e.g., `plt.setp(Line2D)` (all properties) or `plt.setp(Line2D, 'linestyle')` (just one property).

There are cases in which the ACCEPTS string is not useful in the generated Sphinx documentation, e.g. if the valid parameters are already defined in the numpydoc parameter list. You can hide the ACCEPTS string from Sphinx by making it a ReST comment (i.e. use `.. ACCEPTS:`):

```
def set_linestyle(self, linestyle):
    """
    An ACCEPTS string invisible to Sphinx.

    .. ACCEPTS: [ '-' | '--' | '-.' | ':' | 'steps' | 'None' | ' ' | '' ]
    """
```

### 29.3.5 Keyword arguments

---

**Note:** The information in this section is being actively discussed by the development team, so use the docstring interpolation only if necessary. This section has been left in place for now because this interpolation is part of the existing documentation.

---

Since Matplotlib uses a lot of pass-through kwargs, e.g., in every function that creates a line (*plot*, *semilogx*, *semilogy*, etc...), it can be difficult for the new user to know which kwargs are supported. Matplotlib uses a docstring interpolation scheme to support documentation of every function that takes a *\*\*kwargs*. The requirements are:

1. single point of configuration so changes to the properties don't require multiple docstring edits.
2. as automated as possible so that as properties change, the docs are updated automatically.

The function `matplotlib.artist.kwdoc` and the decorator `matplotlib.docstring.dedent_interpd` facilitate this. They combine Python string interpolation in the docstring with the Matplotlib artist introspection facility that underlies `setp` and `getp`. The `kwdoc` function gives the list of properties as a docstring. In order to use this in another docstring, first update the `matplotlib.docstring.interpd` object, as seen in this example from `matplotlib.lines`:

```
# in lines.py
docstring.interpd.update(Line2D=artist.kwdoc(Line2D))
```

Then in any function accepting *Line2D* pass-through kwargs, e.g., `matplotlib.axes.Axes.plot`:

```
# in axes.py
@docstring.dedent_interpd
def plot(self, *args, **kwargs):
    """
    Some stuff omitted

    The kwargs are Line2D properties:
    %(_Line2D_docstr)s

    kwargs scalex and scaley, if defined, are passed on
    to autoscale_view to determine whether the x and y axes are
    autoscaled; default True. See Axes.autoscale_view for more
    information
    """
```

Note there is a problem for *Artist* `__init__` methods, e.g., `matplotlib.patches.Patch.__init__`, which supports *Patch* kwargs, since the artist inspector cannot work until the class is fully defined and we can't modify the `Patch.__init__.__doc__` docstring outside the class definition. There are some manual hacks in this case, violating the "single entry point" requirement above - see the `docstring.interpd.update` calls in `matplotlib.patches`.

### 29.3.6 Inheriting docstrings

If a subclass overrides a method but does not change the semantics, we can reuse the parent docstring for the method of the child class. Python does this automatically, if the subclass method does not have a docstring.

Use a plain comment `# docstring inherited` to denote the intention to reuse the parent docstring. That way we do not accidentally create a docstring in the future:

```
class A:
    def foo():
        """The parent docstring."""
        pass

class B(A):
    def foo():
        # docstring inherited
        pass
```

### 29.3.7 Adding figures

As above (see *Including figures and files*), figures in the examples gallery can be referenced with a `:plot:` directive pointing to the python script that created the figure. For instance the *legend* docstring references the file `examples/text_labels_and_annotations/legend.py`:

```
"""
...

Examples
-----

.. plot:: gallery/text_labels_and_annotations/legend.py
"""
```

Note that `examples/text_labels_and_annotations/legend.py` has been mapped to `gallery/text_labels_and_annotations/legend.py`, a redirection that may be fixed in future re-organization of the docs.

Plots can also be directly placed inside docstrings. Details are in *Plot directive documentation*. A short example is:

```
"""
...

Examples
-----

.. plot::
    import matplotlib.image as mpimg
    img = mpimg.imread('_static/stinkbug.png')
    imgplot = plt.imshow(img)
"""
```

An advantage of this style over referencing an example script is that the code will also appear in interactive docstrings.

## 29.4 Writing examples and tutorials

Examples and tutorials are python scripts that are run by [Sphinx Gallery](#) to create a gallery of images in the `/doc/gallery` and `/doc/tutorials` directories respectively. To exclude an example from having an plot generated insert "sgskip" somewhere in the filename.

The format of these files is relatively straightforward. Properly formatted comment blocks are treated as [ReST](#) text, the code is displayed, and figures are put into the built page.

For instance the example `/gallery/lines_bars_and_markers/simple_plot` example is generated from `/examples/lines_bars_and_markers/simple_plot.py`, which looks like:

```
"""
=====
Simple Plot
=====

Create a simple plot.
"""
import matplotlib.pyplot as plt
import numpy as np

# Data for plotting
t = np.arange(0.0, 2.0, 0.01)
s = 1 + np.sin(2 * np.pi * t)

# Note that using plt.subplots below is equivalent to using
# fig = plt.figure and then ax = fig.add_subplot(111)
fig, ax = plt.subplots()
ax.plot(t, s)

ax.set(xlabel='time (s)', ylabel='voltage (mV)',
       title='About as simple as it gets, folks')
ax.grid()
plt.show()
```

The first comment block is treated as [ReST](#) text. The other comment blocks render as comments in `/gallery/lines_bars_and_markers/simple_plot`.

Tutorials are made with the exact same mechanism, except they are longer, and typically have more than one comment block (i.e. *Usage Guide*). The first comment block can be the same as the example above. Subsequent blocks of [ReST](#) text are delimited by a line of `###` characters:

```
"""
=====
Simple Plot
=====

Create a simple plot.
"""
...
ax.grid()
plt.show()
```

(continues on next page)

```
#####  
# Second plot  
# =====  
#  
# This is a second plot that is very nice  
  
fig, ax = plt.subplots()  
ax.plot(np.sin(range(50)))
```

In this way text, code, and figures are output in a “notebook” style.

### 29.4.1 Order of examples in the gallery

The order of the sections of the *Tutorials* and the gallery, as well as the order of the examples within each section are determined in a two step process from within the `/doc/sphinxext/gallery_order.py`:

- *Explicit order*: This file contains a list of folders for the section order and a list of examples for the subsection order. The order of the items shown in the doc pages is the order those items appear in those lists.
- *Implicit order*: If a folder or example is not in those lists, it will be appended after the explicitly ordered items and all of those additional items will be ordered by pathname (for the sections) or by filename (for the subsections).

As a consequence, if you want to let your example appear in a certain position in the gallery, extend those lists with your example. In case no explicit order is desired or necessary, still make sure to name your example consistently, i.e. use the main function or subject of the example as first word in the filename; e.g. an image example should ideally be named similar to `imshow_mynewexample.py`.

## 29.5 Miscellaneous

### 29.5.1 Adding animations

There is a Matplotlib Google/Gmail account with username `mplgithub` which was used to setup the github account but can be used for other purposes, like hosting Google docs or Youtube videos. You can embed a Matplotlib animation in the docs by first saving the animation as a movie using `matplotlib.animation.Animation.save()`, and then uploading to [matplotlib's Youtube channel](#) and inserting the embedding string youtube provides like:

```
.. raw:: html  
  
    <iframe width="420" height="315"  
        src="http://www.youtube.com/embed/32cjc6V00ZY"  
        frameborder="0" allowfullscreen>  
    </iframe>
```

An example save command to generate a movie looks like this

```
ani = animation.FuncAnimation(fig, animate, np.arange(1, len(y)),
                              interval=25, blit=True, init_func=init)

ani.save('double_pendulum.mp4', fps=15)
```

Contact Michael Droettboom for the login password to upload youtube videos of google docs to the mplgithub account.

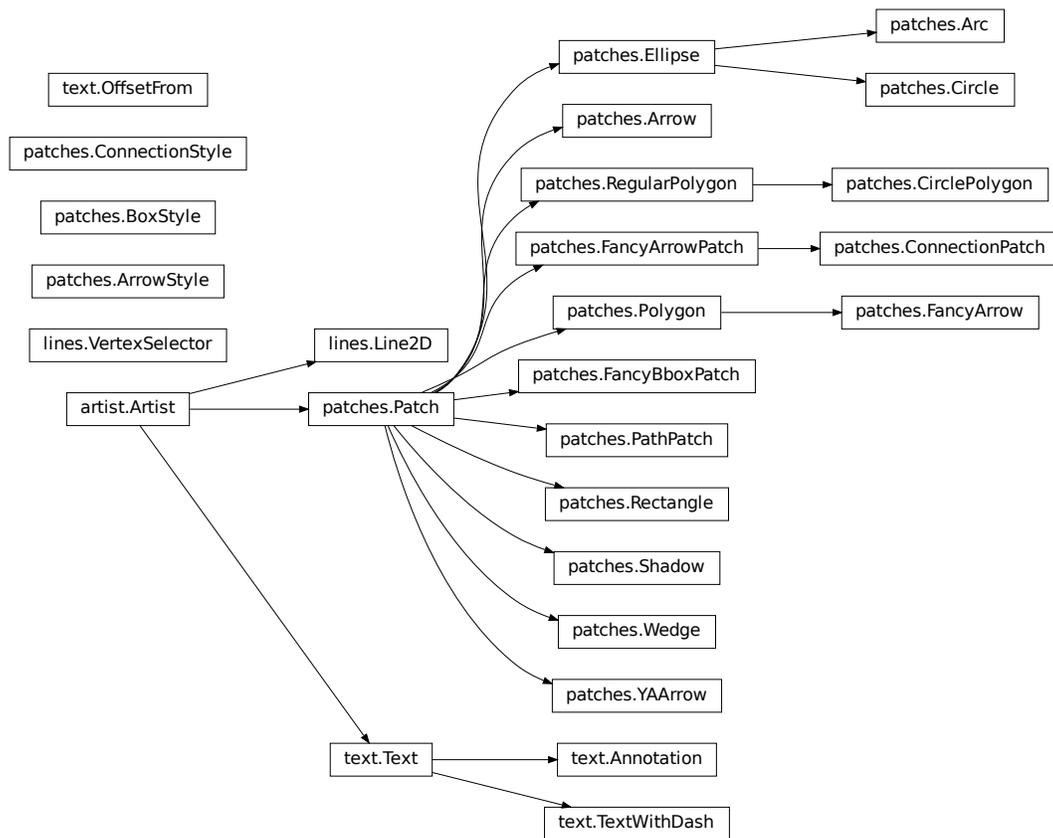
### 29.5.2 Generating inheritance diagrams

Class inheritance diagrams can be generated with the `inheritance-diagram` directive. To use it, provide the directive with a number of class or module names (separated by whitespace). If a module name is provided, all classes in that module will be used. All of the ancestors of these classes will be included in the inheritance diagram.

A single option is available: `parts` controls how many of parts in the path to the class are shown. For example, if `parts == 1`, the class `matplotlib.patches.Patch` is shown as `Patch`. If `parts == 2`, it is shown as `patches.Patch`. If `parts == 0`, the full path is shown.

Example:

```
.. inheritance-diagram:: matplotlib.patches matplotlib.lines matplotlib.text
   :parts: 2
```



### 29.5.3 Emacs helpers

There is an emacs mode `rst.el` which automates many important ReST tasks like building and updating table-of-contents, and promoting or demoting section headings. Here is the basic `.emacs` configuration:

```
(require 'rst)
(setq auto-mode-alist
      (append '(("\\.txt$" . rst-mode)
                ("\\.rst$" . rst-mode)
                ("\\.rest$" . rst-mode)) auto-mode-alist))
```

Some helpful functions:

C-c TAB - `rst-toc-insert`

Insert table of contents at point

C-c C-u - `rst-toc-update`

(continues on next page)

(continued from previous page)

Update the table of contents at point

C-c C-l rst-shift-region-left

Shift region to the left

C-c C-r rst-shift-region-right

Shift region to the right



## PLOT DIRECTIVE DOCUMENTATION

A directive for including a matplotlib plot in a Sphinx document.

By default, in HTML output, `plot` will include a `.png` file with a link to a high-res `.png` and `.pdf`. In LaTeX output, it will include a `.pdf`.

The source code for the plot may be included in one of three ways:

1. A **path to a source file** as the argument to the directive:

```
.. plot:: path/to/plot.py
```

When a path to a source file is given, the content of the directive may optionally contain a caption for the plot:

```
.. plot:: path/to/plot.py

   This is the caption for the plot
```

Additionally, one may specify the name of a function to call (with no arguments) immediately after importing the module:

```
.. plot:: path/to/plot.py plot_function1
```

2. Included as **inline content** to the directive:

```
.. plot::

   import matplotlib.pyplot as plt
   import matplotlib.image as mpimg
   import numpy as np
   img = mpimg.imread('_static/stinkbug.png')
   imgplot = plt.imshow(img)
```

3. Using **doctest** syntax:

```
.. plot::
   A plotting example:
   >>> import matplotlib.pyplot as plt
   >>> plt.plot([1,2,3], [4,5,6])
```

## 30.1 Options

The `plot` directive supports the following options:

- format** [`{'python', 'doctest'}`] Specify the format of the input
- include-source** [bool] Whether to display the source code. The default can be changed using the `plot_include_source` variable in `conf.py`
- encoding** [str] If this source file is in a non-UTF8 or non-ASCII encoding, the encoding must be specified using the `:encoding:` option. The encoding will not be inferred using the `-- coding --` metacomment.
- context** [bool or str] If provided, the code will be run in the context of all previous plot directives for which the `:context:` option was specified. This only applies to inline code plot directives, not those run from files. If the `:context: reset` option is specified, the context is reset for this and future plots, and previous figures are closed prior to running the code. `:context:close-figs` keeps the context but closes previous figures before running the code.
- nofigs** [bool] If specified, the code block will be run, but no figures will be inserted. This is usually useful with the `:context:` option.

Additionally, this directive supports all of the options of the `image` directive, except for `target` (since `plot` will add its own target). These include `alt`, `height`, `width`, `scale`, `align` and `class`.

## 30.2 Configuration options

The `plot` directive has the following configuration options:

- plot\_include\_source** Default value for the `include-source` option
- plot\_html\_show\_source\_link** Whether to show a link to the source in HTML.
- plot\_pre\_code** Code that should be executed before each plot. If not specified or `None` it will default to a string containing:

```
import numpy as np
from matplotlib import pyplot as plt
```

- plot\_basedir** Base directory, to which `plot::` file names are relative to. (If `None` or empty, file names are relative to the directory where the file containing the directive is.)
- plot\_formats** File formats to generate. List of tuples or strings:

```
[(suffix, dpi), suffix, ...]
```

that determine the file format and the DPI. For entries whose DPI was omitted, sensible defaults are chosen. When passing from the command line through `sphinx_build` the list should be passed as `suffix:dpi,suffix:dpi, ...`

- plot\_html\_show\_formats** Whether to show links to the files in HTML.
- plot\_rcparams** A dictionary containing any non-standard rcParams that should be applied before each plot.

**plot\_apply\_rcparams** By default, rcParams are applied when `context` option is not used in a plot directive. This configuration option overrides this behavior and applies rcParams before each plot.

**plot\_working\_directory** By default, the working directory will be changed to the directory of the example, so the code can get at its data files, if any. Also its path will be added to `sys.path` so it can import any helper modules sitting beside it. This configuration option can be used to specify a central directory (also added to `sys.path`) where data files and helper modules for all code are located.

**plot\_template** Provide a customized template for preparing restructured text.

```
class matplotlib.sphinxext.plot_directive.PlotDirective(name, arguments, options, content, lineno, content_offset, block_text, state, state_machine)
```

Implementation of the `.. plot::` directive.

See the module docstring for details.

```
run(self)
    Run the plot directive.
```

```
exception matplotlib.sphinxext.plot_directive.PlotError
```

```
matplotlib.sphinxext.plot_directive.mark_plot_labels(app, document)
```

To make plots referenceable, we need to move the reference from the "htmlonly" (or "latexonly") node to the actual figure node itself.

```
matplotlib.sphinxext.plot_directive.out_of_date(original, derived)
```

Return whether *derived* is out-of-date relative to *original*, both of which are full file paths.

```
matplotlib.sphinxext.plot_directive.plot_directive(name, arguments, options, content, lineno, content_offset, block_text, state, state_machine)
```

[*Deprecated*] Implementation of the `.. plot::` directive.

See the module docstring for details.

## Notes

Deprecated since version 3.1.

```
matplotlib.sphinxext.plot_directive.remove_coding(text)
    Remove the coding comment, which six.exec_ doesn't like.
```

```
matplotlib.sphinxext.plot_directive.render_figures(code, code_path, output_dir, output_base, context, function_name, config, context_reset=False, close_figs=False)
```

Run a pyplot script and save the images in *output\_dir*.

Save the images under *output\_dir* with file names derived from *output\_base*

```
matplotlib.sphinxext.plot_directive.run_code(code, code_path, ns=None, function_name=None)
```

Import a Python module from a path, and run the function given by name, if *function\_name* is not None.

`matplotlib.sphinxext.plot_directive.split_code_at_show(text)`  
Split code at `plt.show()`.

`matplotlib.sphinxext.plot_directive.unescape_doctest(text)`  
Extract code from a piece of text, which contains either Python code or doctests.

## DEVELOPER'S GUIDE FOR CREATING SCALES AND TRANSFORMATIONS

Matplotlib supports the addition of custom procedures that transform the data before it is displayed.

There is an important distinction between two kinds of transformations. Separable transformations, working on a single dimension, are called "scales", and non-separable transformations, that handle data in two or more dimensions at a time, are called "projections".

From the user's perspective, the scale of a plot can be set with `set_xscale()` and `set_yscale()`. Projections can be chosen using the `projection` keyword argument to the `plot()` or `subplot()` functions, e.g.:

```
plot(x, y, projection="custom")
```

This document is intended for developers and advanced users who need to create new scales and projections for matplotlib. The necessary code for scales and projections can be included anywhere: directly within a plot script, in third-party code, or in the matplotlib source tree itself.

### 31.1 Creating a new scale

Adding a new scale consists of defining a subclass of `matplotlib.scale.ScaleBase`, that includes the following elements:

- A transformation from data coordinates into display coordinates.
- An inverse of that transformation. This is used, for example, to convert mouse positions from screen space back into data space.
- A function to limit the range of the axis to acceptable values (`limit_range_for_scale()`). A log scale, for instance, would prevent the range from including values less than or equal to zero.
- Locators (major and minor) that determine where to place ticks in the plot, and optionally, how to adjust the limits of the plot to some "good" values. Unlike `limit_range_for_scale()`, which is always enforced, the range setting here is only used when automatically setting the range of the plot.
- Formatters (major and minor) that specify how the tick labels should be drawn.

Once the class is defined, it must be registered with matplotlib so that the user can select it.

A full-fledged and heavily annotated example is in `/gallery/scales/custom_scale`. There are also some classes in `matplotlib.scale` that may be used as starting points.

## 31.2 Creating a new projection

Adding a new projection consists of defining a projection axes which subclasses `matplotlib.axes.Axes` and includes the following elements:

- A transformation from data coordinates into display coordinates.
- An inverse of that transformation. This is used, for example, to convert mouse positions from screen space back into data space.
- Transformations for the gridlines, ticks and ticklabels. Custom projections will often need to place these elements in special locations, and matplotlib has a facility to help with doing so.
- Setting up default values (overriding `cla()`), since the defaults for a rectilinear axes may not be appropriate.
- Defining the shape of the axes, for example, an elliptical axes, that will be used to draw the background of the plot and for clipping any data elements.
- Defining custom locators and formatters for the projection. For example, in a geographic projection, it may be more convenient to display the grid in degrees, even if the data is in radians.
- Set up interactive panning and zooming. This is left as an "advanced" feature left to the reader, but there is an example of this for polar plots in `matplotlib.projections.polar`.
- Any additional methods for additional convenience or features.

Once the projection axes is defined, it can be used in one of two ways:

- By defining the class attribute `name`, the projection axes can be registered with `matplotlib.projections.register_projection()` and subsequently simply invoked by name:

```
plt.axes(projection='my_proj_name')
```

- For more complex, parameterisable projections, a generic "projection" object may be defined which includes the method `_as_mpl_axes`. `_as_mpl_axes` should take no arguments and return the projection's axes subclass and a dictionary of additional arguments to pass to the subclass' `__init__` method. Subsequently a parameterised projection can be initialised with:

```
plt.axes(projection=MyProjection(param1=param1_value))
```

where `MyProjection` is an object which implements a `_as_mpl_axes` method.

A full-fledged and heavily annotated example is in `/gallery/misc/custom_projection`. The polar plot functionality in `matplotlib.projections.polar` may also be of interest.

## 31.3 API documentation

- `matplotlib.scale`

- *matplotlib.projections*
- *matplotlib.projections.polar*



## WORKING WITH *MATPLOTLIB* SOURCE CODE

Contents:

### 32.1 Introduction

These pages describe a [git](#) and [github](#) workflow for the [Matplotlib](#) project.

There are several different workflows here, for different ways of working with *Matplotlib*.

This is not a comprehensive git reference, it's just a workflow for our own project. It's tailored to the [github](#) hosting service. You may well find better or quicker ways of getting stuff done with git, but these should get you started.

For general resources for learning git, see [git resources](#).

### 32.2 Install git

#### 32.2.1 Overview

Debian / Ubuntu	<code>sudo apt-get install git</code>
Fedora	<code>sudo yum install git</code>
Windows	Download and install <a href="#">msysGit</a>
OS X	Use the <a href="#">git-osx-installer</a>

#### 32.2.2 In detail

See the [git](#) page for the most recent information.

Have a look at the [github](#) install help pages available from [github help](#)

There are good instructions here: <https://git-scm.com/book/en/v2/Getting-Started-Installing-Git>

## 32.3 Following the latest source

These are the instructions if you just want to follow the latest *Matplotlib* source, but you don't need to do any development for now.

The steps are:

- *Install git*
- get local copy of the [Matplotlib github](#) git repository
- update local copy from time to time

### 32.3.1 Get the local copy of the code

From the command line:

```
git clone git://github.com/matplotlib/matplotlib.git
```

You now have a copy of the code tree in the new `matplotlib` directory.

### 32.3.2 Updating the code

From time to time you may want to pull down the latest code. Do this with:

```
cd matplotlib
git pull
```

The tree in `matplotlib` will now have the latest changes from the initial repository.

## 32.4 Making a patch

You've discovered a bug or something else you want to change in [Matplotlib](#) .. — excellent!

You've worked out a way to fix it — even better!

You want to tell us about it — best of all!

The easiest way is to make a *patch* or set of patches. Here we explain how. Making a patch is the simplest and quickest, but if you're going to be doing anything more than simple quick things, please consider following the *Git for development* model instead.

### 32.4.1 Making patches

#### Overview

```
# tell git who you are
git config --global user.email you@yourdomain.example.com
git config --global user.name "Your Name Comes Here"
# get the repository if you don't have it
```

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```
git clone git://github.com/matplotlib/matplotlib.git
# make a branch for your patching
cd matplotlib
git branch the-fix-im-thinking-of
git checkout the-fix-im-thinking-of
# hack, hack, hack
# Tell git about any new files you've made
git add somewhere/tests/test_my_bug.py
# commit work in progress as you go
git commit -am 'BF - added tests for Funny bug'
# hack hack, hack
git commit -am 'BF - added fix for Funny bug'
# make the patch files
git format-patch -M -C master
```

Then, send the generated patch files to the [Matplotlib mailing list](#) — where we will thank you warmly.

### In detail

1. Tell git who you are so it can label the commits you've made:

```
git config --global user.email you@yourdomain.example.com
git config --global user.name "Your Name Comes Here"
```

2. If you don't already have one, clone a copy of the [Matplotlib](#) repository:

```
git clone git://github.com/matplotlib/matplotlib.git
cd matplotlib
```

3. Make a 'feature branch'. This will be where you work on your bug fix. It's nice and safe and leaves you with access to an unmodified copy of the code in the main branch:

```
git branch the-fix-im-thinking-of
git checkout the-fix-im-thinking-of
```

4. Do some edits, and commit them as you go:

```
# hack, hack, hack
# Tell git about any new files you've made
git add somewhere/tests/test_my_bug.py
# commit work in progress as you go
git commit -am 'BF - added tests for Funny bug'
# hack hack, hack
git commit -am 'BF - added fix for Funny bug'
```

Note the `-am` options to `commit`. The `m` flag just signals that you're going to type a message on the command line. The `a` flag — you can just take on faith — or see [why the -a flag?](#)

5. When you have finished, check you have committed all your changes:

```
git status
```

6. Finally, make your commits into patches. You want all the commits since you branched from the master branch:

```
git format-patch -M -C master
```

You will now have several files named for the commits:

```
0001-BF-added-tests-for-Funny-bug.patch
0002-BF-added-fix-for-Funny-bug.patch
```

Send these files to the [Matplotlib mailing list](#).

When you are done, to switch back to the main copy of the code, just return to the master branch:

```
git checkout master
```

### 32.4.2 Moving from patching to development

If you find you have done some patches, and you have one or more feature branches, you will probably want to switch to development mode. You can do this with the repository you have.

Fork the [Matplotlib](#) repository on github — *Making your own copy (fork) of Matplotlib*. Then:

```
# checkout and refresh master branch from main repo
git checkout master
git pull origin master
# rename pointer to main repository to 'upstream'
git remote rename origin upstream
# point your repo to default read / write to your fork on github
git remote add origin git@github.com:your-user-name/matplotlib.git
# push up any branches you've made and want to keep
git push origin the-fix-im-thinking-of
```

Then you can, if you want, follow the *Development workflow*.

## 32.5 Git for development

Contents:

### 32.5.1 Making your own copy (fork) of Matplotlib

You need to do this only once. The instructions here are very similar to the instructions at <https://help.github.com/forking/> — please see that page for more detail. We're repeating some of it here just to give the specifics for the [Matplotlib](#) project, and to suggest some default names.

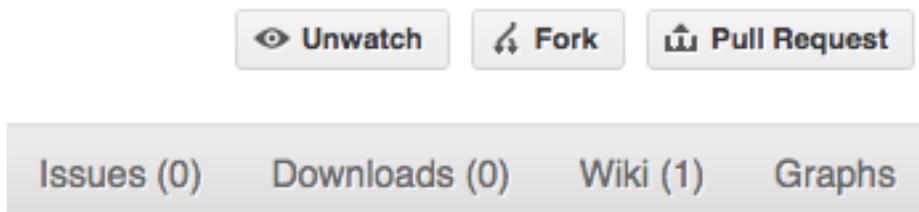
## Set up and configure a github account

If you don't have a github account, go to the github page, and make one.

You then need to configure your account to allow write access — see the [Generating SSH keys help](#) on [github help](#).

## Create your own forked copy of Matplotlib

1. Log into your github account.
2. Go to the [Matplotlib github](#) home at [Matplotlib github](#).
3. Click on the *fork* button:



Now, after a short pause, you should find yourself at the home page for your own forked copy of [Matplotlib](#).

### 32.5.2 Set up your fork

First you follow the instructions for *Making your own copy (fork) of Matplotlib*.

#### Overview

```
git clone https://github.com/your-user-name/matplotlib.git
cd matplotlib
git remote add upstream git://github.com/matplotlib/matplotlib.git
```

#### In detail

##### Clone your fork

1. Clone your fork to the local computer with `git clone https://github.com/your-user-name/matplotlib.git`
2. Investigate. Change directory to your new repo: `cd matplotlib`. Then `git branch -a` to show you all branches. You'll get something like:

```
* master
remotes/origin/master
```

This tells you that you are currently on the `master` branch, and that you also have a remote connection to `origin/master`. What remote repository is `remote/origin`? Try `git remote -v` to see the URLs for the remote. They will point to your github fork.

Now you want to connect to the upstream [Matplotlib github](#) repository, so you can merge in changes from trunk.

### Linking your repository to the upstream repo

```
cd matplotlib
git remote add upstream git://github.com/matplotlib/matplotlib.git
```

`upstream` here is just the arbitrary name we're using to refer to the main [Matplotlib](#) repository at [Matplotlib github](#).

Note that we've used `git://` for the URL rather than `https://` or `git@`. The `git://` URL is read only. This means that we can't accidentally (or deliberately) write to the upstream repo, and we are only going to use it to merge into our own code.

Just for your own satisfaction, show yourself that you now have a new 'remote', with `git remote -v show`, giving you something like:

```
upstream      git://github.com/matplotlib/matplotlib.git (fetch)
upstream      git://github.com/matplotlib/matplotlib.git (push)
origin        https://github.com/your-user-name/matplotlib.git (fetch)
origin        https://github.com/your-user-name/matplotlib.git (push)
```

## 32.5.3 Configure git

### Overview

Your personal git configurations are saved in the `.gitconfig` file in your home directory.

Here is an example `.gitconfig` file:

```
[user]
  name = Your Name
  email = you@yourdomain.example.com

[alias]
  ci = commit -a
  co = checkout
  st = status
  stat = status
  br = branch
  wdiff = diff --color-words

[core]
  editor = vim

[merge]
  summary = true
```

You can edit this file directly or you can use the `git config --global` command:

```
git config --global user.name "Your Name"
git config --global user.email you@yourdomain.example.com
git config --global alias.ci "commit -a"
git config --global alias.co checkout
git config --global alias.st "status -a"
git config --global alias.stat "status -a"
git config --global alias.br branch
git config --global alias.wdiff "diff --color-words"
git config --global core.editor vim
git config --global merge.summary true
```

To set up on another computer, you can copy your `~/.gitconfig` file, or run the commands above.

## In detail

### user.name and user.email

It is good practice to tell `git` who you are, for labeling any changes you make to the code. The simplest way to do this is from the command line:

```
git config --global user.name "Your Name"
git config --global user.email you@yourdomain.example.com
```

This will write the settings into your `git` configuration file, which should now contain a user section with your name and email:

```
[user]
  name = Your Name
  email = you@yourdomain.example.com
```

Of course you'll need to replace `Your Name` and `you@yourdomain.example.com` with your actual name and email address.

## Aliases

You might well benefit from some aliases to common commands.

For example, you might well want to be able to shorten `git checkout` to `git co`. Or you may want to alias `git diff --color-words` (which gives a nicely formatted output of the diff) to `git wdiff`

The following `git config --global` commands:

```
git config --global alias.ci "commit -a"
git config --global alias.co checkout
git config --global alias.st "status -a"
git config --global alias.stat "status -a"
git config --global alias.br branch
git config --global alias.wdiff "diff --color-words"
```

will create an alias section in your `.gitconfig` file with contents like this:

```
[alias]
    ci = commit -a
    co = checkout
    st = status -a
    stat = status -a
    br = branch
    wdiff = diff --color-words
```

## Editor

You may also want to make sure that your editor of choice is used

```
git config --global core.editor vim
```

## Merging

To enforce summaries when doing merges (`~/ .gitconfig` file again):

```
[merge]
    log = true
```

Or from the command line:

```
git config --global merge.log true
```

## Fancy log output

This is a very nice alias to get a fancy log output; it should go in the alias section of your `.gitconfig` file:

```
lg = log --graph --pretty=format:'%Cred%h%Creset -%C(yellow)%d%Creset %s %Cgreen(%cr)
↳%C(bold blue)[%an]%Creset' --abbrev-commit --date=relative
```

You use the alias with:

```
git lg
```

and it gives graph / text output something like this (but with color!):

```
* 6d8e1ee - (HEAD, origin/my-fancy-feature, my-fancy-feature) NF - a fancy file (45↳
↳minutes ago) [Matthew Brett]
* d304a73 - (origin/placeholder, placeholder) Merge pull request #48 from hhuuggo/
↳master (2 weeks ago) [Jonathan Terhorst]
|\
| * 4aff2a8 - fixed bug 35, and added a test in test_bugfixes (2 weeks ago) [Hugo]
|/
* a7ff2e5 - Added notes on discussion/proposal made during Data Array Summit. (2 weeks↳
↳ago) [Corran Webster]
```

(continues on next page)

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```

* 68f6752 - Initial implimentation of AxisIndexer - uses 'index_by' which needs to be
↳changed to a call on an Axes object - this is all very sketchy right now. (2 weeks
↳ago) [Corr
* 376adbd - Merge pull request #46 from terhorst/master (2 weeks ago) [Jonathan
↳Terhorst]
| \
| * b605216 - updated joshu example to current api (3 weeks ago) [Jonathan Terhorst]
| * 2e991e8 - add testing for outer ufunc (3 weeks ago) [Jonathan Terhorst]
| * 7beda5a - prevent axis from throwing an exception if testing equality with non-axis
↳object (3 weeks ago) [Jonathan Terhorst]
| * 65af65e - convert unit testing code to assertions (3 weeks ago) [Jonathan Terhorst]
| * 956fbab - Merge remote-tracking branch 'upstream/master' (3 weeks ago) [Jonathan
↳Terhorst]
| | \
| | /

```

Thanks to Yury V. Zaytsev for posting it.

### 32.5.4 Development workflow

You already have your own forked copy of the [Matplotlib](#) repository, by following *Making your own copy (fork) of Matplotlib*. You have *Set up your fork*. You have configured git by following *Configure git*. Now you are ready for some real work.

#### Workflow summary

In what follows we'll refer to the upstream Matplotlib master branch, as "trunk".

- Don't use your `master` branch for anything. Consider deleting it.
- When you are starting a new set of changes, fetch any changes from trunk, and start a new *feature branch* from that.
- Make a new branch for each separable set of changes — "one task, one branch" ([ipython git workflow](#)).
- Name your branch for the purpose of the changes - e.g. `bugfix-for-issue-14` or `refactor-database-code`.
- If you can possibly avoid it, avoid merging trunk or any other branches into your feature branch while you are working.
- If you do find yourself merging from trunk, consider *Rebasing on trunk*
- Ask on the [Matplotlib mailing list](#) if you get stuck.
- Ask for code review!

This way of working helps to keep work well organized, with readable history. This in turn makes it easier for project maintainers (that might be you) to see what you've done, and why you did it.

See [linux git workflow](#) and [ipython git workflow](#) for some explanation.

### Consider deleting your master branch

It may sound strange, but deleting your own `master` branch can help reduce confusion about which branch you are on. See [deleting master on github](#) for details.

### Update the mirror of trunk

First make sure you have done *Linking your repository to the upstream repo*.

From time to time you should fetch the upstream (trunk) changes from github:

```
git fetch upstream
```

This will pull down any commits you don't have, and set the remote branches to point to the right commit. For example, 'trunk' is the branch referred to by (remote/branchname) `upstream/master` - and if there have been commits since you last checked, `upstream/master` will change after you do the fetch.

### Make a new feature branch

When you are ready to make some changes to the code, you should start a new branch. Branches that are for a collection of related edits are often called 'feature branches'.

Making an new branch for each set of related changes will make it easier for someone reviewing your branch to see what you are doing.

Choose an informative name for the branch to remind yourself and the rest of us what the changes in the branch are for. For example `add-ability-to-fly`, or `buxfix-for-issue-42`.

```
# Update the mirror of trunk
git fetch upstream
# Make new feature branch starting at current trunk
git branch my-new-feature upstream/master
git checkout my-new-feature
```

Generally, you will want to keep your feature branches on your public [github](#) fork of [Matplotlib](#). To do this, you `git push` this new branch up to your github repo. Generally (if you followed the instructions in these pages, and by default), git will have a link to your github repo, called `origin`. You push up to your own repo on github with:

```
git push origin my-new-feature
```

In git  $\geq$  1.7 you can ensure that the link is correctly set by using the `--set-upstream` option:

```
git push --set-upstream origin my-new-feature
```

From now on git will know that `my-new-feature` is related to the `my-new-feature` branch in the github repo.

### The editing workflow

## Overview

```
# hack hack
git add my_new_file
git commit -am 'NF - some message'
git push
```

### In more detail

1. Make some changes
2. See which files have changed with `git status` (see [git status](#)). You'll see a listing like this one:

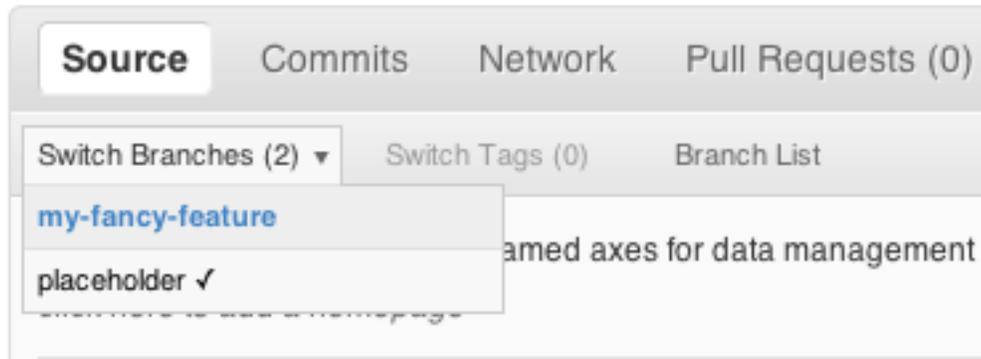
```
# On branch ny-new-feature
# Changed but not updated:
#   (use "git add <file>..." to update what will be committed)
#   (use "git checkout -- <file>..." to discard changes in working directory)
#
#   modified:   README
#
# Untracked files:
#   (use "git add <file>..." to include in what will be committed)
#
#   INSTALL
no changes added to commit (use "git add" and/or "git commit -a")
```

3. Check what the actual changes are with `git diff` ([git diff](#)).
4. Add any new files to version control `git add new_file_name` (see [git add](#)).
5. To commit all modified files into the local copy of your repo,, do `git commit -am 'A commit message'`. Note the `-am` options to `commit`. The `m` flag just signals that you're going to type a message on the command line. The `a` flag — you can just take on faith — or see [why the -a flag?](#) — and the helpful use-case description in the [tangled working copy problem](#). The [git commit](#) manual page might also be useful.
6. To push the changes up to your forked repo on github, do a `git push` (see [git push](#)).

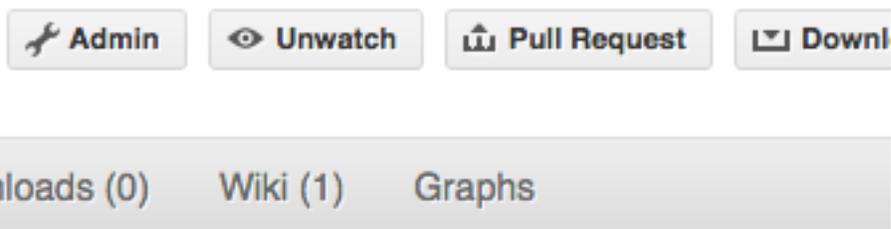
### Ask for your changes to be reviewed or merged

When you are ready to ask for someone to review your code and consider a merge:

1. Go to the URL of your forked repo, say <https://github.com/your-user-name/matplotlib>.
2. Use the 'Switch Branches' dropdown menu near the top left of the page to select the branch with your changes:



3. Click on the 'Pull request' button:



Enter a title for the set of changes, and some explanation of what you've done. Say if there is anything you'd like particular attention for - like a complicated change or some code you are not happy with.

If you don't think your request is ready to be merged, just say so in your pull request message. This is still a good way of getting some preliminary code review.

### Some other things you might want to do

#### Delete a branch on github

```
git checkout master
# delete branch locally
git branch -D my-unwanted-branch
# delete branch on github
git push origin :my-unwanted-branch
```

Note the colon : before my-unwanted-branch. See also: <https://help.github.com/articles/pushing-to-a-remote/#deleting-a-remote-branch-or-tag>

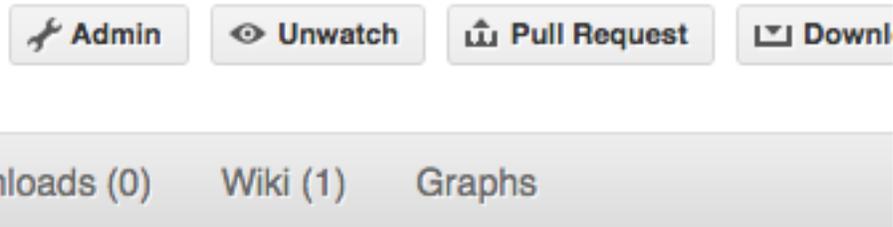
#### Several people sharing a single repository

If you want to work on some stuff with other people, where you are all committing into the same repository, or even the same branch, then just share it via github.

First fork Matplotlib into your account, as from *Making your own copy (fork) of Matplotlib*.

Then, go to your forked repository github page, say <https://github.com/your-user-name/matplotlib>

Click on the 'Admin' button, and add anyone else to the repo as a collaborator:



Now all those people can do:

```
git clone https://github.com/your-user-name/matplotlib.git
```

Remember that links starting with `https` or `git@` are read-write, and that `git@` uses the ssh protocol; links starting with `git://` are read-only.

Your collaborators can then commit directly into that repo with the usual:

```
git commit -am 'ENH - much better code'
git push origin master # pushes directly into your repo
```

### Explore your repository

To see a graphical representation of the repository branches and commits:

```
gitk --all
```

To see a linear list of commits for this branch:

```
git log
```

You can also look at the [network graph visualizer](#) for your github repo.

Finally the *Fancy log output* `lg` alias will give you a reasonable text-based graph of the repository.

### Rebasing on trunk

Let's say you thought of some work you'd like to do. You *Update the mirror of trunk* and *Make a new feature branch* called `cool-feature`. At this stage trunk is at some commit, let's call it E. Now you make some new commits on your `cool-feature` branch, let's call them A, B, C. Maybe your changes take a while, or you come back to them after a while. In the meantime, trunk has progressed from commit E to commit (say) G:

```

      A---B---C cool-feature
      /
D---E---F---G trunk
```

At this stage you consider merging trunk into your feature branch, and you remember that this here page sternly advises you not to do that, because the history will get messy. Most of the time you can just ask for a review, and not worry that trunk has got a little ahead. But

sometimes, the changes in trunk might affect your changes, and you need to harmonize them. In this situation you may prefer to do a rebase.

rebase takes your changes (A, B, C) and replays them as if they had been made to the current state of trunk. In other words, in this case, it takes the changes represented by A, B, C and replays them on top of G. After the rebase, your history will look like this:

```
      A'--B'--C' cool-feature
      /
D---E---F---G trunk
```

See [rebase without tears](#) for more detail.

To do a rebase on trunk:

```
# Update the mirror of trunk
git fetch upstream
# go to the feature branch
git checkout cool-feature
# make a backup in case you mess up
git branch tmp cool-feature
# rebase cool-feature onto trunk
git rebase --onto upstream/master upstream/master cool-feature
```

In this situation, where you are already on branch `cool-feature`, the last command can be written more succinctly as:

```
git rebase upstream/master
```

When all looks good you can delete your backup branch:

```
git branch -D tmp
```

If it doesn't look good you may need to have a look at *Recovering from mess-ups*.

If you have made changes to files that have also changed in trunk, this may generate merge conflicts that you need to resolve - see the [git rebase](#) man page for some instructions at the end of the "Description" section. There is some related help on merging in the git user manual - see [resolving a merge](#).

### Recovering from mess-ups

Sometimes, you mess up merges or rebases. Luckily, in git it is relatively straightforward to recover from such mistakes.

If you mess up during a rebase:

```
git rebase --abort
```

If you notice you messed up after the rebase:

```
# reset branch back to the saved point
git reset --hard tmp
```

If you forgot to make a backup branch:

```
# look at the reflog of the branch
git reflog show cool-feature

8630830 cool-feature@{0}: commit: BUG: io: close file handles immediately
278dd2a cool-feature@{1}: rebase finished: refs/heads/my-feature-branch onto
↳11ee694744f2552d
26aa21a cool-feature@{2}: commit: BUG: lib: make seek_gzip_factory not leak gzip obj
...

# reset the branch to where it was before the botched rebase
git reset --hard cool-feature@{2}
```

### Rewriting commit history

**Note:** Do this only for your own feature branches.

There's an embarrassing typo in a commit you made? Or perhaps the you made several false starts you would like the posterity not to see.

This can be done via *interactive rebasing*.

Suppose that the commit history looks like this:

```
git log --oneline
eadc391 Fix some remaining bugs
a815645 Modify it so that it works
2dec1ac Fix a few bugs + disable
13d7934 First implementation
6ad92e5 * masked is now an instance of a new object, MaskedConstant
29001ed Add pre-nep for a copule of structured_array_extensions.
...
```

and 6ad92e5 is the last commit in the cool-feature branch. Suppose we want to make the following changes:

- Rewrite the commit message for 13d7934 to something more sensible.
- Combine the commits 2dec1ac, a815645, eadc391 into a single one.

We do as follows:

```
# make a backup of the current state
git branch tmp HEAD
# interactive rebase
git rebase -i 6ad92e5
```

This will open an editor with the following text in it:

```
pick 13d7934 First implementation
pick 2dec1ac Fix a few bugs + disable
pick a815645 Modify it so that it works
pick eadc391 Fix some remaining bugs
```

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```
# Rebase 6ad92e5..eadc391 onto 6ad92e5
#
# Commands:
# p, pick = use commit
# r, reword = use commit, but edit the commit message
# e, edit = use commit, but stop for amending
# s, squash = use commit, but meld into previous commit
# f, fixup = like "squash", but discard this commit's log message
#
# If you remove a line here THAT COMMIT WILL BE LOST.
# However, if you remove everything, the rebase will be aborted.
#
```

To achieve what we want, we will make the following changes to it:

```
r 13d7934 First implementation
pick 2de1ac Fix a few bugs + disable
f a815645 Modify it so that it works
f eadc391 Fix some remaining bugs
```

This means that (i) we want to edit the commit message for 13d7934, and (ii) collapse the last three commits into one. Now we save and quit the editor.

Git will then immediately bring up an editor for editing the commit message. After revising it, we get the output:

```
[detached HEAD 721fc64] F00: First implementation
 2 files changed, 199 insertions(+), 66 deletions(-)
[detached HEAD 0f22701] Fix a few bugs + disable
 1 files changed, 79 insertions(+), 61 deletions(-)
Successfully rebased and updated refs/heads/my-feature-branch.
```

and the history looks now like this:

```
0f22701 Fix a few bugs + disable
721fc64 ENH: Sophisticated feature
6ad92e5 * masked is now an instance of a new object, MaskedConstant
```

If it went wrong, recovery is again possible as explained *above*.

### 32.5.5 Maintainer workflow

This page is for maintainers — those of us who merge our own or other peoples' changes into the upstream repository.

Being as how you're a maintainer, you are completely on top of the basic stuff in *Development workflow*.

The instructions in *Linking your repository to the upstream repo* add a remote that has read-only access to the upstream repo. Being a maintainer, you've got read-write access.

It's good to have your upstream remote have a scary name, to remind you that it's a read-write remote:

```
git remote add upstream-rw git@github.com:matplotlib/matplotlib.git
git fetch upstream-rw
```

### Integrating changes

Let's say you have some changes that need to go into trunk (upstream-rw/master).

The changes are in some branch that you are currently on. For example, you are looking at someone's changes like this:

```
git remote add someone git://github.com/someone/matplotlib.git
git fetch someone
git branch cool-feature --track someone/cool-feature
git checkout cool-feature
```

So now you are on the branch with the changes to be incorporated upstream. The rest of this section assumes you are on this branch.

### A few commits

If there are only a few commits, consider rebasing to upstream:

```
# Fetch upstream changes
git fetch upstream-rw
# rebase
git rebase upstream-rw/master
```

Remember that, if you do a rebase, and push that, you'll have to close any github pull requests manually, because github will not be able to detect the changes have already been merged.

### A long series of commits

If there are a longer series of related commits, consider a merge instead:

```
git fetch upstream-rw
git merge --no-ff upstream-rw/master
```

The merge will be detected by github, and should close any related pull requests automatically.

Note the `--no-ff` above. This forces git to make a merge commit, rather than doing a fast-forward, so that these set of commits branch off trunk then rejoin the main history with a merge, rather than appearing to have been made directly on top of trunk.

### Check the history

Now, in either case, you should check that the history is sensible and you have the right commits:

```
git log --oneline --graph
git log -p upstream-rw/master..
```

The first line above just shows the history in a compact way, with a text representation of the history graph. The second line shows the log of commits excluding those that can be reached from trunk (`upstream-rw/master`), and including those that can be reached from current HEAD (implied with the `..` at the end). So, it shows the commits unique to this branch compared to trunk. The `-p` option shows the diff for these commits in patch form.

### Push to trunk

```
git push upstream-rw my-new-feature:master
```

This pushes the `my-new-feature` branch in this repository to the `master` branch in the `upstream-rw` repository.

## 32.6 git resources

### 32.6.1 Tutorials and summaries

- [github help](#) has an excellent series of how-to guides.
- The [pro git book](#) is a good in-depth book on git.
- A [git cheat sheet](#) is a page giving summaries of common commands.
- The [git user manual](#)
- The [git tutorial](#)
- The [git community book](#)
- [git ready](#) — a nice series of tutorials
- [git magic](#) — extended introduction with intermediate detail
- The [git parable](#) is an easy read explaining the concepts behind git.
- [git foundation](#) expands on the [git parable](#).
- Fernando Perez' [git page](#) — [Fernando's git page](#) — many links and tips
- A good but technical page on [git concepts](#)
- [git svn crash course](#): git for those of us used to [subversion](#)

### 32.6.2 Advanced git workflow

There are many ways of working with git; here are some posts on the rules of thumb that other projects have come up with:

- Linus Torvalds on [git management](#)

- Linus Torvalds on [linux git workflow](#) . Summary; use the git tools to make the history of your edits as clean as possible; merge from upstream edits as little as possible in branches where you are doing active development.

### 32.6.3 Manual pages online

You can get these on your own machine with (e.g) `git help push` or (same thing) `git push --help`, but, for convenience, here are the online manual pages for some common commands:

- `git add`
- `git branch`
- `git checkout`
- `git clone`
- `git commit`
- `git config`
- `git diff`
- `git log`
- `git pull`
- `git push`
- `git remote`
- `git status`

## 32.7 Two and three dots in difference specs

Thanks to Yarik Halchenko for this explanation.

Imagine a series of commits A, B, C, D... Imagine that there are two branches, *topic* and *master*. You branched *topic* off *master* when *master* was at commit 'E'. The graph of the commits looks like this:

```

  A---B---C topic
  /
D---E---F---G master

```

Then:

```
git diff master..topic
```

will output the difference from G to C (i.e. with effects of F and G), while:

```
git diff master...topic
```

would output just differences in the topic branch (i.e. only A, B, and C).



## REVIEWERS GUIDELINE

### 33.1 Pull request checklist

#### 33.1.1 Branch selection

In general target the master branch for all new features and bug-fixes. PRs may target maintenance or doc branches on a case-by-case basis.

#### 33.1.2 Documentation

- Every new feature should be documented. If it's a new module, don't forget to add a new rst file to the API docs.
- Each high-level plotting function should have a small example in the `Example` section of the docstring. This should be as simple as possible to demonstrate the method. More complex examples should go in the `examples` section of the documentation.
- Build the docs and make sure all formatting warnings are addressed.
- See *Writing documentation* for our documentation style guide.
- If your change is a major new feature, add an entry to `doc/users/whats_new.rst`.
- If you change the API in a backward-incompatible way, please document it in `doc/api/api_changes.rst`.

### 33.2 PR Review guidelines

- Be patient and *kind* with contributors.
- If you have commit rights, then you are trusted to use them. Please help review and merge PRs!
- Documentation and examples may be merged by the first reviewer. Use the threshold "is this better than it was?" as the review criteria.
- For code changes (anything in `src` or `lib`) at least two developers (those with commit rights) should review all pull requests. If you are the first to review a PR and approve of the changes use the github '[approve review](#)' tool to mark it as such. If you are a subsequent reviewer please approve the review and if you think no more review is needed, merge the PR.

Ensure that all API changes are documented in `doc/api/api_changes` and significant new features have an entry in `doc/user/whats_new`.

- Make sure the Travis, Appveyor, circle, and codecov tests are passing before merging.
  - Whenever a pull request is created or updated, Travis and Appveyor automatically runs the test suite on all versions of Python supported by Matplotlib. The `tox` support in Matplotlib may be useful for testing locally.
- Do not self merge, except for 'small' patches to un-break the CI or when another reviewer explicitly allows it (ex, "Approve modulo CI passing, may self merge when green")
- Squashing is case-by-case. The balance is between burden on the contributor, keeping a relatively clean history, and keeping a history usable for bisecting. The only time we are really strict about it is to eliminate binary files (ex multiple test image re-generations) and to remove upstream merges.
- Do not let perfect be the enemy of the good, particularly for documentation or example PRs. If you find yourself making many small suggestions, either open a PR against the original branch, push changes to the contributor branch, or merge the PR and then open a new PR against upstream.
- If you push to a contributor branch leave a comment explaining what you did, ex "I took the liberty of pushing a small clean-up PR to your branch, thanks for your work.". If you are going to make substantial changes to the code or intent of the PR please check with the contributor first.

## 33.3 Branches and Backports

The current active branches are

**master** This will be Matplotlib 3.0. Supports Python 3.5+.

**v2.2.x** Maintenance branch for Matplotlib 2.2 LTS. Supports Python 2.7, 3.4+

**v2.2.N-doc** Documentation for the current release. On a patch release, this will be replaced by a properly named branch for the new release.

We always will backport to 2.2.x

- critical bug fixes (segfault, failure to import, things that the user can not work around)
- fixes for regressions against 2.0 or 2.1

Everything else (regressions against 1.x versions, bugs/api inconsistencies the user can work around in their code) are on a case-by-case basis, should be low-risk, and need someone to advocate for and shepherd through the backport.

The only changes to be backported to 2.2.N-doc are changes to `doc`, `examples`, or `tutorials`. Any changes to `lib` or `src` should not be backported to this branch.

### 33.3.1 Automated backports

We use `meeseeksdev` bot to automatically backport merges to the correct maintenance branch based on the milestone. To work properly the milestone must be set before merging. If you have commit rights, the bot can also be manually triggered after a merge by leaving a message `@meeseeksdev backport to BRANCH` on the PR. If there are conflicts `meeseeksdevs` will inform you that the backport needs to be done manually.

The target branch is configured by putting `on-merge: backport to TARGETBRANCH` in the milestone description on it's own line.

If the bot is not working as expected, please report issues to [Meeseeksdev](#).

### 33.3.2 Manual backports

When doing backports please copy the form used by [meeseekdev](#), `Backport PR #XXXX: TITLE OF PR`. If you need to manually resolve conflicts make note of them and how you resolved them in the commit message.

We do a backport from master to `v2.2.x` assuming:

- `matplotlib` is a read-only remote branch of the `matplotlib/matplotlib` repo

The `TARGET_SHA` is the hash of the merge commit you would like to backport. This can be read off of the github PR page (in the UI with the merge notification) or through the git CLI tools.

Assuming that you already have a local branch `v2.2.x` (if not, then `git checkout -b v2.2.x`), and that your remote pointing to `https://github.com/matplotlib/matplotlib` is called `upstream`:

```
git fetch upstream
git checkout v2.2.x # or include -b if you don't already have this.
git reset --hard upstream/v2.2.x
git cherry-pick -m 1 TARGET_SHA
# resolve conflicts and commit if required
```

Files with conflicts can be listed by `git status`, and will have to be fixed by hand (search on >>>>). Once the conflict is resolved, you will have to re-add the file(s) to the branch and then continue the cherry pick:

```
git add lib/matplotlib/conflicted_file.py
git add lib/matplotlib/conflicted_file2.py
git cherry-pick --continue
```

Use your discretion to push directly to upstream or to open a PR; be sure to push or PR against the `v2.2.x` upstream branch, not `master`!



## RELEASE GUIDE

---

**This document is only relevant for matplotlib release managers.**

A guide for developers who are doing a matplotlib release.

---

**Note:** This assumes that a read-only remote for the canonical repository is `remote` and a read/write remote is `DANGER`

---

### 34.1 All Releases

#### 34.1.1 Testing

We use `travis-ci` for continuous integration. When preparing for a release, the final tagged commit should be tested locally before it is uploaded:

```
pytest -n 8 .
```

In addition the following test should be run and manually inspected:

```
python unit/memleak.py agg agg.pdf
```

In addition the following should be run and manually inspected, but is currently broken:

```
pushd examples/tests/  
python backend_driver_sgskip.py  
popd
```

#### 34.1.2 GitHub Stats

We automatically extract GitHub issue, PRs, and authors from GitHub via the API. copy the current `github_stats.rst` to `github_stats_X.Y.Z.rst`.

To re-generate the updated

```
python tools/github_stats.py --since-tag v2.2.0 --milestone=v3.0 --project 'matplotlib/  
↪matplotlib' --links > doc/users/github_stats.rst
```

Review and commit changes. Some issue/PR titles may not be valid rst (the most common issue is \* which is interpreted as unclosed markup).

### 34.1.3 Update and Validate the Docs

Merge the most recent 'doc' branch (v3.0.2-doc) into the branch you are going to tag on and delete the doc branch on GitHub.

Before tagging, update the "what's new" and "API changes" listings.

for the "what's new"

1. copy the current content to a file in doc/users/prev\_whats\_new
2. merge all of the files in doc/users/next\_whats\_new/ into doc/users/whats\_new.rst and delete the individual files
3. comment out the next whats new glob at the top

Similarly for the "API changes"

1. copy the current api changes to a file in doc/api/prev\_api\_changes
2. merge all of the files in doc/api/next\_api\_changes/ into doc//whats\_new.rst
3. comment out the next API changes at the top.

In both cases step 3 will have to be un-done right after the release.

Finally, make sure that the docs build cleanly

```
make -Cdoc O=-j$(nproc) html latexpdf
```

After the docs are built, check that all of the links, internal and external, are still valid. We use linkchecker for this, which has not been ported to python3 yet. You will need to create a python2 environment with requests==2.9.0 and linkchecker

```
conda create -p /tmp/lnkchk python=2 requests==2.9.0
source activate /tmp/lnkchk
pip install linkchecker
pushd doc/build/html
linkchecker index.html --check-extern
popd
```

Address any issues which may arise. The internal links are checked on travis, this should only flag failed external links.

### 34.1.4 Create release commit and tag

To create the tag, first create an empty commit with a very terse set of the release notes in the commit message

```
git commit --allow-empty
```

and then create a signed, annotated tag with the same text in the body message

```
git tag -a -s v2.0.0
```

which will prompt you for your gpg key password and an annotation. For pre releases it is important to follow [PEP 440](#) so that the build artifacts will sort correctly in pypi. Finally, push the tag to GitHub

```
git push -t DANGER v2.0.0
```

Congratulations, the scariest part is done!

To prevent issues with any down-stream builders which download the tarball from GitHub it is important to move all branches away from the commit with the tag<sup>1</sup>:

```
git commit --allow-empty
git push DANGER master
```

If this is a final release, also create a 'doc' branch (this is not done for pre-releases):

```
git branch v2.0.0-doc
git push DANGER v2.0.0-doc
```

and if this is a major or minor release, also create a bug-fix branch (a micro release will be cut off of this branch):

```
git branch v2.0.x
```

On this branch un-comment the globs from *Update and Validate the Docs*. And then

```
git push DANGER v2.0.x
```

### 34.1.5 Release Management / DOI

Via the [GitHub UI](#), turn the newly pushed tag into a release. If this is a pre-release remember to mark it as such.

For final releases also get a DOI from [zenodo](#) and edit `doc/citing.rst` with DOI link and commit to the VER-doc branch and push to GitHub

```
git checkout v2.0.0-doc
emacs doc/_templates/citing.html
git push DANGER v2.0.0-doc:v2.0.0-doc
```

### 34.1.6 Building binaries

We distribute mac, windows, and many linux wheels as well as a source tarball via pypi. Before uploading anything, contact the various builders. Mac and manylinux wheels are built

<sup>1</sup> The tarball that is provided by GitHub is produced using [git archive](#). We use [versioneer](#) which uses a format string in `lib/matplotlib/_version.py` to have git insert a list of references to exported commit (see `.gitattributes` for the configuration). This string is then used by `versioneer` to produce the correct version, based on the git tag, when users install from the tarball. However, if there is a branch pointed at the tagged commit, then the branch name will also be included in the tarball. When the branch eventually moves, anyone who checked the hash of the tarball before the branch moved will have an incorrect hash.

To generate the file that GitHub does use

```
git archive v2.0.0 -o matplotlib-2.0.0.tar.gz --prefix=matplotlib-2.0.0/
```

on travis . You need to edit the `.travis.yml` file and push to the correct branch of [the build project](#). For new minor versions create a new branch, for bug-fixes continue to use the current release branch.

The auto-tick bot should open a pull request into the [conda-forge feedstock](#). Review and merge (if you have the power to).

**Warning:** Because this is automated, it is extremely important to bump all branches away from the tag as discussed in *Create release commit and tag*.

If this is a final release the following downstream packagers should be contacted:

- Debian
- Fedora
- Arch
- Gentoo
- Macports
- Homebrew
- Christoph Gohlke
- Continuum
- Enthought

This can be done ahead of collecting all of the binaries and uploading to pypi.

### 34.1.7 make distribution and upload to pypi / SF

Once you have collected all of the wheels (expect this to take about a day), generate the tarball

```
git checkout v2.0.0
git clean -xfd
python setup.py sdist
```

and copy all of the wheels into dist directory. You should use `twine` to upload all of the files to pypi

```
twine upload -s dist/matplotlib*tar.gz
twine upload dist/*whl
```

Congratulations, you have now done the second scariest part!

Additionally, for a final release, upload all of the files to sourceforge.

### 34.1.8 Build and Deploy Documentation

To build the documentation you must have the tagged version installed, but build the docs from the `ver-doc` branch. An easy way to arrange this is:

```

pip install matplotlib
pip install -r requirements/doc/doc-requirements.txt
git checkout v2.0.0-doc
git clean -xfd
cd doc
make O=-n$(nproc) html latexpdf

```

which will build both the html and pdf version of the documentation.

The built documentation exists in the [matplotlib.github.com](https://matplotlib.github.com) repository. Pushing changes to master automatically updates the website.

The documentation is organized by version. At the root of the tree is always the documentation for the latest stable release. Under that, there are directories containing the documentation for older versions. The documentation for current master are built on travis and push to the [devdocs](https://matplotlib.org/devdocs) repository. These are available at [matplotlib.org/devdocs](https://matplotlib.org/devdocs).

Assuming you have this repository checked out in the same directory as matplotlib

```

cd ../matplotlib.github.com
mkdir 2.0.0
rsync -a ../matplotlib/doc/build/html/* 2.0.0
cp ../matplotlib/doc/build/latex/Matplotlib.pdf 2.0.0

```

which will copy the built docs over. If this is a final release, also replace the top-level docs

```
rsync -a 2.0.0/* ./
```

You will need to manually edit `versions.html` to show the last 3 tagged versions. Now commit and push everything to GitHub

```

git add *
git commit -a -m 'Updating docs for v2.0.0'
git push DANGER master

```

Congratulations you have now done the third scariest part!

If you have access, clear the cloudflare caches.

It typically takes about 5-10 minutes for GitHub to process the push and update the live web page (remember to clear your browser cache).

### 34.1.9 Announcing

The final step is to announce the release to the world. A short version of the release notes along with acknowledgments should be sent to

- [matplotlib-user@python.org](mailto:matplotlib-user@python.org)
- [matplotlib-devel@python.org](mailto:matplotlib-devel@python.org)
- [matplotlib-announce@python.org](mailto:matplotlib-announce@python.org)

For final releases announcements should also be sent to the numpy/scipy/scikit-image mailing lists.

In addition, announcements should be made on social networks (twitter via the @matplotlib account, any other via personal accounts). NumFOCUS should be contacted for inclusion in their newsletter.

## MINIMUM VERSION OF DEPENDENCIES POLICY

For the purpose of this document, 'minor version' is in the sense of SemVer (major, minor, patch) and includes both major and minor releases. For projects that use date-based versioning, every release is a 'minor version'.

### 35.1 Python and numpy

- support minor versions of Python initially released 36 months prior to our planned release date.
- support minor versions of numpy initially released in the 36 months prior to our planned release date or oldest that supports the minimum python version (which ever is higher)

We will bump the minimum python and numpy versions as we can every minor and major release, but never on a patch release.

### 35.2 Python Dependencies

For python dependencies we should support at least:

**with compiled extensions** minor versions initially released in the 36 months prior to our planned release date or the oldest that support our minimum python + numpy

**without complied extensions** minor versions initially released in the 24 months prior to our planed release date or the oldest that supports our minimum python.

We will only bump these dependencies as we need new features or the old versions no longer support our minimum numpy or python.

### 35.3 Test and Documentation Dependencies

As these packages are only needed for testing or building the docs and not needed by end-users, we can be more aggressive about dropping support for old versions. However, we need to be careful to not over-run what down-stream packagers support (as most of the run the tests and build the documentation as part of the packaging process).

We will support at least minor versions of the development dependencies released in the 12 months prior to our planned release.

We will only bump these as needed or versions no longer support our minimum Python and numpy.

## 35.4 System and C-dependencies

For system or c-dependencies (libpng, freetype, GUI frameworks, latex, gs, ffmpeg) support as old as practical. These can be difficult to install for end-users and we want to be usable on as many systems as possible. We will bump these on a case-by-case basis.

## MATPLOTLIB ENHANCEMENT PROPOSALS

Matplotlib Enhancement Proposals (MEP), inspired by cpython's [PEP's](#) but less formal, are design documents for large or controversial changes to Matplotlib. These documents should provide a discussion of both why and how the changes should be made.

To create a new MEP open a pull request (PR) adding a file based on *the template* to this the MEP directory. For the initial PR only a rough description is required and it should be merged quickly. Further detailed discussion can happen in follow on PRs.

### 36.1 MEP Template

- *Status*
- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
- *Implementation*
- *Backward compatibility*
- *Alternatives*

This MEP template is a guideline of the sections that a MEP should contain. Extra sections may be added if appropriate, and unnecessary sections may be noted as such.

#### 36.1.1 Status

MEPs go through a number of phases in their lifetime:

- **Discussion:** The MEP is being actively discussed on the mailing list and it is being improved by its author. The mailing list discussion of the MEP should include the MEP number (MEPxxx) in the subject line so they can be easily related to the MEP.
- **Progress:** Consensus was reached and implementation work has begun.
- **Completed:** The implementation has been merged into master.
- **Superseded:** This MEP has been abandoned in favor of another approach.
- **Rejected:** There are currently no plans to implement the proposal.

### 36.1.2 Branches and Pull requests

All development branches containing work on this MEP should be linked to from here.

All pull requests submitted relating to this MEP should be linked to from here. (A MEP does not need to be implemented in a single pull request if it makes sense to implement it in discrete phases).

### 36.1.3 Abstract

The abstract should be a short description of what the MEP will achieve.

### 36.1.4 Detailed description

This section describes the need for the MEP. It should describe the existing problem that it is trying to solve and why this MEP makes the situation better. It should include examples of how the new functionality would be used and perhaps some use cases.

### 36.1.5 Implementation

This section lists the major steps required to implement the MEP. Where possible, it should be noted where one step is dependent on another, and which steps may be optionally omitted. Where it makes sense, each step should include a link related pull requests as the implementation progresses.

### 36.1.6 Backward compatibility

This section describes the ways in which the MEP breaks backward incompatibility.

### 36.1.7 Alternatives

If there were any alternative solutions to solving the same problem, they should be discussed here, along with a justification for the chosen approach.

## 36.2 MEP8: PEP8

- *Status*
- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
- *Implementation*

- *Backward compatibility*
- *Alternatives*

### 36.2.1 Status

#### **Completed**

We are currently enforcing a sub-set of pep8 on new code contributions.

### 36.2.2 Branches and Pull requests

None so far.

### 36.2.3 Abstract

The matplotlib codebase predates PEP8, and therefore is less than consistent style-wise in some areas. Bringing the codebase into compliance with PEP8 would go a long way to improving its legibility.

### 36.2.4 Detailed description

Some files use four space indentation, some use three. Some use different levels in the same file.

For the most part, class/function/variable naming follows PEP8, but it wouldn't hurt to fix where necessary.

### 36.2.5 Implementation

The implementation should be fairly mechanical: running the pep8 tool over the code and fixing where appropriate.

This should be merged in after the 2.0 release, since the changes will likely make merging any pending pull requests more difficult.

Additionally, and optionally, PEP8 compliance could be tracked by an automated build system.

### 36.2.6 Backward compatibility

Public names of classes and functions that require change (there shouldn't be many of these) should first be deprecated and then removed in the next release cycle.

### 36.2.7 Alternatives

PEP8 is a popular standard for Python code style, blessed by the Python core developers, making any alternatives less desirable.

## 36.3 MEP9: Global interaction manager

- *Status*
- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
- *Implementation*
- *Current summary of the mixin*
- *Backward compatibility*
- *Alternatives*

Add a global manager for all user interactivity with artists; make any artist resizable, moveable, highlightable, and selectable as desired by the user.

### 36.3.1 Status

#### Discussion

### 36.3.2 Branches and Pull requests

<https://github.com/dhyams/matplotlib/tree/MEP9>

### 36.3.3 Abstract

The goal is to be able to interact with matplotlib artists in a very similar way as drawing programs do. When appropriate, the user should be able to move, resize, or select an artist that is already on the canvas. Of course, the script writer is ultimately in control of whether an artist is able to be interacted with, or whether it is static.

This code to do this has already been privately implemented and tested, and would need to be migrated from its current "mixin" implementation, to a bona-fide part of matplotlib.

The end result would be to have four new keywords available to `matplotlib.artist.Artist`: `_moveable_`, `_resizeable_`, `_selectable_`, and `_highlightable_`. Setting any one of these keywords to `True` would activate interactivity for that artist.

In effect, this MEP is a logical extension of event handling in matplotlib; matplotlib already supports "low level" interactions like left mouse presses, a key press, or similar. The MEP extends the support to the logical level, where callbacks are performed on the artists when certain interactive gestures from the user are detected.

### 36.3.4 Detailed description

This new functionality would be used to allow the end-user to better interact with the graph. Many times, a graph is almost what the user wants, but a small repositioning and/or resizing

of components is necessary. Rather than force the user to go back to the script to trial-and-error the location, and simple drag and drop would be appropriate.

Also, this would better support applications that use matplotlib; here, the end-user has no reasonable access or desire to edit the underlying source in order to fine-tune a plot. Here, if matplotlib offered the capability, one could move or resize artists on the canvas to suit their needs. Also, the user should be able to highlight (with a mouse over) an artist, and select it with a double-click, if the application supports that sort of thing. In this MEP, we also want to support the highlighting and selection natively; it is up to application to handle what happens when the artist is selected. A typical handling would be to display a dialog to edit the properties of the artist.

In the future, as well (this is not part of this MEP), matplotlib could offer backend-specific property dialogs for each artist, which are raised on artist selection. This MEP would be a necessary stepping stone for that sort of capability.

There are currently a few interactive capabilities in matplotlib (e.g. `legend.draggable()`), but they tend to be scattered and are not available for all artists. This MEP seeks to unify the interactive interface and make it work for all artists.

The current MEP also includes grab handles for resizing artists, and appropriate boxes drawn when artists are moved or resized.

### 36.3.5 Implementation

- Add appropriate methods to the “tree” of artists so that the interactivity manager has a consistent interface for the interactivity manager to deal with. The proposed methods to add to the artists, if they are to support interactivity, are:
  - `get_pixel_position_ll(self)`: get the pixel position of the lower left corner of the artist’s bounding box
  - `get_pixel_size(self)`: get the size of the artist’s bounding box, in pixels
  - `set_pixel_position_and_size(self,x,y,dx,dy)`: set the new size of the artist, such that it fits within the specified bounding box.
- add capability to the backends to 1) provide cursors, since these are needed for visual indication of moving/resizing, and 2) provide a function that gets the current mouse position
- Implement the manager. This has already been done privately (by dhyams) as a mixin, and has been tested quite a bit. The goal would be to move the functionality of the manager into the artists so that it is in matplotlib properly, and not as a “monkey patch” as I currently have it coded.

### 36.3.6 Current summary of the mixin

(Note that this mixin is for now just private code, but can be added to a branch obviously)

InteractiveArtistMixin:

Mixin class to make any generic object that is drawn on a matplotlib canvas moveable and possibly resizable. The Powerpoint model is followed as closely as possible; not because I’m enamoured with Powerpoint, but because that’s what most people understand. An artist can also be selectable, which means that the artist will receive the `on_activated()` callback when double clicked. Finally, an artist can be highlightable, which means that a highlight is drawn

on the artist whenever the mouse passes over. Typically, highlightable artists will also be selectable, but that is left up to the user. So, basically there are four attributes that can be set by the user on a per-artist basis:

- highlightable
- selectable
- moveable
- resizable

To be moveable (draggable) or resizable, the object that is the target of the mixin must support the following protocols:

- `get_pixel_position_ll(self)`
- `get_pixel_size(self)`
- `set_pixel_position_and_size(self,x,y,sx,sy)`

Note that nonresizable objects are free to ignore the `sx` and `sy` parameters. To be highlightable, the object that is the target of the mixin must also support the following protocol:

- `get_highlight(self)`

Which returns a list of artists that will be used to draw the highlight.

If the object that is the target of the mixin is not a matplotlib artist, the following protocols must also be implemented. Doing so is usually fairly trivial, as there has to be an artist *somewhere* that is being drawn. Typically your object would just route these calls to that artist.

- `get_figure(self)`
- `get_axes(self)`
- `contains(self,event)`
- `set_animated(self,flag)`
- `draw(self,renderer)`
- `get_visible(self)`

The following notifications are called on the artist, and the artist can optionally implement these.

- `on_select_begin(self)`
- `on_select_end(self)`
- `on_drag_begin(self)`
- `on_drag_end(self)`
- `on_activated(self)`
- `on_highlight(self)`
- `on_right_click(self,event)`
- `on_left_click(self,event)`
- `on_middle_click(self,event)`
- `on_context_click(self,event)`
- `on_key_up(self,event)`

- `on_key_down(self,event)`

The following notifications are called on the canvas, if no interactive artist handles the event:

- `on_press(self,event)`
- `on_left_click(self,event)`
- `on_middle_click(self,event)`
- `on_right_click(self,event)`
- `on_context_click(self,event)`
- `on_key_up(self,event)`
- `on_key_down(self,event)`

The following functions, if present, can be used to modify the behavior of the interactive object:

- `press_filter(self,event)` # determines if the object wants to have the press event routed to it
- `handle_unpicked_cursor()` # can be used by the object to set a cursor as the cursor passes over the object when it is unpicked.

Supports multiple canvases, maintaining a drag lock, motion notifier, and a global "enabled" flag per canvas. Supports fixed aspect ratio resizings by holding the shift key during the resize.

Known problems:

- Zorder is not obeyed during the selection/drag operations. Because of the blit technique used, I do not believe this can be fixed. The only way I can think of is to search for all artists that have a zorder greater than me, set them all to animated, and then redraw them all on top during each drag refresh. This might be very slow; need to try.
- the mixin only works for wx backends because of two things: 1) the cursors are hard-coded, and 2) there is a call to `wx.GetMousePosition()` Both of these shortcomings are reasonably fixed by having each backend supply these things.

### 36.3.7 Backward compatibility

No problems with backward compatibility, although once this is in place, it would be appropriate to obsolete some of the existing interactive functions (like `legend.draggable()`)

### 36.3.8 Alternatives

None that I know of.

## 36.4 MEP10: Docstring consistency

- *Status*

- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
  - *Numpy docstring format*
  - *Cross references*
  - *Overriding signatures*
  - *Linking rather than duplicating*
  - *autosummary extension*
  - *Examples linking to relevant documentation*
  - *Documentation using help() vs a browser*
- *Implementation*
- *Backward compatibility*
- *Alternatives*

### 36.4.1 Status

#### **Progress**

This is still an on-going effort

### 36.4.2 Branches and Pull requests

### 36.4.3 Abstract

matplotlib has a great deal of inconsistency between docstrings. This not only makes the docs harder to read, but it is harder on contributors, because they don't know which specifications to follow. There should be a clear docstring convention that is followed consistently.

The organization of the API documentation is difficult to follow. Some pages, such as pyplot and axes, are enormous and hard to browse. There should instead be short summary tables that link to detailed documentation. In addition, some of the docstrings themselves are quite long and contain redundant information.

Building the documentation takes a long time and uses a `make.py` script rather than a Makefile.

### 36.4.4 Detailed description

There are number of new tools and conventions available since matplotlib started using Sphinx that make life easier. The following is a list of proposed changes to docstrings, most of which involve these new features.

## Numpy docstring format

**Numpy docstring format:** This format divides the docstring into clear sections, each having different parsing rules that make the docstring easy to read both as raw text and as HTML. We could consider alternatives, or invent our own, but this is a strong choice, as it's well used and understood in the Numpy/Scipy community.

## Cross references

Most of the docstrings in matplotlib use explicit "roles" when linking to other items, for example: `:func:`myfunction``. As of Sphinx 0.4, there is a "default\_role" that can be set to "obj", which will polymorphically link to a Python object of any type. This allows one to write ``myfunction`` instead. This makes docstrings much easier to read and edit as raw text. Additionally, Sphinx allows for setting a current module, so links like ``~matplotlib.axes.Axes.set_xlim`` could be written as ``~axes.Axes.set_xlim``.

## Overriding signatures

Many methods in matplotlib use the `*args` and `**kwargs` syntax to dynamically handle the keyword arguments that are accepted by the function, or to delegate on to another function. This, however, is often not useful as a signature in the documentation. For this reason, many matplotlib methods include something like:

```
def annotate(self, *args, **kwargs):
    """
    Create an annotation: a piece of text referring to a data
    point.

    Call signature::

        annotate(s, xy, xytext=None, xycoords='data',
               textcoords='data', arrowprops=None, **kwargs)
    """
```

This can't be parsed by Sphinx, and is rather verbose in raw text. As of Sphinx 1.1, if the `autodoc_docstring_signature` config value is set to True, Sphinx will extract a replacement signature from the first line of the docstring, allowing this:

```
def annotate(self, *args, **kwargs):
    """
    annotate(s, xy, xytext=None, xycoords='data',
            textcoords='data', arrowprops=None, **kwargs)

    Create an annotation: a piece of text referring to a data
    point.
    """
```

The explicit signature will replace the actual Python one in the generated documentation.

### Linking rather than duplicating

Many of the docstrings include long lists of accepted keywords by interpolating things into the docstring at load time. This makes the docstrings very long. Also, since these tables are the same across many docstrings, it inserts a lot of redundant information in the docs - particularly a problem in the printed version.

These tables should be moved to docstrings on functions whose only purpose is for help. The docstrings that refer to these tables should link to them, rather than including them verbatim.

### autosummary extension

The Sphinx autosummary extension should be used to generate summary tables, that link to separate pages of documentation. Some classes that have many methods (e.g. `Axes.axes`) should be documented with one method per page, whereas smaller classes should have all of their methods together.

### Examples linking to relevant documentation

The examples, while helpful at illustrating how to use a feature, do not link back to the relevant docstrings. This could be addressed by adding module-level docstrings to the examples, and then including that docstring in the parsed content on the example page. These docstrings could easily include references to any other part of the documentation.

### Documentation using `help()` vs a browser

Using Sphinx markup in the source allows for good-looking docs in your browser, but the markup also makes the raw text returned using `help()` look terrible. One of the aims of improving the docstrings should be to make both methods of accessing the docs look good.

## 36.4.5 Implementation

1. The `numpydoc` extensions should be turned on for `matplotlib`. There is an important question as to whether these should be included in the `matplotlib` source tree, or used as a dependency. Installing `Numpy` is not sufficient to get the `numpydoc` extensions - it's a separate install procedure. In any case, to the extent that they require customization for our needs, we should endeavor to submit those changes upstream and not fork them.
2. Manually go through all of the docstrings and update them to the new format and conventions. Updating the cross references (from ``:func:`myfunc`` to ``func``) may be able to be semi-automated. This is a lot of busy work, and perhaps this labor should be divided on a per-module basis so no single developer is over-burdened by it.
3. Reorganize the API docs using `autosummary` and `sphinx-autogen`. This should hopefully have minimal impact on the narrative documentation.
4. Modify the example page generator (`gen_rst.py`) so that it extracts the module docstring from the example and includes it in a non-literal part of the example page.
5. Use `sphinx-quickstart` to generate a new-style Sphinx Makefile. The following features in the current `make.py` will have to be addressed in some other way:

- Copying of some static content
- Specifying a "small" build (only low-resolution PNG files for examples)

Steps 1, 2, and 3 are interdependent. 4 and 5 may be done independently, though 5 has some dependency on 3.

### 36.4.6 Backward compatibility

As this mainly involves docstrings, there should be minimal impact on backward compatibility.

### 36.4.7 Alternatives

None yet discussed.

## 36.5 MEP11: Third-party dependencies

- *Status*
- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
  - *Current behavior*
  - *Desired behavior*
- *Implementation*
- *Backward compatibility*
- *Alternatives*

This MEP attempts to improve the way in which third-party dependencies in matplotlib are handled.

### 36.5.1 Status

**Completed** - needs to be merged

### 36.5.2 Branches and Pull requests

#1157: Use automatic dependency resolution

#1290: Debundle pyparsing

#1261: Update six to 1.2

### 36.5.3 Abstract

One of the goals of matplotlib has been to keep it as easy to install as possible. To that end, some third-party dependencies are included in the source tree and, under certain circumstances, installed alongside matplotlib. This MEP aims to resolve some problems with that approach, bring some consistency, while continuing to make installation convenient.

At the time that was initially done, `setuptools`, `easy_install` and `PyPI` were not mature enough to be relied on. However, at present, we should be able to safely leverage the “modern” versions of those tools, `distribute` and `pip`.

While matplotlib has dependencies on both Python libraries and C/C++ libraries, this MEP addresses only the Python libraries so as to not confuse the issue. C libraries represent a larger and mostly orthogonal set of problems.

### 36.5.4 Detailed description

matplotlib depends on the following third-party Python libraries:

- Numpy
- `dateutil` (pure Python)
- `pytz` (pure Python)
- `six` - required by `dateutil` (pure Python)
- `pyparsing` (pure Python)
- PIL (optional)
- GUI frameworks: `pygtk`, `gobject`, `tkinter`, `PySide`, `PyQt4`, `wx` (all optional, but one is required for an interactive GUI)

#### Current behavior

When installing from source, a `git checkout` or `pip`:

- `setup.py` attempts to `import numpy`. If this fails, the installation fails.
- For each of `dateutil`, `pytz` and `six`, `setup.py` attempts to import them (from the top-level namespace). If that fails, matplotlib installs its local copy of the library into the top-level namespace.
- `pyparsing` is always installed inside of the matplotlib namespace.

This behavior is most surprising when used with `pip`, because no `pip` dependency resolution is performed, even though it is likely to work for all of these packages.

The fact that `pyparsing` is installed in the matplotlib namespace has reportedly (#1290) confused some users into thinking it is a matplotlib-related module and import it from there rather than the top-level.

When installing using the Windows installer, `dateutil`, `pytz` and `six` are installed at the top-level *always*, potentially overwriting already installed copies of those libraries.

TODO: Describe behavior with the OS-X installer.

When installing using a package manager (Debian, RedHat, MacPorts etc.), this behavior actually does the right thing, and there are no special patches in the matplotlib packages to

deal with the fact that we handle `dateutil`, `pytz` and `six` in this way. However, care should be taken that whatever approach we move to continues to work in that context.

Maintaining these packages in the matplotlib tree and making sure they are up-to-date is a maintenance burden. Advanced new features that may require a third-party pure Python library have a higher barrier to inclusion because of this burden.

### Desired behavior

Third-party dependencies are downloaded and installed from their canonical locations by leveraging `pip`, `distribute` and `PyPI`.

`dateutil`, `pytz`, and `yparsing` should be made into optional dependencies - though obviously some features would fail if they aren't installed. This will allow the user to decide whether they want to bother installing a particular feature.

### 36.5.5 Implementation

For installing from source, and assuming the user has all of the C-level compilers and dependencies, this can be accomplished fairly easily using `distribute` and following the instructions [here](#). The only anticipated change to the matplotlib library code will be to import `yparsing` from the top-level namespace rather than from within `matplotlib`. Note that `distribute` will also allow us to remove the direct dependency on `six`, since it is, strictly speaking, only a direct dependency of `dateutil`.

For binary installations, there are a number of alternatives (here ordered from best/hardest to worst/easiest):

1. The distutils wininst installer allows a post-install script to run. It might be possible to get this script to run `pip` to install the other dependencies. (See [this thread](#) for someone who has trod that ground before).
2. Continue to ship `dateutil`, `pytz`, `six` and `yparsing` in our installer, but use the post-install-script to install them *only* if they can not already be found.
3. Move all of these packages inside a (new) `matplotlib.extern` namespace so it is clear for outside users that these are external packages. Add some conditional imports in the core matplotlib codebase so `dateutil` (at the top-level) is tried first, and failing that `matplotlib.extern.dateutil` is used.

2 and 3 are undesirable as they still require maintaining copies of these packages in our tree - and this is exacerbated by the fact that they are used less - only in the binary installers. None of these 3 approaches address Numpy, which will still have to be manually installed using an installer.

TODO: How does this relate to the Mac OS-X installer?

### 36.5.6 Backward compatibility

At present, matplotlib can be installed from source on a machine without the third party dependencies and without an internet connection. After this change, an internet connection (and a working PyPI) will be required to install matplotlib for the first time. (Subsequent matplotlib updates or development work will run without accessing the network).

### 36.5.7 Alternatives

Distributing binary eggs doesn't feel like a usable solution. That requires getting `easy_install` installed first, and Windows users generally prefer the well known `exe` or `msi` installer that works out of the box.

## 36.6 MEP12: Improve Gallery and Examples

- *Status*
- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
- *Implementation*
  - *Gallery sections*
  - *Clean up guidelines*
    - \* *Additional suggestions*
- *Backward compatibility*
- *Alternatives*
  - *Tags*

### 36.6.1 Status

#### Progress

Initial changes added in 1.3. Conversion of the gallery is on-going. 29 September 2015 - The last `pylab_examples` where `pylab` is imported has been converted over to use `matplotlib.pyplot` and `numpy`.

### 36.6.2 Branches and Pull requests

#1623, #1924, #2181

PR #2474 <<https://github.com/matplotlib/matplotlib/pull/2474>>\_ demonstrates a single example being cleaned up and moved to the appropriate section.

### 36.6.3 Abstract

Reorganizing the matplotlib plot gallery would greatly simplify navigation of the gallery. In addition, examples should be cleaned-up and simplified for clarity.

### 36.6.4 Detailed description

The matplotlib gallery was recently set up to split examples up into sections. As discussed in that PR<sup>1</sup>, the current example sections (`api`, `pylab_examples`) aren't terribly useful to users: New sections in the gallery would help users find relevant examples.

These sections would also guide a cleanup of the examples: Initially, all the current examples would remain and be listed under their current directories. Over time, these examples could be cleaned up and moved into one of the new sections.

This process allows users to easily identify examples that need to be cleaned up; i.e. anything in the `api` and `pylab_examples` directories.

### 36.6.5 Implementation

1. Create new gallery sections. [Done]
2. Clean up examples and move them to the new gallery sections (over the course of many PRs and with the help of many users/developers). [In progress]

#### Gallery sections

The naming of sections is critical and will guide the clean-up effort. The current sections are:

- Lines, bars, and markers (more-or-less 1D data)
- Shapes and collections
- Statistical plots
- Images, contours, and fields
- Pie and polar charts: Round things
- Color
- Text, labels, and annotations
- Ticks and spines
- Subplots, axes, and figures
- Specialty plots (e.g., sankey, radar, tornado)
- Showcase (plots with tweaks to make them publication-quality)
- separate sections for toolboxes (already exists: `'mplot3d'`, `'axes_grid'`, `'units'`, `'widgets'`)

These names are certainly up for debate. As these sections grow, we should reevaluate them and split them up as necessary.

#### Clean up guidelines

The current examples in the `api` and `pylab_examples` sections of the gallery would remain in those directories until they are cleaned up. After clean-up, they would be moved to one of the new gallery sections described above. "Clean-up" should involve:

---

<sup>1</sup> <https://github.com/matplotlib/matplotlib/pull/714>

- [sphinx-gallery docstrings](#): a title and a description of the example formatted as follows, at the top of the example:

```
"""
=====
Colormaps alter your perception
=====

Here I plot the function

.. math:: f(x, y) = \sin(x) + \cos(y)

with different colormaps. Look at how colormaps alter your perception!
"""
```

- PEP8 clean-ups (running [flake8](#), or a similar checker, is highly recommended)
- Commented-out code should be removed.
- Replace uses of pylab interface with pyplot (+ numpy, etc.). See [c25ef1e](#)
- Remove shebang line, e.g.:  

```
#!/usr/bin/env python
```
- Use consistent imports. In particular:  

```
import numpy as np
import matplotlib.pyplot as plt
```

Avoid importing specific functions from these modules (e.g. from numpy import sin)
- Each example should focus on a specific feature (excluding showcase examples, which will show more "polished" plots). Tweaking unrelated to that feature should be removed. See [f7b2217](#), [e57b5fc](#), and [1458aa8](#)

Use of pylab should be demonstrated/discussed on a dedicated help page instead of the gallery examples.

**Note:** When moving an existing example, you should search for references to that example. For example, the API documentation for `axes.py` and `pyplot.py` may use these examples to generate plots. Use your favorite search tool (e.g., `grep`, `ack`, [grin](#), [pss](#)) to search the matplotlib package. See [2dc9a46](#) and [aa6b410](#)

### Additional suggestions

- Provide links (both ways) between examples and API docs for the methods/objects used. (issue [#2222](#))
- Use `plt.subplots` (note trailing "s") in preference over `plt.subplot`.
- Rename the example to clarify it's purpose. For example, the most basic demo of `imshow` might be `imshow_demo.py`, and one demonstrating different interpolation settings would be `imshow_demo_interpolation.py` (*not* `imshow_demo2.py`).
- Split up examples that try to do too much. See [5099675](#) and [fc2ab07](#)
- Delete examples that don't show anything new.

- Some examples exercise esoteric features for unit testing. These tweaks should be moved out of the gallery to an example in the `unit` directory located in the root directory of the package.
- Add plot titles to clarify intent of the example. See [bd2b13c](#)

### 36.6.6 Backward compatibility

The website for each Matplotlib version is readily accessible, so users who want to refer to old examples can still do so.

### 36.6.7 Alternatives

#### Tags

Tagging examples will also help users search the example gallery. Although tags would be a big win for users with specific goals, the plot gallery will remain the entry point to these examples, and sections could really help users navigate the gallery. Thus, tags are complementary to this reorganization.

## 36.7 MEP13: Use properties for Artists

- *Status*
- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
- *Implementation*
- *Backward compatibility*
- *Examples*
  - `axes.Axes.set_axis_off/set_axis_on`
  - `axes.Axes.get_xlim/set_xlim` and `get_autoscalex_on/set_autoscalex_on`
  - `axes.Axes.get_title/set_title`
  - `axes.Axes.get_xticklabels/set_xticklabels`
- *Alternatives*

### 36.7.1 Status

- **Discussion**

### 36.7.2 Branches and Pull requests

None

### 36.7.3 Abstract

Wrap all of the matplotlib getter and setter methods with python `properties`, allowing them to be read and written like class attributes.

### 36.7.4 Detailed description

Currently matplotlib uses getter and setter functions (usually prefixed with `get_` and `set_`, respectively) for reading and writing data related to classes. However, since 2.6 python supports properties, which allow such setter and getter functions to be accessed as though they were attributes. This proposal would implement all existing setter and getter methods as properties.

### 36.7.5 Implementation

1. All existing getter and setter methods will need to have two aliases, one with the `get_` or `set_` prefix and one without. Getter methods that currently lack prefixes should be recording in a text file.
2. Classes should be reorganized so setter and getter methods are sequential in the code, with getter methods first.
3. Getter and setter methods the provide additional optional optional arguments should have those arguments accessible in another manner, either as additional getter or setter methods or attributes of other classes. If those classes are not accessible, getters for them should be added.
4. Property decorators will be added to the setter and getter methods without the prefix. Those with the prefix will be marked as deprecated.
5. Docstrings will need to be rewritten so the getter with the prefix has the current docstring and the getter without the prefix has a generic docstring appropriate for an attribute.
6. Automatic alias generation will need to be modified so it will also create aliases for the properties.
7. All instances of getter and setter method calls will need to be changed to attribute access.
8. All setter and getter aliases with prefixes will be removed

The following steps can be done simultaneously: 1, 2, and 3; 4 and 5; 6 and 7.

Only the following steps must be done in the same release: 4, 5, and 6. All other changes can be done in separate releases. 8 should be done several major releases after everything else.

### 36.7.6 Backward compatibility

All existing getter methods that do not have a prefix (such as `get_`) will need to be changed from function calls to attribute access. In most cases this will only require removing the parenthesis.

setter and getter methods that have additional optional arguments will need to have those arguments implemented in another way, either as a separate property in the same class or as attributes or properties of another class.

Cases where the setter returns a value will need to be changed to using the setter followed by the getter.

Cases where there are `set_ATTR_on()` and `set_ATTR_off()` methods will be changed to `ATTR_on` properties.

### 36.7.7 Examples

#### `axes.Axes.set_axis_off/set_axis_on`

Current implementation:

```
axes.Axes.set_axis_off()
axes.Axes.set_axis_on()
```

New implementation:

```
True = axes.Axes.axis_on
False = axes.Axes.axis_off
axes.Axes.axis_on = True
axes.Axes.axis_off = False
```

#### `axes.Axes.get_xlim/set_xlim` and `get_autoscalex_on/set_autoscalex_on`

Current implementation:

```
[left, right] = axes.Axes.get_xlim()
auto = axes.Axes.get_autoscalex_on()

[left, right] = axes.Axes.set_xlim(left=left, right=right, emit=emit, auto=auto)
[left, right] = axes.Axes.set_xlim(left=left, right=None, emit=emit, auto=auto)
[left, right] = axes.Axes.set_xlim(left=None, right=right, emit=emit, auto=auto)
[left, right] = axes.Axes.set_xlim(left=left, emit=emit, auto=auto)
[left, right] = axes.Axes.set_xlim(right=right, emit=emit, auto=auto)

axes.Axes.set_autoscalex_on(auto)
```

New implementation:

```
[left, right] = axes.Axes.axes_xlim
auto = axes.Axes.autoscalex_on
```

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```

axes.Axes.axes_xlim = [left, right]
axes.Axes.axes_xlim = [left, None]
axes.Axes.axes_xlim = [None, right]
axes.Axes.axes_xlim[0] = left
axes.Axes.axes_xlim[1] = right

axes.Axes.autoscalex_on = auto

axes.Axes.emit_xlim = emit

```

**axes.Axes.get\_title/set\_title**

Current implementation:

```

string = axes.Axes.get_title()
axes.Axes.set_title(string, fontdict=fontdict, **kwargs)

```

New implementation:

```

string = axes.Axes.title
string = axes.Axes.title_text.text

text.Text = axes.Axes.title_text
text.Text.<attribute> = attribute
text.Text.fontdict = fontdict

axes.Axes.title = string
axes.Axes.title = text.Text
axes.Axes.title_text = string
axes.Axes.title_text = text.Text

```

**axes.Axes.get\_xticklabels/set\_xticklabels**

Current implementation:

```

[text.Text] = axes.Axes.get_xticklabels()
[text.Text] = axes.Axes.get_xticklabels(minor=False)
[text.Text] = axes.Axes.get_xticklabels(minor=True)
[text.Text] = axes.Axes.([string], fontdict=None, **kwargs)
[text.Text] = axes.Axes.([string], fontdict=None, minor=False, **kwargs)
[text.Text] = axes.Axes.([string], fontdict=None, minor=True, **kwargs)

```

New implementation:

```

[text.Text] = axes.Axes.xticklabels
[text.Text] = axes.Axes.xminorticklabels
axes.Axes.xticklabels = [string]
axes.Axes.xminorticklabels = [string]
axes.Axes.xticklabels = [text.Text]
axes.Axes.xminorticklabels = [text.Text]

```

### 36.7.8 Alternatives

Instead of using decorators, it is also possible to use the property function. This would change the procedure so that all getter methods that lack a prefix will need to be renamed or removed. This makes handling docstrings more difficult and harder to read.

It is not necessary to deprecate the setter and getter methods, but leaving them in will complicate the code.

This could also serve as an opportunity to rewrite or even remove automatic alias generation.

Another alternate proposal:

Convert `set_xlim`, `set_xlabel`, `set_title`, etc. to `xlim`, `xlabel`, `title`,... to make the transition from `plt` functions to `axes` methods significantly simpler. These would still be methods, not properties, but it's still a great usability enhancement while retaining the interface.

## 36.8 MEP14: Text handling

- *Status*
- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
- *Implementation*
- *Backward compatibility*
- *Alternatives*

### 36.8.1 Status

- **Discussion**

### 36.8.2 Branches and Pull requests

Issue #253 demonstrates a bug where using the bounding box rather than the advance width of text results in misaligned text. This is a minor point in the grand scheme of things, but it should be addressed as part of this MEP.

### 36.8.3 Abstract

By reorganizing how text is handled, this MEP aims to:

- improve support for Unicode and non-ltr languages
- improve text layout (especially multi-line text)

- allow support for more fonts, especially non-Apple-format TrueType fonts and OpenType fonts.
- make the font configuration easier and more transparent

### 36.8.4 Detailed description

#### Text layout

At present, matplotlib has two different ways to render text: "built-in" (based on FreeType and our own Python code), and "usetex" (based on calling out to a TeX installation). Adjunct to the "built-in" renderer there is also the Python-based "mathtext" system for rendering mathematical equations using a subset of the TeX language without having a TeX installation available. Support for these two engines is strewn about many source files, including every backend, where one finds clauses like

```
if rcParams['text.usetex']: # do one thing else: # do another
```

Adding a third text rendering approach (more on that later) would require editing all of these places as well, and therefore doesn't scale.

Instead, this MEP proposes adding a concept of "text engines", where the user could select one of many different approaches for rendering text. The implementations of each of these would be localized to their own set of modules, and not have little pieces around the whole source tree.

Why add more text rendering engines? The "built-in" text rendering has a number of shortcomings.

- It only handles right-to-left languages, and doesn't handle many special features of Unicode, such as combining diacriticals.
- The multiline support is imperfect and only supports manual line-breaking - it can not break up a paragraph into lines of a certain length.
- It also does not handle inline formatting changes in order to support something like Markdown, reStructuredText or HTML. (Though rich-text formatting is contemplated in this MEP, since we want to make sure this design allows it, the specifics of a rich-text formatting implementation is outside of the scope of this MEP.)

Supporting these things is difficult, and is the "full-time job" of a number of other projects:

- [pango/harfbuzz](#)
- [QtTextLayout](#)
- [Microsoft DirectWrite](#)
- [Apple Core Text](#)

Of the above options, it should be noted that `harfbuzz` is designed from the start as a cross platform option with minimal dependencies, so therefore is a good candidate for a single option to support.

Additionally, for supporting rich text, we could consider using [WebKit](#), and possibly whether that represents a good single cross-platform option. Again, however, rich text formatting is outside of the scope of this project.

Rather than trying to reinvent the wheel and add these features to matplotlib's "built-in" text renderer, we should provide a way to leverage these projects to get more powerful text

layout. The “built-in” renderer will still need to exist for reasons of ease of installation, but its feature set will be more limited compared to the others. [TODO: This MEP should clearly decide what those limited features are, and fix any bugs to bring the implementation into a state of working correctly in all cases that we want it to work. I know @leejjoon has some thoughts on this.]

### Font selection

Going from an abstract description of a font to a file on disk is the task of the font selection algorithm – it turns out to be much more complicated than it seems at first.

The “built-in” and “usetex” renderers have very different ways of handling font selection, given their different technologies. TeX requires the installation of TeX-specific font packages, for example, and can not use TrueType fonts directly. Unfortunately, despite the different semantics for font selection, the same set of font properties are used for each. This is true of both the `FontProperties` class and the font-related `rcParams` (which basically share the same code underneath). Instead, we should define a core set of font selection parameters that will work across all text engines, and have engine-specific configuration to allow the user to do engine-specific things when required. For example, it is possible to directly select a font by name in the “built-in” using `font.family`, but the same is not possible with “usetex”. It may be possible to make it easier to use TrueType fonts by using XeTeX, but users will still want to use the traditional metafonts through TeX font packages. So the issue still stands that different text engines will need engine-specific configuration, and it should be more obvious to the user which configuration will work across text engines and which are engine-specific.

Note that even excluding “usetex”, there are different ways to find fonts. The default is to use the font list cache in `font_manager.py` which matches fonts using our own algorithm based on the [CSS font matching algorithm](#). It doesn’t always do the same thing as the native font selection algorithms on Linux ([fontconfig](#)), Mac and Windows, and it doesn’t always find all of the fonts on the system that the OS would normally pick up. However, it is cross-platform, and always finds the fonts that ship with matplotlib. The Cairo and MacOSX backends (and presumably a future HTML5-based backend) currently bypass this mechanism and use the OS-native ones. The same is true when not embedding fonts in SVG, PS or PDF files and opening them in a third-party viewer. A downside there is that (at least with Cairo, need to confirm with MacOSX) they don’t always find the fonts we ship with matplotlib. (It may be possible to add the fonts to their search path, though, or we may need to find a way to install our fonts to a location the OS expects to find them).

There are also special modes in the PS and PDF to only use the core fonts that are always available to those formats. There, the font lookup mechanism must only match against those fonts. It is unclear whether the OS-native font lookup systems can handle this case.

There is also experimental support for using [fontconfig](#) for font selection in matplotlib, turned off by default. `fontconfig` is the native font selection algorithm on Linux, but is also cross platform and works well on the other platforms (though obviously is an additional dependency there).

Many of the text layout libraries proposed above (`pango`, `QtTextLayout`, `DirectWrite` and `CoreText` etc.) insist on using the font selection library from their own ecosystem.

All of the above seems to suggest that we should move away from our self-written font selection algorithm and use the native APIs where possible. That’s what Cairo and MacOSX backends already want to use, and it will be a requirement of any complex text layout library. On Linux, we already have the bones of a `fontconfig` implementation (which could also be accessed through `pango`). On Windows and Mac we may need to write custom wrappers. The nice thing is that the API for font lookup is relatively small, and essentially consist of “given a dictionary of font properties, give me a matching font file”.

## Font subsetting

Font subsetting is currently handled using `ttconv`. `ttconv` was a standalone commandline utility for converting TrueType fonts to subsetted Type 3 fonts (among other features) written in 1995, which matplotlib (well, I) forked in order to make it work as a library. It only handles Apple-style TrueType fonts, not ones with the Microsoft (or other vendor) encodings. It doesn't handle OpenType fonts at all. This means that even though the STIX fonts come as `.otf` files, we have to convert them to `.ttf` files to ship them with matplotlib. The Linux packagers hate this - they'd rather just depend on the upstream STIX fonts. `ttconv` has also been shown to have a few bugs that have been difficult to fix over time.

Instead, we should be able to use FreeType to get the font outlines and write our own code (probably in Python) to output subsetted fonts (Type 3 on PS and PDF and paths on SVG). FreeType, as a popular and well-maintained project, handles a wide variety of fonts in the wild. This would remove a lot of custom C code, and remove some code duplication between backends.

Note that subsetting fonts this way, while the easiest route, does lose the hinting in the font, so we will need to continue, as we do now, provide a way to embed the entire font in the file where possible.

Alternative font subsetting options include using the subsetting built-in to Cairo (not clear if it can be used without the rest of Cairo), or using `fontforge` (which is a heavy and not terribly cross-platform dependency).

## FreeType wrappers

Our FreeType wrapper could really use a reworking. It defines its own image buffer class (when a Numpy array would be easier). While FreeType can handle a huge diversity of font files, there are limitations to our wrapper that make it much harder to support non-Apple-vendor TrueType files, and certain features of OpenType files. (See #2088 for a terrible result of this, just to support the fonts that ship with Windows 7 and 8). I think a fresh rewrite of this wrapper would go a long way.

## Text anchoring and alignment and rotation

The handling of baselines was changed in 1.3.0 such that the backends are now given the location of the baseline of the text, not the bottom of the text. This is probably the correct behavior, and the MEP refactoring should also follow this convention.

In order to support alignment on multi-line text, it should be the responsibility of the (proposed) text engine to handle text alignment. For a given chunk of text, each engine calculates a bounding box for that text and the offset of the anchor point within that box. Therefore, if the `va` of a block was "top", the anchor point would be at the top of the box.

Rotating of text should always be around the anchor point. I'm not sure that lines up with current behavior in matplotlib, but it seems like the sanest/least surprising choice. [This could be revisited once we have something working]. Rotation of text should not be handled by the text engine - that should be handled by a layer between the text engine and the rendering backend so it can be handled in a uniform way. [I don't see any advantage to rotation being handled by the text engines individually...]

There are other problems with text alignment and anchoring that should be resolved as part of this work. [TODO: enumerate these].

## Other minor problems to fix

The `mathtext` code has backend-specific code - it should instead provide its output as just another text engine. However, it's still desirable to have `mathtext` layout inserted as part of a larger layout performed by another text engine, so it should be possible to do this. It's

an open question whether embedding the text layout of an arbitrary text engine in another should be possible.

The text mode is currently set by a global rcParam ("text.usetex") so it's either all on or all off. We should continue to have a global rcParam to choose the text engine ("text.layout\_engine"), but it should under the hood be an overridable property on the Text object, so the same figure can combine the results of multiple text layout engines if necessary.

### 36.8.5 Implementation

A concept of a "text engine" will be introduced. Each text engine will implement a number of abstract classes. The TextFont interface will represent text for a given set of font properties. It isn't necessarily limited to a single font file - if the layout engine supports rich text, it may handle a number of font files in a family. Given a TextFont instance, the user can get a TextLayout instance, which represents the layout for a given string of text in a given font. From a TextLayout, an iterator over TextSpans is returned so the engine can output raw editable text using as few spans as possible. If the engine would rather get individual characters, they can be obtained from the TextSpan instance:

```
class TextFont(TextFontBase):
    def __init__(self, font_properties):
        """
        Create a new object for rendering text using the given font properties.
        """
        pass

    def get_layout(self, s, ha, va):
        """
        Get the TextLayout for the given string in the given font and
        the horizontal (left, center, right) and vertical alignment (top,
        center, baseline, bottom)
        """
        pass

class TextLayout(TextLayoutBase):
    def get_metrics(self):
        """
        Return the bounding box of the layout, anchored at (0, 0).
        """
        pass

    def get_spans(self):
        """
        Returns an iterator over the spans of different in the layout.
        This is useful for backends that want to editable raw text as
        individual lines. For rich text where the font may change,
        each span of different font type will have its own span.
        """
        pass

    def get_image(self):
        """
        Returns a rasterized image of the text. Useful for raster backends,
```

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```

    like Agg.

    In all likelihood, this will be overridden in the backend, as it can
    be created from get_layout(), but certain backends may want to
    override it if their library provides it (as freetype does).
    """
    pass

def get_rectangles(self):
    """
    Returns an iterator over the filled black rectangles in the layout.
    Used by TeX and mathtext for drawing, for example, fraction lines.
    """
    pass

def get_path(self):
    """
    Returns a single Path object of the entire laid out text.

    [Not strictly necessary, but might be useful for textpath
    functionality]
    """
    pass

class TextSpan(TextSpanBase):
    x, y      # Position of the span -- relative to the text layout as a whole
              # where (0, 0) is the anchor.  y is the baseline of the span.
    fontfile  # The font file to use for the span
    text      # The text content of the span

    def get_path(self):
        pass # See TextLayout.get_path

    def get_chars(self):
        """
        Returns an iterator over the characters in the span.
        """
        pass

class TextChar(TextCharBase):
    x, y      # Position of the character -- relative to the text layout as
              # a whole, where (0, 0) is the anchor.  y is in the baseline
              # of the character.
    codepoint # The unicode code point of the character -- only for informational
              # purposes, since the mapping of codepoint to glyph_id may have been
              # handled in a complex way by the layout engine.  This is an int
              # to avoid problems on narrow Unicode builds.
    glyph_id  # The index of the glyph within the font
    fontfile  # The font file to use for the char

    def get_path(self):
        """

```

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```

Get the path for the character.
    """
pass

```

Graphic backends that want to output subset of fonts would likely build up a file-global dictionary of characters where the keys are (fontname, glyph\_id) and the values are the paths so that only one copy of the path for each character will be stored in the file.

Special casing: The "usetex" functionality currently is able to get Postscript directly from TeX to insert directly in a Postscript file, but for other backends, parses a DVI file and generates something more abstract. For a case like this, TextLayout would implement `get_spans` for most backends, but add `get_ps` for the Postscript backend, which would look for the presence of this method and use it if available, or fall back to `get_spans`. This kind of special casing may also be necessary, for example, when the graphics backend and text engine belong to the same ecosystem, e.g. Cairo and Pango, or MacOSX and CoreText.

There are three main pieces to the implementation:

- 1) Rewriting the freetype wrapper, and removing `ttconv`.
    - a) Once (1) is done, as a proof of concept, we can move to the upstream STIX .otf fonts
    - b) Add support for web fonts loaded from a remote URL. (Enabled by using freetype for font subsetting).
  - 2) Refactoring the existing "builtin" and "usetex" code into separate text engines and to follow the API outlined above.
  - 3) Implementing support for advanced text layout libraries.
- (1) and (2) are fairly independent, though having (1) done first will allow (2) to be simpler. (3) is dependent on (1) and (2), but even if it doesn't get done (or is postponed), completing (1) and (2) will make it easier to move forward with improving the "builtin" text engine.

### 36.8.6 Backward compatibility

The layout of text with respect to its anchor and rotation will change in hopefully small, but improved, ways. The layout of multiline text will be much better, as it will respect horizontal alignment. The layout of bidirectional text or other advanced Unicode features will now work inherently, which may break some things if users are currently using their own workarounds.

Fonts will be selected differently. Hacks that used to sort of work between the "builtin" and "usetex" text rendering engines may no longer work. Fonts found by the OS that weren't previously found by matplotlib may be selected.

### 36.8.7 Alternatives

TBD

## 36.9 MEP15 - Fix axis autoscaling when limits are specified for one axis only

- *Status*
- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
- *Implementation*
- *Backward compatibility*
- *Alternatives*

### 36.9.1 Status

#### Discussion

### 36.9.2 Branches and Pull requests

None so far.

### 36.9.3 Abstract

When one axis of a 2-dimensional plot is overridden via `xlim` or `ylim`, automatic scaling of the remaining axis should be based on the data that falls within the specified limits of the first axis.

### 36.9.4 Detailed description

When axis limits for a 2-D plot are specified for one axis only (via `xlim` or `ylim`), matplotlib currently does not currently rescale the other axis. The result is that the displayed curves or symbols may be compressed into a tiny portion of the available area, so that the final plot conveys much less information than it would with appropriate axis scaling.

The proposed change of behavior would make matplotlib choose the scale for the remaining axis using only the data that falls within the limits for the axis where limits were specified.

### 36.9.5 Implementation

I don't know enough about the internals of matplotlib to be able to suggest an implementation.

### 36.9.6 Backward compatibility

From the standpoint of software interfaces, there would be no break in backward compatibility. Some outputs would be different, but if the user truly desires the previous behavior, he/she can achieve this by overriding the axis scaling for both axes.

### 36.9.7 Alternatives

The only alternative that I can see is to maintain the status quo.

## 36.10 MEP19: Continuous Integration

### 36.10.1 Status

#### **Completed**

### 36.10.2 Branches and Pull requests

### 36.10.3 Abstract

matplotlib could benefit from better and more reliable continuous integration, both for testing and building installers and documentation.

### 36.10.4 Detailed description

#### **Current state-of-the-art**

#### **Testing**

matplotlib currently uses Travis-CI for automated tests. While Travis-CI should be praised for how much it does as a free service, it has a number of shortcomings:

- It often fails due to network timeouts when installing dependencies.
- It often fails for inexplicable reasons.
- build or test products can only be saved from build off of branches on the main repo, not pull requests, so it is often difficult to "post mortem" analyse what went wrong. This is particularly frustrating when the failure can not be subsequently reproduced locally.
- It is not extremely fast. matplotlib's cpu and memory requirements for testing are much higher than the average Python project.
- It only tests on Ubuntu Linux, and we have only minimal control over the specifics of the platform. It can be upgraded at any time outside of our control, causing unexpected delays at times that may not be convenient in our release schedule.

On the plus side, Travis-CI's integration with github - automatically testing all pending pull requests - is exceptional.

#### **Builds**

There is no centralized effort for automated binary builds for matplotlib. However, the following disparate things are being done [If the authors mentioned here could fill in detail, that would be great!]:

- @sandrotosi: builds Debian packages
- @takluyver: Has automated Ubuntu builds on Launchpad
- @cgohlke: Makes Windows builds (don't know how automated that is)
- @r-owen: Makes OS-X builds (don't know how automated that is)

### Documentation

Documentation of master is now built by travis and uploaded to <http://matplotlib.org/devdocs/index.html>

@NelleV, I believe, generates the docs automatically and posts them on the web to chart MEP10 progress.

### Peculiarities of matplotlib

matplotlib has complex requirements that make testing and building more taxing than many other Python projects.

- The CPU time to run the tests is quite high. It puts us beyond the free accounts of many CI services (e.g. ShiningPanda)
- It has a large number of dependencies, and testing the full matrix of all combinations is impractical. We need to be clever about what space we test and guarantee to support.

### Requirements

This section outlines the requirements that we would like to have.

1. Testing all pull requests by hooking into the Github API, as Travis-CI does
2. Testing on all major platforms: Linux, Mac OS-X, MS Windows (in that order of priority, based on user survey)
3. Retain the last n days worth of build and test products, to aid in post-mortem debugging.
4. Automated nightly binary builds, so that users can test the bleeding edge without installing a complete compilation environment.
5. Automated benchmarking. It would be nice to have a standard benchmark suite (separate from the tests) whose performance could be tracked over time, in different backends and platforms. While this is separate from building and testing, ideally it would run on the same infrastructure.
6. Automated nightly building and publishing of documentation (or as part of testing, to ensure PRs don't introduce documentation bugs). (This would not replace the static documentation for stable releases as a default).
7. The test systems should be manageable by multiple developers, so that no single person becomes a bottleneck. (Travis-CI's design does this well - storing build configuration in the git repository, rather than elsewhere, is a very good design.)

8. Make it easy to test a large but sparse matrix of different versions of matplotlib's dependencies. The matplotlib user survey provides some good data as to where to focus our efforts: <https://docs.google.com/spreadsheets/ccc?key=0AjrPjITMRTwTdHpQS25pcTZIRWdqX0pNckNSU01sMHc#gid=0>
9. Nice to have: A decentralized design so that those with more obscure platforms can publish build results to a central dashboard.

### 36.10.5 Implementation

This part is yet-to-be-written.

However, ideally, the implementation would be a third-party service, to avoid adding system administration to our already stretched time. As we have some donated funds, this service may be a paid one if it offers significant time-saving advantages over free offerings.

### 36.10.6 Backward compatibility

Backward compatibility is not a major concern for this MEP. We will replace current tools and procedures with something better and throw out the old.

### 36.10.7 Alternatives

### 36.10.8 Hangout Notes

#### CI Infrastructure

- We like Travis and it will probably remain part of our arsenal in any event. The reliability issues are being looked into.
- Enable Amazon S3 uploads of testing products on Travis. This will help with post-mortem of failures (@mdboom is looking into this now).
- We want Mac coverage. The best bet is probably to push Travis to enable it for our project by paying them for a Pro account (since they don't otherwise allow testing on both Linux and Mac).
- We want Windows coverage. Shining Panda is an option there.
- Investigate finding or building a tool that would collect and synthesize test results from a number of sources and post it to Github using the Github API. This may be of general use to the Scipy community.
- For both Windows and Mac, we should document (or better yet, script) the process of setting up the machine for a build, and how to build binaries and installers. This may require getting information from Russel Owen and Christoph Gohlke. This is a necessary step for doing automated builds, but would also be valuable for a number of other reasons.

### The test framework itself

- We should investigate ways to make it take less time
  - Eliminating redundant tests, if possible
  - General performance improvements to matplotlib will help
- We should be covering more things, particularly more backends
- We should have more unit tests, fewer integration tests, if possible

## 36.11 MEP21: color and cm refactor

- *Status*
- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
- *Implementation*
- *Backward compatibility*
- *Alternatives*

### 36.11.1 Status

- **Discussion:** This MEP has not commenced yet, but here are some ongoing ideas which may become a part of this MEP:

### 36.11.2 Branches and Pull requests

### 36.11.3 Abstract

- color
  - tidy up the namespace
  - Define a "Color" class
  - make it easy to convert from one color type to another ``hex` -> RGB`, `RGB` -> hex`, `HSV` -> RGB` etc.`
  - improve the construction of a colormap - the dictionary approach is archaic and overly complex (though incredibly powerful)
  - make it possible to interpolate between two or more color types in different modes, especially useful for construction of colormaps in HSV space for instance
- cm
  - rename the module to something more descriptive - mappables?

Overall, there are a lot of improvements that can be made with matplotlib color handling - managing backwards compatibility will be difficult as there are some badly named variables/modules which really shouldn't exist - but a clear path and message for migration should be available, with a large amount of focus on this in the API changes documentation.

#### 36.11.4 Detailed description

#### 36.11.5 Implementation

#### 36.11.6 Backward compatibility

#### 36.11.7 Alternatives

### 36.12 MEP22: Toolbar rewrite

- *Status*
- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
- *Implementation*
  - *ToolBase(object)*
  - *ToolToggleBase(ToolBase)*
  - *NavigationBase*
  - *ToolbarBase*
- *Backward compatibility*

#### 36.12.1 Status

##### Progress

#### 36.12.2 Branches and Pull requests

##### Previous work

- <https://github.com/matplotlib/matplotlib/pull/1849>
- <https://github.com/matplotlib/matplotlib/pull/2557>
- <https://github.com/matplotlib/matplotlib/pull/2465>

##### Pull Requests:

- Removing the NavigationToolbar classes <https://github.com/matplotlib/matplotlib/pull/2740> **CLOSED**

- Keeping the NavigationToolbar classes <https://github.com/matplotlib/matplotlib/pull/2759> **CLOSED**
- Navigation by events: <https://github.com/matplotlib/matplotlib/pull/3652>

### 36.12.3 Abstract

The main goal of this MEP is to make it easier to modify (add, change, remove) the way the user interacts with the figures.

The user interaction with the figure is deeply integrated within the Canvas and Toolbar. Making extremely difficult to do any modification.

This MEP proposes the separation of this interaction into Toolbar, Navigation and Tools to provide independent access and reconfiguration.

This approach will make easier to create and share tools among users. In the far future, we can even foresee a kind of Marketplace for Tools where the most popular can be added into the main distribution.

### 36.12.4 Detailed description

The reconfiguration of the Toolbar is complex, most of the time it requires a custom backend.

The creation of custom Tools sometimes interferes with the Toolbar, as example see <https://github.com/matplotlib/matplotlib/issues/2694> also the shortcuts are hardcoded and again not easily modifiable <https://github.com/matplotlib/matplotlib/issues/2699>

The proposed solution is to take the actions out of the Toolbar and the shortcuts out of the Canvas. This actions and shortcuts will be in the form of Tools.

A new class Navigation will be the bridge between the events from the Canvas and Toolbar and redirect them to the appropriate Tool.

At the end the user interaction will be divided into three classes:

- NavigationBase: This class is instantiated for each FigureManager and connect the all user interactions with the Tools
- ToolbarBase: This existing class is relegated only as a GUI access to Tools.
- ToolBase: Is the basic definition of Tools.

### 36.12.5 Implementation

#### ToolBase(object)

Tools can have a graphical representation as the SubplotTool or not even be present in the Toolbar as Quit

The ToolBase has the following class attributes for configuration at definition time

- keymap = None: Key(s) to be used to trigger the tool
- description = "": Small description of the tool
- image = None: Image that is used in the toolbar

**The following instance attributes are set at instantiation:**

- name
- navigation

**Methods**

- `trigger(self, event)`: This is the main method of the Tool, it is called when the Tool is triggered by: \* Toolbar button click \* keypress associated with the Tool Keymap \* Call to `navigation.trigger_tool(name)`
- `set_figure(self, figure)`: Set the figure and navigation attributes
- `destroy(self, *args)`: Destroy the Tool graphical interface (if exists)

**Available Tools**

- ToolQuit
- ToolEnableAllNavigation
- ToolEnableNavigation
- ToolToggleGrid
- ToolToggleFullScreen
- ToolToggleYScale
- ToolToggleXScale
- ToolHome
- ToolBack
- ToolForward
- SaveFigureBase
- ConfigureSubplotsBase

**ToolToggleBase(ToolBase)**

The `ToolToggleBase` has the following class attributes for configuration at definition time

- `radio_group = None`: Attribute to group 'radio' like tools (mutually exclusive)
- `cursor = None`: Cursor to use when the tool is active

The **Toggleable** Tools, can capture keypress, mouse moves, and mouse button press

**It defines the following methods**

- `enable(self, event)`: Called by `ToolToggleBase.trigger` method
- `disable(self, event)`: Called when the tool is untoggled
- `toggled` : **Property** True or False

**Available Tools**

- ToolZoom
- ToolPan

## NavigationBase

### Defines the following attributes

- `canvas`:
- **keypresslock**: Lock to know if the `canvas key_press_event` is available and process it
- `messagelock`: Lock to know if the message is available to write

### Public methods for User use:

- `nav_connect(self, s, func)`: Connect to to navigation for events
- `nav_disconnect(self, cid)`: Disconnect from navigation event
- `message_event(self, message, sender=None)`: Emit a `tool_message_event` event
- `active_toggle(self)`: **Property** The currently toggled tools or None
- `get_tool_keymap(self, name)`: Return a list of keys that are associated with the tool
- `set_tool_keymap(self, name, *keys)`: Set the keys for the given tool
- `remove_tool(self, name)`: Removes tool from the navigation control.
- `add_tools(self, tools)`: Add multiple tools to `Navigation`
- `add_tool(self, name, tool, group=None, position=None)`: Add a tool to the `Navigation`
- `tool_trigger_event(self, name, sender=None, canvasevent=None, data=None)`: Trigger a tool and fire the event
- `tools(self)` **Property**: Return a dict with available tools with corresponding keymaps, descriptions and objects
- `get_tool(self, name)`: Return the tool object

## ToolbarBase

### Methods for Backend implementation

- `add_toolitem(self, name, group, position, image, description, toggle)`: Add a toolitem to the toolbar. This method is a callback from `tool_added_event` (emitted by navigation)
- `set_message(self, s)`: Display a message on toolbar or in status bar
- `toggle_toolitem(self, name)`: Toggle the toolitem without firing event.
- `remove_toolitem(self, name)`: Remove a toolitem from the `Toolbar`

### 36.12.6 Backward compatibility

For backward compatibility added a 'navigation' key to `rcsetup.validate_toolbar`, that is used for `Navigation` classes instantiation instead of the `NavigationToolbar` classes

With this parameter, it makes it transparent to anyone using the existing backends.

[@pelson comment: This also gives us an opportunity to avoid needing to implement all of this in the same PR - some backends can potentially exist without the new functionality for a short while (but it must be done at some point).]

## 36.13 MEP23: Multiple Figures per GUI window

- *Status*
- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
- *Implementation*
  - *FigureManagerBase*
  - *new\_figure\_manager*
  - *new\_figure\_manager\_given\_figure*
  - *NavigationBase*
- *Backward compatibility*
- *Alternatives*

### 36.13.1 Status

#### Discussion

### 36.13.2 Branches and Pull requests

**Previous work** - <https://github.com/matplotlib/matplotlib/pull/2465> **To-delete**

### 36.13.3 Abstract

Add the possibility to have multiple figures grouped under the same `FigureManager`

### 36.13.4 Detailed description

Under the current structure, every canvas has its own window.

This is and may continue to be the desired method of operation for most use cases.

Sometimes when there are too many figures open at the same time, it is desirable to be able to group these under the same window [see](<https://github.com/matplotlib/matplotlib/issues/2194>).

The proposed solution modifies `FigureManagerBase` to contain and manage more than one canvas. The settings parameter `rcParams["backend.multifigure"]` control when the **MultiFigure** behaviour is desired.

### Note

It is important to note, that the proposed solution, assumes that the [MEP22](<https://github.com/matplotlib/matplotlib/wiki/MEP22>) is already in place. This is simply because the actual implementation of the `Toolbar` makes it pretty hard to switch between canvases.

## 36.13.5 Implementation

The first implementation will be done in GTK3 using a Notebook as canvas container.

### `FigureManagerBase`

will add the following new methods

- `add_canvas`: To add a canvas to an existing `FigureManager` object
- `remove_canvas`: To remove a canvas from a `FigureManager` object, if it is the last one, it will be destroyed
- `move_canvas`: To move a canvas from one `FigureManager` to another.
- `set_canvas_title`: To change the title associated with a specific canvas container
- `get_canvas_title`: To get the title associated with a specific canvas container
- `get_active_canvas`: To get the canvas that is in the foreground and is subject to the gui events. There is no `set_active_canvas` because the active canvas, is defined when `show` is called on a `Canvas` object.

### `new_figure_manager`

To control which `FigureManager` will contain the new figures, an extra optional parameter `figuremanager` will be added, this parameter value will be passed to `new_figure_manager_given_figure`

### `new_figure_manager_given_figure`

- If `figuremanager` parameter is give, this `FigureManager` object will be used instead of creating a new one.
- If `rcParams['backend.multifigure'] == True`: The last `FigureManager` object will be used instead of creating a new one.

### `NavigationBase`

Modifies the `NavigationBase` to keep a list of canvases, directing the actions to the active one

### 36.13.6 Backward compatibility

For the **MultiFigure** properties to be visible, the user has to activate them directly setting `rcParams['backend.multifigure'] = True`

It should be backwards compatible for backends that adhere to the current `FigureManagerBase` structure even if they have not implemented the **MultiFigure** magic yet.

### 36.13.7 Alternatives

Insted of modifying the `FigureManagerBase` it could be possible to add a parallel class, that handles the cases where `rcParams['backend.multifigure'] = True`. This will warranty that there won't be any problems with custom made backends, but also makes bigger the code, and more things to maintain.

## 36.14 MEP24: negative radius in polar plots

- *Status*
- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
- *Implementation*
- *Related Issues*
- *Backward compatibility*
- *Alternatives*

### 36.14.1 Status

*Discussion*

### 36.14.2 Branches and Pull requests

None

### 36.14.3 Abstract

It is clear that polar plots need to be able to gracefully handle negative  $r$  values (not by clipping or reflection).

### 36.14.4 Detailed description

One obvious application that we should support is bB plots (see <https://github.com/matplotlib/matplotlib/issues/1730#issuecomment-40815837>), but this seems more generally useful (for example growth rate as a function of angle). The assumption in the current code (as I understand it) is that the center of the graph is  $r=0$ , however it would be good to be able to set the center to be at any  $r$  (with any value less than the offset clipped).

### 36.14.5 Implementation

### 36.14.6 Related Issues

#1730, #1603, #2203, #2133

### 36.14.7 Backward compatibility

### 36.14.8 Alternatives

## 36.15 MEP25: Serialization

- *Status*
- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
- *Examples*
- *Implementation*
- *Backward compatibility*
- *Alternatives*

### 36.15.1 Status

#### **Rejected**

This work is important, but this particular effort has stalled.

### 36.15.2 Branches and Pull requests

- development branches:
- related pull requests:

### 36.15.3 Abstract

This MEP aims at adding a serializable `Controller` objects to act as an `Artist` managers. Users would then communicate changes to an `Artist` via a `Controller`. In this way, functionality of the `Controller` objects may be added incrementally since each `Artist` is still responsible for drawing everything. The goal is to create an API that is usable both by graphing libraries requiring high-level descriptions of figures and libraries requiring low-level interpretations.

### 36.15.4 Detailed description

Matplotlib is a core plotting engine with an API that many users already understand. It's difficult/impossible for other graphing libraries to (1) get a complete figure description, (2) output raw data from the figure object as the user has provided it, (3) understand the semantics of the figure objects without heuristics, and (4) give matplotlib a complete figure description to visualize. In addition, because an `Artist` has no conception of its own semantics within the figure, it's difficult to interact with them in a natural way.

In this sense, matplotlib will adopt a standard Model-View-Controller (MVC) framework. The *Model* will be the user defined data, style, and semantics. The *Views* are the ensemble of each individual `Artist`, which are responsible for producing the final image based on the *model*. The *Controller* will be the `Controller` object managing its set of `Artist` objects.

The `Controller` must be able to export the information that it's carrying about the figure on command, perhaps via a `to_json` method or similar. Because it would be extremely extraneous to duplicate all of the information in the model with the controller, only user-specified information (data + style) are explicitly kept. If a user wants more information (defaults) from the view/model, it should be able to query for it.

- This might be annoying to do, non-specified kwargs are pulled from the `rcParams` object which is in turn created from reading a user specified file and can be dynamically changed at run time. I suppose we could keep a dict of default defaults and compare against that. Not clear how this will interact with the style sheet [[MEP26]] - @tacaswell

Additional Notes:

- The raw data does not necessarily need to be a `list`, `ndarray`, etc. Rather, it can more abstractly just have a method to yield data when needed.
- Because the `Controller` will contain extra information that users may not want to keep around, it should *not* be created by default. You should be able to both (a) instantiate a `Controller` with a figure and (b) build a figure with a `Controller`.

Use Cases:

- Export all necessary informat
- Serializing a matplotlib figure, saving it, and being able to rerun later.
- Any other source sending an appropriately formatted representation to matplotlib to open

### 36.15.5 Examples

Here are some examples of what the controllers should be able to do.

1. Instantiate a matplotlib figure from a serialized representation (e.g., JSON):

```
import json
from matplotlib.controllers import Controller
with open('my_figure') as f:
    o = json.load(f)
c = Controller(o)
fig = c.figure
```

2. Manage artists from the controller (e.g., Line2D):

```
# not really sure how this should look
c.axes[0].lines[0].color = 'b'
# ?
```

3. Export serializable figure representation:

```
o = c.to_json()
# or... we should be able to throw a figure object in there too
o = Controller.to_json(mpl_fig)
```

### 36.15.6 Implementation

1. Create base Controller objects that are able to manage Artist objects (e.g., Hist)

Comments:

- initialization should happen via unpacking \*\*, so we need a copy of call signature parameter for the Artist we're ultimately trying to control. Unfortunate hard-coded repetition...
- should the additional \*\*kwargs accepted by each Artist be tracked at the Controller
- how does a Controller know which artist belongs where? E.g., do we need to pass axes references?

Progress:

- A simple NB demonstrating some functionality for Line2DController objects: <https://nbviewer.jupyter.org/gist/theengineear/f0aa8d79f64325e767c0>

2. Write in protocols for the Controller to *update* the model.

Comments:

- how should containers be dealt with? E.g., what happens to old patches when we re-bin a histogram?
- in the link from (1), the old line is completely destroyed and redrawn, what if something is referencing it?

3. Create method by which a json object can be assembled from the Controllers
4. Deal with serializing the unserializable aspects of a figure (e.g., non-affine transforms?)
5. Be able to instantiate from a serialized representation
6. Reimplement the existing pyplot and Axes method, e.g. `pyplot.hist` and `Axes.hist` in terms of the new controller class.

> @theengineer: in #2 above, what do you mean by *get updates* from each Artist?

^ Yup. The Controller *shouldn't* need to get updated. This just happens in #3. Delete comments when you see this.

### 36.15.7 Backward compatibility

- pickling will change
- non-affine transformations will require a defined pickling method

### 36.15.8 Alternatives

PR #3150 suggested adding semantics by parasitically attaching extra containers to axes objects. This is a more complete solution with what should be a more developed/flexible/powerful framework.

## 36.16 MEP26: Artist styling

- *Status*
- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
- *Implementation*
  - *BNF Grammar*
  - *Syntax*
    - \* *Selectors*
    - \* *GID selector*
    - \* *Attributes and values*
  - *Parsing*
  - *Visitor pattern for matplotlib figure*
- *Backward compatibility*
- *Alternatives*
- *Appendix*
  - *Matplotlib primitives*

### 36.16.1 Status

#### Rejected

## 36.16.2 Branches and Pull requests

### 36.16.3 Abstract

This MEP proposes a new stylesheet implementation to allow more comprehensive and dynamic styling of artists.

The current version of matplotlib (1.4.0) allows stylesheets based on the rcParams syntax to be applied before creation of a plot. The methodology below proposes a new syntax, based on CSS, which would allow styling of individual artists and properties, which can be applied dynamically to existing objects.

This is related to (and makes steps toward) the overall goal of moving to a DOM/tree-like architecture.

### 36.16.4 Detailed description

Currently, the look and appearance of existing artist objects (figure, axes, Line2D etc...) can only be updated via `set_` and `get_` methods on the artist object, which is quite laborious, especially if no reference to the artist(s) has been stored. The new style sheets introduced in 1.4 allow styling before a plot is created, but do not offer any means to dynamically update plots or distinguish between artists of the same type (i.e. to specify the line color and line style separately for differing Line2D objects).

The initial development should concentrate on allowing styling of artist primitives (those artists that do not contain other artists), and further development could expand the CSS syntax rules and parser to allow more complex styling. See the appendix for a list of primitives.

The new methodology would require development of a number of steps:

- A new stylesheet syntax (likely based on CSS) to allow selection of artists by type, class, id etc...
- A mechanism by which to parse a stylesheet into a tree
- A mechanism by which to translate the parse-tree into something which can be used to update the properties of relevant artists. Ideally this would implement a method by which to traverse the artists in a tree-like structure.
- A mechanism by which to generate a stylesheet from existing artist properties. This would be useful to allow a user to export a stylesheet from an existing figure (where the appearance may have been set using the matplotlib API)...

### 36.16.5 Implementation

It will be easiest to allow a '3rd party' to modify/set the style of an artist if the 'style' is created as a separate class and store against the artist as a property. The GraphicsContext class already provides a the basis of a Style class and an artists draw method can be refactored to use the Style class rather than setting up it's own GraphicsContext and transferring it's style-related properties to it. A minimal example of how this could be implemented is shown here: [https://github.com/JamesRamm/mpl\\_experiment](https://github.com/JamesRamm/mpl_experiment)

IMO, this will also make the API and code base much neater as individual get/set methods for artist style properties are now redundant... Indirectly related would be a general drive to

replace get/set methods with properties. Implementing the style class with properties would be a big stride toward this...

For initial development, I suggest developing a syntax based on a much (much much) simplified version of CSS. I am in favour of dubbing this Artist Style Sheets :+1: :

### BNF Grammar

I propose a very simple syntax to implement initially (like a proof of concept), which can be expanded upon in the future. The BNF form of the syntax is given below and then explained

```
RuleSet ::= SelectorSequence "{"Declaration""}"
SelectorSequence ::= Selector {"," Selector}
Declaration ::= propName":" propValue";"
Selector ::= ArtistIdent{"#"Ident}
propName ::= Ident
propValue ::= Ident | Number | Colour | "None"
```

ArtistIdent, Ident, Number and Colour are tokens (the basic building blocks of the expression) which are defined by regular expressions.

### Syntax

A CSS stylesheet consists of a series of **rule sets** in hierarchical order (rules are applied from top to bottom). Each rule follows the syntax

```
selector {attribute: value;}
```

Each rule can have any number of attribute: value pairs, and a stylesheet can have any number of rules.

The initial syntax is designed only for artist primitives. It does not address the question of how to set properties on container types (whose properties may themselves be artists with settable properties), however, a future solution to this could simply be nested RuleSet s

### Selectors

Selectors define the object to which the attribute updates should be applied. As a starting point, I propose just 2 selectors to use in initial development:

Artist Type Selector

Select an artist by it's type. E.g Line2D or Text:

```
Line2D {attribute: value}
```

The regex for matching the artist type selector (ArtistIdent in the BNF grammar) would be:

```
ArtistIdent = r'(?P<ArtistIdent>  
↪\bLine2D\b|\bText\b|\bAxesImage\b|\bFigureImage\b|\bPatch\b)'
```

### GID selector

Select an artist by its gid:

```
Line2D#myGID {attribute: value}
```

A gid can be any string, so the regex could be as follows:

```
Ident = r'(?P<Ident>[a-zA-Z_][a-zA-Z_0-9]*)'
```

The above selectors roughly correspond to their CSS counterparts (<http://www.w3.org/TR/CSS21/selector.html>)

### Attributes and values

- Attributes are any valid (settable) property for the artist in question.
- Values are any valid value for the property (Usually a string, or number).

### Parsing

Parsing would consist of breaking the stylesheet into tokens (the python cookbook gives a nice tokenizing recipe on page 66), applying the syntax rules and constructing a Tree. This requires defining the grammar of the stylesheet (again, we can borrow from CSS) and writing a parser. Happily, there is a recipe for this in the python cookbook aswell.

### Visitor pattern for matplotlib figure

In order to apply the stylesheet rules to the relevant artists, we need to 'visit' each artist in a figure and apply the relevant rule. Here is a visitor class (again, thanks to python cookbook), where each node would be an artist in the figure. A `visit_` method would need to be implemented for each mpl artist, to handle the different properties for each

```
class Visitor:  
    def visit(self, node):  
        name = 'visit_' + type(node).__name__  
        meth = getattr(self, name, None)  
        if meth is None:  
            raise NotImplementedError  
        return meth(node)
```

An evaluator class would then take the stylesheet rules and implement the visitor on each one of them.

### 36.16.6 Backward compatibility

Implementing a separate `Style` class would break backward compatibility as many get/set methods on an artist would become redundant. While it would be possible to alter these methods to hook into the `Style` class (stored as a property against the artist), I would be in favor of simply removing them to both neaten/simplify the codebase and to provide a simple, uncluttered API...

### 36.16.7 Alternatives

No alternatives, but some of the ground covered here overlaps with MEP25, which may assist in this development

### 36.16.8 Appendix

#### Matplotlib primitives

This will form the initial selectors which stylesheets can use.

- Line2D
- Text
- AxesImage
- FigureImage
- Patch

## 36.17 MEP27: decouple pyplot from backends

- *Status*
- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
- *Implementation*
- *Future compatibility*
- *Backward compatibility*
- *Alternatives*
- *Questions*

### 36.17.1 Status

#### Progress

### 36.17.2 Branches and Pull requests

Main PR (including GTK3): + <https://github.com/matplotlib/matplotlib/pull/4143>

Backend specific branch diffs: + <https://github.com/OceanWolf/matplotlib/compare/backend-refactor...OceanWolf:backend-refactor-tkagg> + <https://github.com/OceanWolf/matplotlib/compare/backend-refactor...OceanWolf:backend-refactor-qt> + <https://github.com/OceanWolf/matplotlib/compare/backend-refactor...backend-refactor-wx>

### 36.17.3 Abstract

This MEP refactors the backends to give a more structured and consistent API, removing generic code and consolidate existing code. To do this we propose splitting:

1. `FigureManagerBase` and its derived classes into the core functionality class `FigureManager` and a backend specific class `WindowBase` and
2. `ShowBase` and its derived classes into `Gcf.show_all` and `MainLoopBase`.

### 36.17.4 Detailed description

This MEP aims to consolidate the backends API into one single uniform API, removing generic code out of the backend (which includes `_pylab_helpers` and `Gcf`), and push code to a more appropriate level in `matplotlib`. With this we automatically remove inconsistencies that appear in the backends, such as `FigureManagerBase.resize(w, h)` which sometimes sets the canvas, and other times set the entire window to the dimensions given, depending on the backend.

Two main places for generic code appear in the classes derived from `FigureManagerBase` and `ShowBase`.

1. `FigureManagerBase` has **three** jobs at the moment:
  1. The documentation describes it as a *“Helper class for pyplot mode, wraps everything up into a neat bundle”*
  2. But it doesn't just wrap the canvas and toolbar, it also does all of the windowing tasks itself. The conflation of these two tasks gets seen the best in the following line: ``python self.set_window_title("Figure %d" % num) `` This combines backend specific code `self.set_window_title(title)` with matplotlib generic code `title = "Figure %d" % num`.
  3. Currently the backend specific subclass of `FigureManager` decides when to end the mainloop. This also seems very wrong as the figure should have no control over the other figures.
2. `ShowBase` has two jobs:
  1. It has the job of going through all figure managers registered in `_pylab_helpers.Gcf` and telling them to show themselves.
  2. And secondly it has the job of performing the backend specific mainloop to block the main programme and thus keep the figures from dying.

### 36.17.5 Implementation

The description of this MEP gives us most of the solution:

1. To remove the windowing aspect out of `FigureManagerBase` letting it simply wrap this new class along with the other backend classes. Create a new `WindowBase` class that can handle this functionality, with pass-through methods (`:arrow_right:`) to `WindowBase`. Classes that subclass `WindowBase` should also subclass the GUI specific window class to ensure backward compatibility (`manager.window == manager.window`).
2. Refactor the mainloop of `ShowBase` into `MainLoopBase`, which encapsulates the end of the loop as well. We give an instance of `MainLoop` to `FigureManager` as a key unlock the exit method (requiring all keys returned before the loop can die). Note this opens the possibility for multiple backends to run concurrently.
3. Now that `FigureManagerBase` has no backend specifics in it, to rename it to `FigureManager`, and move to a new file `backend_managers.py` noting that:
  1. This allows us to break up the conversion of backends into separate PRs as we can keep the existing `FigureManagerBase` class and its dependencies intact.
  2. and this also anticipates MEP22 where the new `NavigationBase` has morphed into a backend independent `ToolManager`.

FigureManager-Base(canvas, num)	FigureManager(manager(figure, num)	WindowBase(title	Notes
<code>show</code>		<code>show</code>	
<code>destroy</code>	calls <code>destroy</code> on all components	<code>destroy</code>	
<code>full_screen_toggle</code>	handles logic	<code>set_fullscreen</code>	
<code>resize</code>		<code>resize</code>	
<code>key_press</code>	<code>key_press</code>		
<code>get_window_title</code>		<code>get_window_title</code>	
<code>set_window_title</code>		<code>set_window_title</code>	
	<code>_get_toolbar</code>		A common method to all subclasses of <code>FigureManagerBase</code>
		<code>set_default_size</code>	
		<code>add_element_to_window</code>	

ShowBase	MainLoop-Base	Notes
<code>main-loop</code>	<code>begin</code>	
	<code>end</code>	Gets called automatically when no more instances of the subclass exist
<code>__call__</code>		Method moved to <code>Gcf.show_all</code>

### 36.17.6 Future compatibility

As eluded to above when discussing MEP 22, this refactor makes it easy to add in new generic features. At the moment, MEP 22 has to make ugly hacks to each class extending from `FigureManagerBase`. With this code, this only needs to get made in the single `FigureManager`

class. This also makes the later deprecation of `NavigationToolbar2` very straightforward, only needing to touch the single `FigureManager` class

MEP 23 makes for another use case where this refactored code will come in very handy.

### 36.17.7 Backward compatibility

As we leave all backend code intact, only adding missing methods to existing classes, this should work seamlessly for all use cases. The only difference will lie for backends that used `FigureManager.resize` to resize the canvas and not the window, due to the standardisation of the API.

I would envision that the classes made obsolete by this refactor get deprecated and removed on the same timetable as `NavigationToolbar2`, also note that the change in call signature to the `FigureCanvasWx` constructor, while backward compatible, I think the old (imho ugly style) signature should get deprecated and removed in the same manner as everything else.

back-end	manager.resize(w,h)	Extra
gtk3	window	
Tk	canvas	
Qt	window	
Wx	canvas	<code>FigureManagerWx</code> had <code>frame</code> as an alias to <code>window</code> , so this also breaks BC.

### 36.17.8 Alternatives

If there were any alternative solutions to solving the same problem, they should be discussed here, along with a justification for the chosen approach.

### 36.17.9 Questions

Mdehoon: Can you elaborate on how to run multiple backends concurrently?

OceanWolf: @mdehoon, as I say, not for this MEP, but I see this MEP opens it up as a future possibility. Basically the `MainLoopBase` class acts a per backend Gcf, in this MEP it tracks the number of figures open per backend, and manages the mainloops for those backends. It closes the backend specific mainloop when it detects that no figures remain open for that backend. Because of this I imagine that with only a small amount of tweaking that we can do full-multi-backend matplotlib. No idea yet why one would want to, but I leave the possibility there in `MainLoopBase`. With all the backend-code specifics refactored out of `FigureManager` also aids in this, one manager to rule them (the backends) all.

Mdehoon: @OceanWolf, OK, thanks for the explanation. Having a uniform API for the backends is very important for the maintainability of matplotlib. I think this MEP is a step in the right direction.

## 36.18 MEP28: Remove Complexity from `Axes.boxplot`

- *Status*
- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
  - *Importance*
- *Implementation*
  - *Passing transform functions to `cbook.boxplots_stats`*
  - *Simplifications to the `Axes.boxplot` API and other functions*
- *Backward compatibility*
  - *Schedule*
  - *Anticipated Impacts to Users*
  - *Anticipated Impacts to Downstream Libraries*
- *Alternatives*
  - *Variations on the theme*
  - *Doing less*
  - *Doing nothing*

### 36.18.1 Status

#### Discussion

### 36.18.2 Branches and Pull requests

The following lists any open PRs or branches related to this MEP:

1. Deprecate redundant statistical kwargs in `Axes.boxplot`: <https://github.com/phobson/matplotlib/tree/MEP28-initial-deprecations>
2. Deprecate redundant style options in `Axes.boxplot`: <https://github.com/phobson/matplotlib/tree/MEP28-initial-deprecations>
3. Deprecate passings 2D numpy arrays as input: None
4. Add pre- & post-processing options to `cbook.boxplot_stats`: <https://github.com/phobson/matplotlib/tree/boxplot-stat-transforms>
5. Exposing `cbook.boxplot_stats` through `Axes.boxplot` kwargs: None
6. Remove redundant statistical kwargs in `Axes.boxplot`: None
7. Remove redundant style options in `Axes.boxplot`: None
8. Remaining items that arise through discussion: None

### 36.18.3 Abstract

Over the past few releases, the `Axes.boxplot` method has grown in complexity to support fully customizable artist styling and statistical computation. This led to `Axes.boxplot` being split off into multiple parts. The statistics needed to draw a boxplot are computed in `cbook.boxplot_stats`, while the actual artists are drawn by `Axes.bxp`. The original method, `Axes.boxplot` remains as the most public API that handles passing the user-supplied data to `cbook.boxplot_stats`, feeding the results to `Axes.bxp`, and pre-processing style information for each facet of the boxplot plots.

This MEP will outline a path forward to rollback the added complexity and simplify the API while maintaining reasonable backwards compatibility.

### 36.18.4 Detailed description

Currently, the `Axes.boxplot` method accepts parameters that allow the users to specify medians and confidence intervals for each box that will be drawn in the plot. These were provided so that advanced users could provide statistics computed in a different fashion than the simple method provided by matplotlib. However, handling this input requires complex logic to make sure that the forms of the data structure match what needs to be drawn. At the moment, that logic contains 9 separate if/else statements nested up to 5 levels deep with a for loop, and may raise up to 2 errors. These parameters were added prior to the creation of the `Axes.bxp` method, which draws boxplots from a list of dictionaries containing the relevant statistics. Matplotlib also provides a function that computes these statistics via `cbook.boxplot_stats`. Note that advanced users can now either a) write their own function to compute the stats required by `Axes.bxp`, or b) modify the output returned by `cbook.boxplot_stats` to fully customize the position of the artists of the plots. With this flexibility, the parameters to manually specify only the medians and their confidence intervals remain for backwards compatibility.

Around the same time that the two roles of `Axes.boxplot` were split into `cbook.boxplot_stats` for computation and `Axes.bxp` for drawing, both `Axes.boxplot` and `Axes.bxp` were written to accept parameters that individually toggle the drawing of all components of the boxplots, and parameters that individually configure the style of those artists. However, to maintain backwards compatibility, the `sym` parameter (previously used to specify the symbol of the fliers) was retained. This parameter itself requires fairly complex logic to reconcile the `sym` parameters with the newer `flierprops` parameter at the default style specified by `matplotlibrc`.

This MEP seeks to dramatically simplify the creation of boxplots for novice and advanced users alike. Importantly, the changes proposed here will also be available to downstream packages like `seaborn`, as `seaborn` smartly allows users to pass arbitrary dictionaries of parameters through the `seaborn` API to the underlying matplotlib functions.

This will be achieved in the following way:

1. `cbook.boxplot_stats` will be modified to allow pre- and post- computation transformation functions to be passed in (e.g., `np.log` and `np.exp` for lognormally distributed data)
2. `Axes.boxplot` will be modified to also accept and naively pass them to `cbook.boxplot_stats` (Alt: pass the stat function and a dict of its optional parameters).
3. Outdated parameters from `Axes.boxplot` will be deprecated and later removed.

## Importance

Since the limits of the whiskers are computed arithmetically, there is an implicit assumption of normality in box and whisker plots. This primarily affects which data points are classified as outliers.

Allowing transformations to the data and the results used to draw boxplots will allow users to opt-out of that assumption if the data are known to not fit a normal distribution.

Below is an example of how `Axes.boxplot` classifies outliers of lognormal data differently depending on these types of transforms.

```
import numpy as np
import matplotlib.pyplot as plt
from matplotlib import cbook
np.random.seed(0)

fig, ax = plt.subplots(figsize=(4, 6))
ax.set_yscale('log')
data = np.random.lognormal(-1.75, 2.75, size=37)

stats = cbook.boxplot_stats(data, labels=['arithmetic'])
logstats = cbook.boxplot_stats(np.log(data), labels=['log-transformed'])

for lsdict in logstats:
    for key, value in lsdict.items():
        if key != 'label':
            lsdict[key] = np.exp(value)

stats.extend(logstats)
ax.bxp(stats)
fig.show()
```

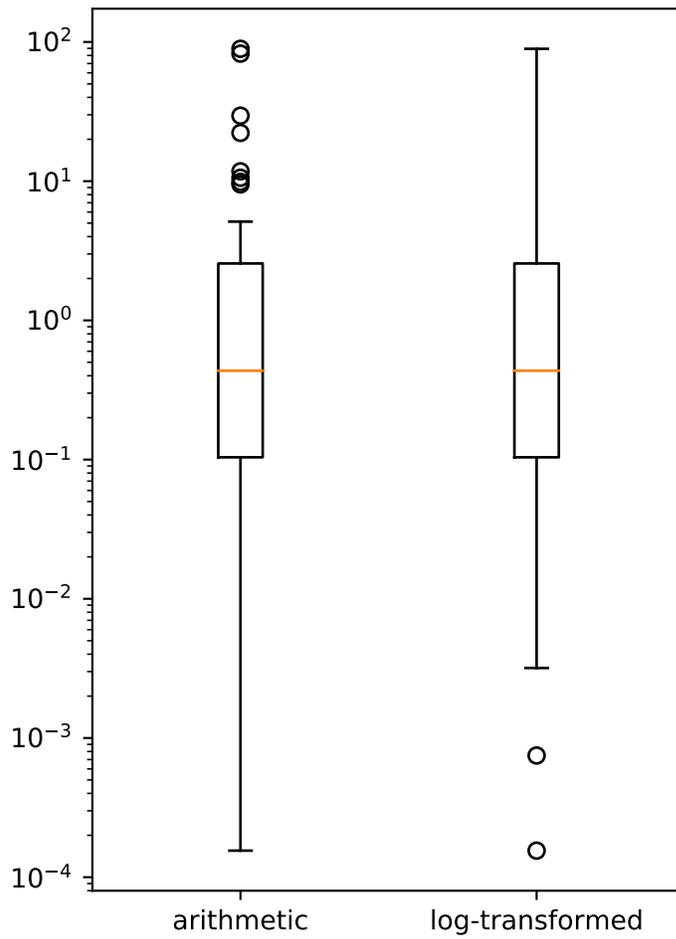
## 36.18.5 Implementation

### Passing transform functions to `cbook.boxplots_stats`

This MEP proposes that two parameters (e.g., `transform_in` and `transform_out`) be added to the cookbook function that computes the statistics for the boxplot function. These will be optional keyword-only arguments and can easily be set to `lambda x: x` as a no-op when omitted by the user. The `transform_in` function will be applied to the data as the `boxplot_stats` function loops through each subset of the data passed to it. After the list of statistics dictionaries are computed the `transform_out` function is applied to each value in the dictionaries.

These transformations can then be added to the call signature of `Axes.boxplot` with little impact to that method's complexity. This is because they can be directly passed to `cbook.boxplot_stats`. Alternatively, `Axes.boxplot` could be modified to accept an optional statistical function kwarg and a dictionary of parameters to be directly passed to it.

At this point in the implementation users and external libraries like `seaborn` would have complete control via the `Axes.boxplot` method. More importantly, at the very least, `seaborn` would require no changes to its API to allow users to take advantage of these new options.



### Simplifications to the `Axes.boxplot` API and other functions

Simplifying the boxplot method consists primarily of deprecating and then removing the redundant parameters. Optionally, a next step would include rectifying minor terminological inconsistencies between `Axes.boxplot` and `Axes.bxp`.

The parameters to be deprecated and removed include:

1. `usermedians` - processed by 10 SLOC, 3 if blocks, a for loop
2. `conf_intervals` - handled by 15 SLOC, 6 if blocks, a for loop
3. `sym` - processed by 12 SLOC, 4 if blocks

Removing the `sym` option allows all code in handling the remaining styling parameters to be moved to `Axes.bxp`. This doesn't remove any complexity, but does reinforce the single responsibility principle among `Axes.bxp`, `cbook.boxplot_stats`, and `Axes.boxplot`.

Additionally, the `notch` parameter could be renamed `shownotches` to be consistent with `Axes.bxp`. This kind of cleanup could be taken a step further and the `whis`, `bootstrap`, `autorange` could be rolled into the `kwargs` passed to the new `statfxn` parameter.

### 36.18.6 Backward compatibility

Implementation of this MEP would eventually result in the backwards incompatible deprecation and then removal of the keyword parameters `usermedians`, `conf_intervals`, and `sym`. cursory searches on GitHub indicated that `usermedians`, `conf_intervals` are used by few users, who all seem to have a very strong knowledge of matplotlib. A robust deprecation cycle should provide sufficient time for these users to migrate to a new API.

Deprecation of `sym` however, may have a much broader reach into the matplotlib userbase.

#### Schedule

An accelerated timeline could look like the following:

1. v2.0.1 add transforms to `cbook.boxplots_stats`, expose in `Axes.boxplot`
2. v2.1.0 Initial Deprecations , and using 2D numpy arrays as input
  - a. Using 2D numpy arrays as input. The semantics around 2D arrays are generally confusing.
  - b. `usermedians`, `conf_intervals`, `sym` parameters
3. v2.2.0
  - a. remove `usermedians`, `conf_intervals`, `sym` parameters
  - b. deprecate `notch` in favor of `shownotches` to be consistent with other parameters and `Axes.bxp`
4. **v2.3.0**
  - a. remove `notch` parameter
  - b. move all style and artist toggling logic to `Axes.bxp` such `Axes.boxplot` is little more than a broker between `Axes.bxp` and `cbook.boxplots_stats`

### Anticipated Impacts to Users

As described above deprecating `usermedians` and `conf_intervals` will likely impact few users. Those who will be impacted are almost certainly advanced users who will be able to adapt to the change.

Deprecating the `sym` option may import more users and effort should be taken to collect community feedback on this.

### Anticipated Impacts to Downstream Libraries

The source code (GitHub master as of 2016-10-17) was inspected for `seaborn` and `python-ggplot` to see if these changes would impact their use. None of the parameters nominated for removal in this MEP are used by `seaborn`. The `seaborn` APIs that use `matplotlib`'s `boxplot` function allow user's to pass arbitrary `**kwargs` through to `matplotlib`'s API. Thus `seaborn` users with modern `matplotlib` installations will be able to take full advantage of any new features added as a result of this MEP.

`Python-ggplot` has implemented its own function to draw boxplots. Therefore, no impact can come to it as a result of implementing this MEP.

## 36.18.7 Alternatives

### Variations on the theme

This MEP can be divided into a few loosely coupled components:

1. Allowing pre- and post-computation transformation function in `cbook.boxplot_stats`
2. Exposing that transformation in the `Axes.boxplot` API
3. Removing redundant statistical options in `Axes.boxplot`
4. Shifting all styling parameter processing from `Axes.boxplot` to `Axes.bxp`.

With this approach, #2 depends on #1, and #4 depends on #3.

There are two possible approaches to #2. The first and most direct would be to mirror the new `transform_in` and `transform_out` parameters of `cbook.boxplot_stats` in `Axes.boxplot` and pass them directly.

The second approach would be to add `statfxn` and `statfxn_args` parameters to `Axes.boxplot`. Under this implementation, the default value of `statfxn` would be `cbook.boxplot_stats`, but users could pass their own function. Then `transform_in` and `transform_out` would then be passed as elements of the `statfxn_args` parameter.

```
def boxplot_stats(data, ..., transform_in=None, transform_out=None):
    if transform_in is None:
        transform_in = lambda x: x

    if transform_out is None:
        transform_out = lambda x: x

    output = []
    for _d in data:
```

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```

    d = transform_in(_d)
    stat_dict = do_stats(d)
    for key, value in stat_dict.item():
        if key != 'label':
            stat_dict[key] = transform_out(value)
    output.append(d)
return output

class Axes(...):
    def boxplot_option1(data, ..., transform_in=None, transform_out=None):
        stats = cbook.boxplot_stats(data, ...,
                                   transform_in=transform_in,
                                   transform_out=transform_out)
        return self.bxp(stats, ...)

    def boxplot_option2(data, ..., statfxn=None, **statopts):
        if statfxn is None:
            statfxn = boxplot_stats
        stats = statfxn(data, **statopts)
        return self.bxp(stats, ...)

```

Both cases would allow users to do the following:

```

fig, ax1 = plt.subplots()
artists1 = ax1.boxplot_optionX(data, transform_in=np.log,
                              transform_out=np.exp)

```

But Option Two lets a user write a completely custom stat function (e.g., `my_box_stats`) with fancy BCA confidence intervals and the whiskers set differently depending on some attribute of the data.

This is available under the current API:

```

fig, ax1 = plt.subplots()
my_stats = my_box_stats(data, bootstrap_method='BCA',
                       whisker_method='dynamic')
ax1.bxp(my_stats)

```

And would be more concise with Option Two

```

fig, ax = plt.subplots()
statopts = dict(transform_in=np.log, transform_out=np.exp)
ax.boxplot(data, ..., **statopts)

```

Users could also pass their own function to compute the stats:

```

fig, ax1 = plt.subplots()
ax1.boxplot(data, statfxn=my_box_stats, bootstrap_method='BCA',
            whisker_method='dynamic')

```

From the examples above, Option Two seems to have only marginal benefit, but in the context of downstream libraries like `seaborn`, its advantage is more apparent as the following would be possible without any patches to `seaborn`:

```
import seaborn
tips = seaborn.load_data('tips')
g = seaborn.factorplot(x="day", y="total_bill", hue="sex", data=tips,
                      kind='box', palette="PRGn", shownotches=True,
                      statfxn=my_box_stats, bootstrap_method='BCA',
                      whisker_method='dynamic')
```

This type of flexibility was the intention behind splitting the overall boxplot API in the current three functions. In practice however, downstream libraries like seaborn support versions of matplotlib dating back well before the split. Thus, adding just a bit more flexibility to the `Axes.boxplot` could expose all the functionality to users of the downstream libraries with modern matplotlib installation without intervention from the downstream library maintainers.

### Doing less

Another obvious alternative would be to omit the added pre- and post- computation transform functionality in `cbook.boxplot_stats` and `Axes.boxplot`, and simply remove the redundant statistical and style parameters as described above.

### Doing nothing

As with many things in life, doing nothing is an option here. This means we simply advocate for users and downstream libraries to take advantage of the split between `cbook.boxplot_stats` and `Axes.bxp` and let them decide how to provide an interface to that.

## 36.19 MEP29: Text light markup

- *Status*
- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
- *Implementation*
  - *Improvements*
  - *Problems*
- *Backward compatibility*
- *Alternatives*

### 36.19.1 Status

Discussion

## 36.19.2 Branches and Pull requests

None at the moment, proof of concept only.

## 36.19.3 Abstract

This MEP proposes to add lightweight markup to the text artist.

## 36.19.4 Detailed description

Using different size/color/family in a text annotation is difficult because the `text` method accepts argument for size/color/family/weight/etc. that are used for the whole text. But, if one wants, for example, to have different colors, one has to look at the gallery where one such example is provided: [http://matplotlib.org/examples/text\\_labels\\_and\\_annotations/rainbow\\_text.html](http://matplotlib.org/examples/text_labels_and_annotations/rainbow_text.html)

This example takes a list of strings as well as a list of colors which makes it cumbersome to use. An alternative would be to use a restricted set of pango-like markup (see <https://developer.gnome.org/pango/stable/PangoMarkupFormat.html>) and to interpret this markup.

Some markup examples:

```
Hello <b>world!</b>`
Hello <span color="blue">world!</span>
```

## 36.19.5 Implementation

A proof of concept is provided in [markup\\_example.py](#) but it currently only handles the horizontal direction.

### Improvements

- This proof of concept uses regex to parse the text but it may be better to use the `html.parser` from the standard library.
- Computation of text fragment positions could benefit from the `OffsetFrom` class. See for example item 5 in [Using Complex Coordinates with Annotations](#)

### Problems

- One serious problem is how to deal with text having both latex and html-like tags. For example, consider the following:

```
 $\langle b \rangle \text{Bold} \langle /b \rangle$ 
```

Recommendation would be to have mutual exclusion.

### 36.19.6 Backward compatibility

None at the moment since it is only a proof of concept

### 36.19.7 Alternatives

As proposed by @anntzer, this could be also implemented as improvements to `mathtext`. For example:

```
r"${\text{Hello \textbf{world}}}$"  
r"${\text{Hello \textcolor{blue}{world}}}$"  
r"${\text{Hello \textsf{\small world}}}$"
```

## LICENSES

Matplotlib only uses BSD compatible code. If you bring in code from another project make sure it has a PSF, BSD, MIT or compatible license (see the Open Source Initiative [licenses page](#) for details on individual licenses). If it doesn't, you may consider contacting the author and asking them to relicense it. GPL and LGPL code are not acceptable in the main code base, though we are considering an alternative way of distributing L/GPL code through an separate channel, possibly a toolkit. If you include code, make sure you include a copy of that code's license in the license directory if the code's license requires you to distribute the license with it. Non-BSD compatible licenses are acceptable in matplotlib toolkits (e.g., basemap), but make sure you clearly state the licenses you are using.

### 37.1 Why BSD compatible?

The two dominant license variants in the wild are GPL-style and BSD-style. There are countless other licenses that place specific restrictions on code reuse, but there is an important difference to be considered in the GPL and BSD variants. The best known and perhaps most widely used license is the GPL, which in addition to granting you full rights to the source code including redistribution, carries with it an extra obligation. If you use GPL code in your own code, or link with it, your product must be released under a GPL compatible license. i.e., you are required to give the source code to other people and give them the right to redistribute it as well. Many of the most famous and widely used open source projects are released under the GPL, including linux, gcc, emacs and sage.

The second major class are the BSD-style licenses (which includes MIT and the python PSF license). These basically allow you to do whatever you want with the code: ignore it, include it in your own open source project, include it in your proprietary product, sell it, whatever. python itself is released under a BSD compatible license, in the sense that, quoting from the PSF license page:

There **is** no GPL-like "copyleft" restriction. Distributing binary-only versions of Python, modified **or not**, **is** allowed. There **is** no requirement to release **any** of your source code. You can also write extension modules **for** Python **and** provide them only **in** binary form.

Famous projects released under a BSD-style license in the permissive sense of the last paragraph are the BSD operating system, python and TeX.

There are several reasons why early matplotlib developers selected a BSD compatible license. matplotlib is a python extension, and we choose a license that was based on the python license (BSD compatible). Also, we wanted to attract as many users and developers as possible, and

many software companies will not use GPL code in software they plan to distribute, even those that are highly committed to open source development, such as [enthought](#), out of legitimate concern that use of the GPL will “infect” their code base by its viral nature. In effect, they want to retain the right to release some proprietary code. Companies and institutions who use matplotlib often make significant contributions, because they have the resources to get a job done, even a boring one. Two of the matplotlib backends (FLTK and WX) were contributed by private companies. The final reason behind the licensing choice is compatibility with the other python extensions for scientific computing: ipython, numpy, scipy, the enthought tool suite and python itself are all distributed under BSD compatible licenses.

## DEFAULT COLOR CHANGES

As discussed at length elsewhere [insert links], `jet` is an empirically bad color map and should not be the default color map. Due to the position that changing the appearance of the plot breaks backward compatibility, this change has been put off for far longer than it should have been. In addition to changing the default color map we plan to take the chance to change the default color-cycle on plots and to adopt a different color map for filled plots (`imshow`, `pcolor`, `contourf`, etc) and for scatter like plots.

### 38.1 Default Heat Map Colormap

The choice of a new color map is fertile ground to bike-shedding (“No, it should be `_this_color_`”) so we have a proposed set criteria (via Nathaniel Smith) to evaluate proposed color maps.

- it should be a sequential colormap, because diverging colormaps are really misleading unless you know where the “center” of the data is, and for a default colormap we generally won’t.
- it should be perceptually uniform, i.e., human subjective judgments of how far apart nearby colors are should correspond as linearly as possible to the difference between the numerical values they represent, at least locally.
- it should have a perceptually uniform luminance ramp, i.e. if you convert to greyscale it should still be uniform. This is useful both in practical terms (greyscale printers are still a thing!) and because luminance is a very strong and natural cue to magnitude.
- it should also have some kind of variation in hue, because hue variation is a really helpful additional cue to perception, having two cues is better than one, and there’s no reason not to do it.
- the hue variation should be chosen to produce reasonable results even for viewers with the more common types of colorblindness. (Which rules out things like red-to-green.)
- For bonus points, it would be nice to choose a hue ramp that still works if you throw away the luminance variation, because then we could use the version with varying luminance for 2d plots, and the version with just hue variation for 3d plots. (In 3d plots you really want to reserve the luminance channel for lighting/shading, because your brain is *really* good at extracting 3d shape from luminance variation. If the 3d surface itself has massively varying luminance then this screws up the ability to see shape.)
- Not infringe any existing IP

### 38.1.1 Example script

### 38.1.2 Proposed Colormaps

## 38.2 Default Scatter Colormap

For heat-map like applications it can be desirable to cover as much of the luminance scale as possible, however when color mapping markers, having markers too close to white can be a problem. For that reason we propose using a different (but maybe related) color map to the heat map for marker-based. The design parameters are the same as above, only with a more limited luminance variation.

### 38.2.1 Example script

```
import numpy as np
import matplotlib.pyplot as plt

np.random.seed(1234)

fig, (ax1, ax2) = plt.subplots(1, 2)

N = 50
x = np.random.rand(N)
y = np.random.rand(N)
colors = np.random.rand(N)
area = np.pi * (15 * np.random.rand(N))**2 # 0 to 15 point radiuses

ax1.scatter(x, y, s=area, c=colors, alpha=0.5)

X,Y = np.meshgrid(np.arange(0, 2*np.pi, .2),
                  np.arange(0, 2*np.pi, .2))
U = np.cos(X)
V = np.sin(Y)
Q = ax2.quiver(X, Y, U, V, units='width')
qd = np.random.rand(np.prod(X.shape))
Q.set_array(qd)
```

### 38.2.2 Proposed Colormaps

## 38.3 Color Cycle / Qualitative color map

When plotting lines it is frequently desirable to plot multiple lines or artists which need to be distinguishable, but there is no inherent ordering.

### 38.3.1 Example script

```
import numpy as np
import matplotlib.pyplot as plt

fig, (ax1, ax2) = plt.subplots(1, 2)

x = np.linspace(0, 1, 10)

for j in range(10):
    ax1.plot(x, x * j)

th = np.linspace(0, 2*np.pi, 1024)
for j in np.linspace(0, np.pi, 10):
    ax2.plot(th, np.sin(th + j))

ax2.set_xlim(0, 2*np.pi)
```

### 38.3.2 Proposed Color cycle



**Part VII**

**Glossary**



**AGG** The Anti-Grain Geometry ([Agg](#)) rendering engine, capable of rendering high-quality images

**Cairo** The [Cairo graphics](#) engine

**dateutil** The [dateutil](#) library provides extensions to the standard datetime module

**EPS** Encapsulated Postscript ([EPS](#))

**FreeType** [FreeType](#) is a font rasterization library used by matplotlib which supports TrueType, Type 1, and OpenType fonts.

**GDK** The Gimp Drawing Kit for GTK+

**GTK** The GIMP Toolkit ([GTK](#)) graphical user interface library

**JPG** The Joint Photographic Experts Group ([JPEG](#)) compression method and file format for photographic images

**numpy** [numpy](#) is the standard numerical array library for python, the successor to Numeric and numarray. numpy provides fast operations for homogeneous data sets and common mathematical operations like correlations, standard deviation, fourier transforms, and convolutions.

**PDF** Adobe's Portable Document Format ([PDF](#))

**PNG** Portable Network Graphics ([PNG](#)), a raster graphics format that employs lossless data compression which is more suitable for line art than the lossy jpg format. Unlike the gif format, png is not encumbered by requirements for a patent license.

**PS** Postscript ([PS](#)) is a vector graphics ASCII text language widely used in printers and publishing. Postscript was developed by adobe systems and is starting to show its age: for example it does not have an alpha channel. PDF was designed in part as a next-generation document format to replace postscript

**PyGObject** [PyGObject](#) provides Python wrappers for the *GTK* widgets library

**pyqt** [pyqt](#) provides python wrappers for the *Qt* widgets library and is required by the matplotlib Qt5Agg and Qt4Agg backends. Widely used on linux and windows; many linux distributions package this as 'python-qt5' or 'python-qt4'.

**python** [python](#) is an object oriented interpreted language widely used for scripting, application development, web application servers, scientific computing and more.

**Qt** *Qt* is a cross-platform application framework for desktop and embedded development.

**Qt4** *Qt4* is the previous, but most widely used, version of *Qt* cross-platform application framework for desktop and embedded development.

**Qt5** *Qt5* is the current version of *Qt* cross-platform application framework for desktop and embedded development.

**raster graphics** [Raster graphics](#), or bitmaps, represent an image as an array of pixels which is resolution dependent. Raster graphics are generally most practical for photo-realistic images, but do not scale easily without loss of quality.

**SVG** The Scalable Vector Graphics format ([SVG](#)). An XML based vector graphics format supported by many web browsers.

**TIFF** Tagged Image File Format ([TIFF](#)) is a file format for storing images, including photographs and line art.

**Tk** *Tk* is a graphical user interface for Tcl and many other dynamic languages. It can produce rich, native applications that run unchanged across Windows, Mac OS X, Linux and more.

**vector graphics** [vector graphics](#) use geometrical primitives based upon mathematical equations to represent images in computer graphics. Primitives can include points, lines, curves, and shapes or polygons. Vector graphics are scalable, which means that they can be resized without suffering from issues related to inherent resolution like are seen in raster graphics. Vector graphics are generally most practical for typesetting and graphic design applications.

**wxpython** [wxpython](#) provides python wrappers for the *wxWidgets* library for use with the WX and WXAgg backends. Widely used on linux, OS-X and windows, it is often packaged by linux distributions as 'python-wxgtk'

**wxWidgets** [WX](#) is cross-platform GUI and tools library for GTK, MS Windows, and MacOS. It uses native widgets for each operating system, so applications will have the look-and-feel that users on that operating system expect.

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