Div. Ingeniería de Sistemas y Automática

Universidad Miguel Hernández

Current Subjects in Computer Science

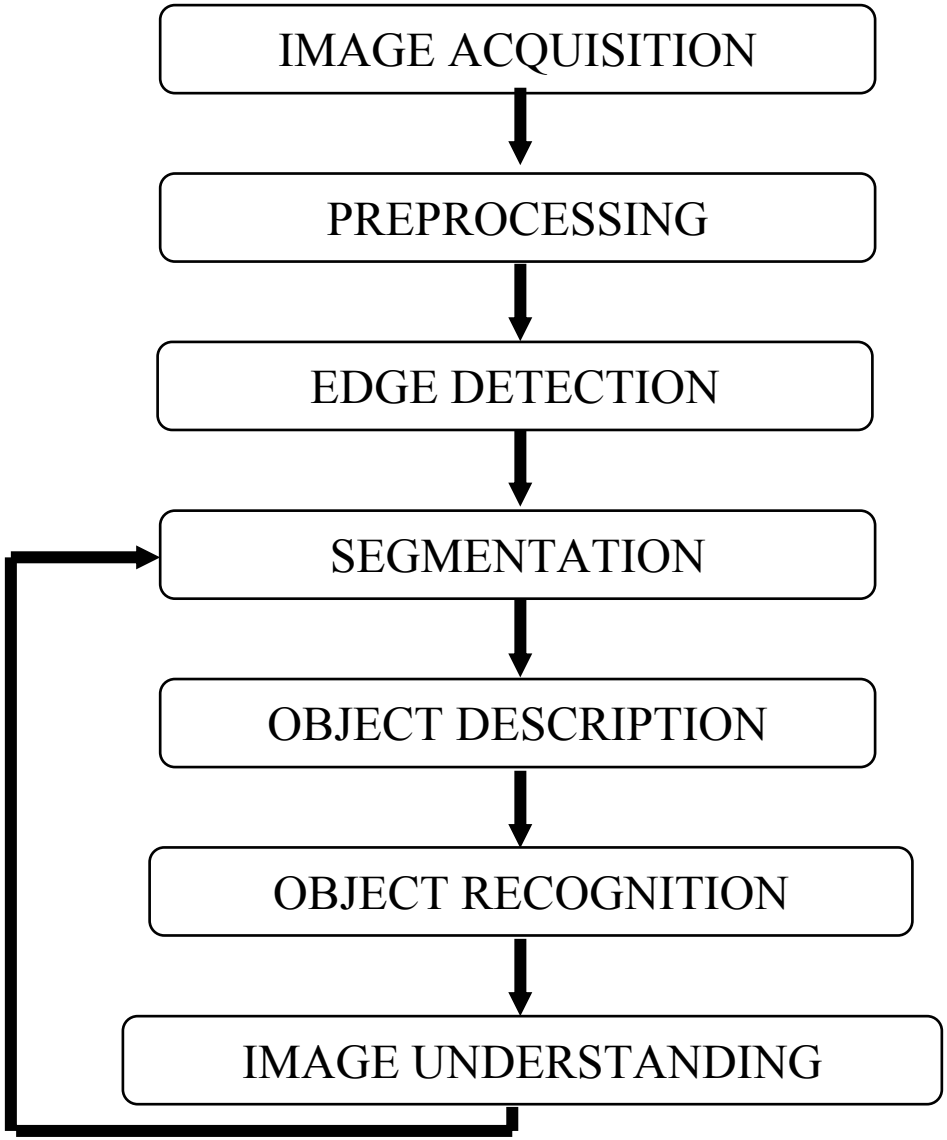
Segmentation

- Segmentation

  Image segmentation refers to the decomposition of a particular scene into its fundamental components

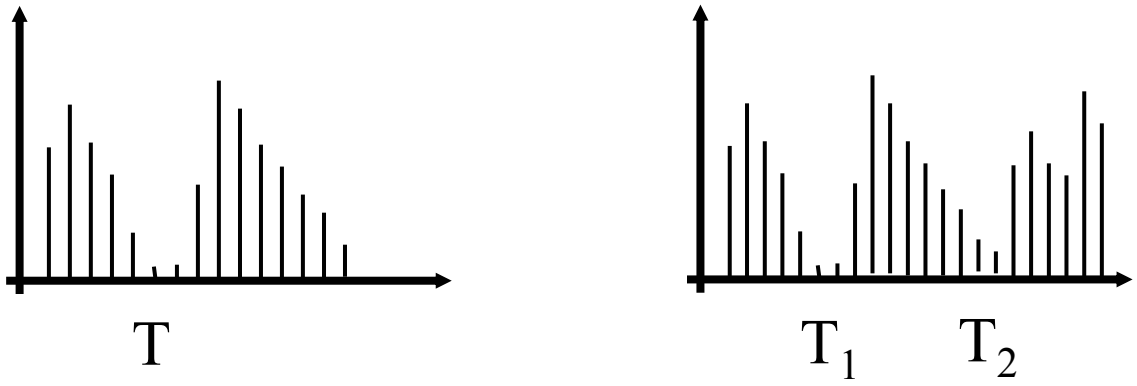
  Image division in areas with some meaning

General outline



Current Subjects in Computer Science

- Fundamentals:
  - Gray level is a property that may be the same for the pixels that belong to the same object.
  - Each object in the scene is characterized by a particular gray value.

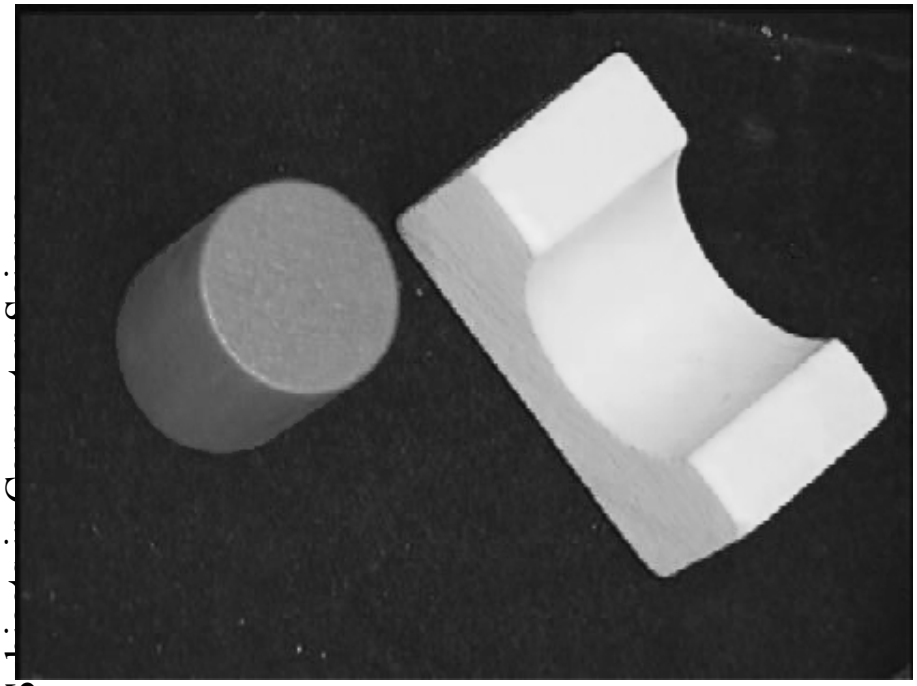


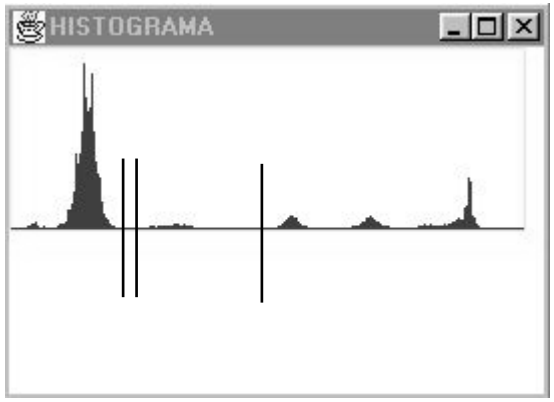
  - We would like to select a value T that separates the image into two groups

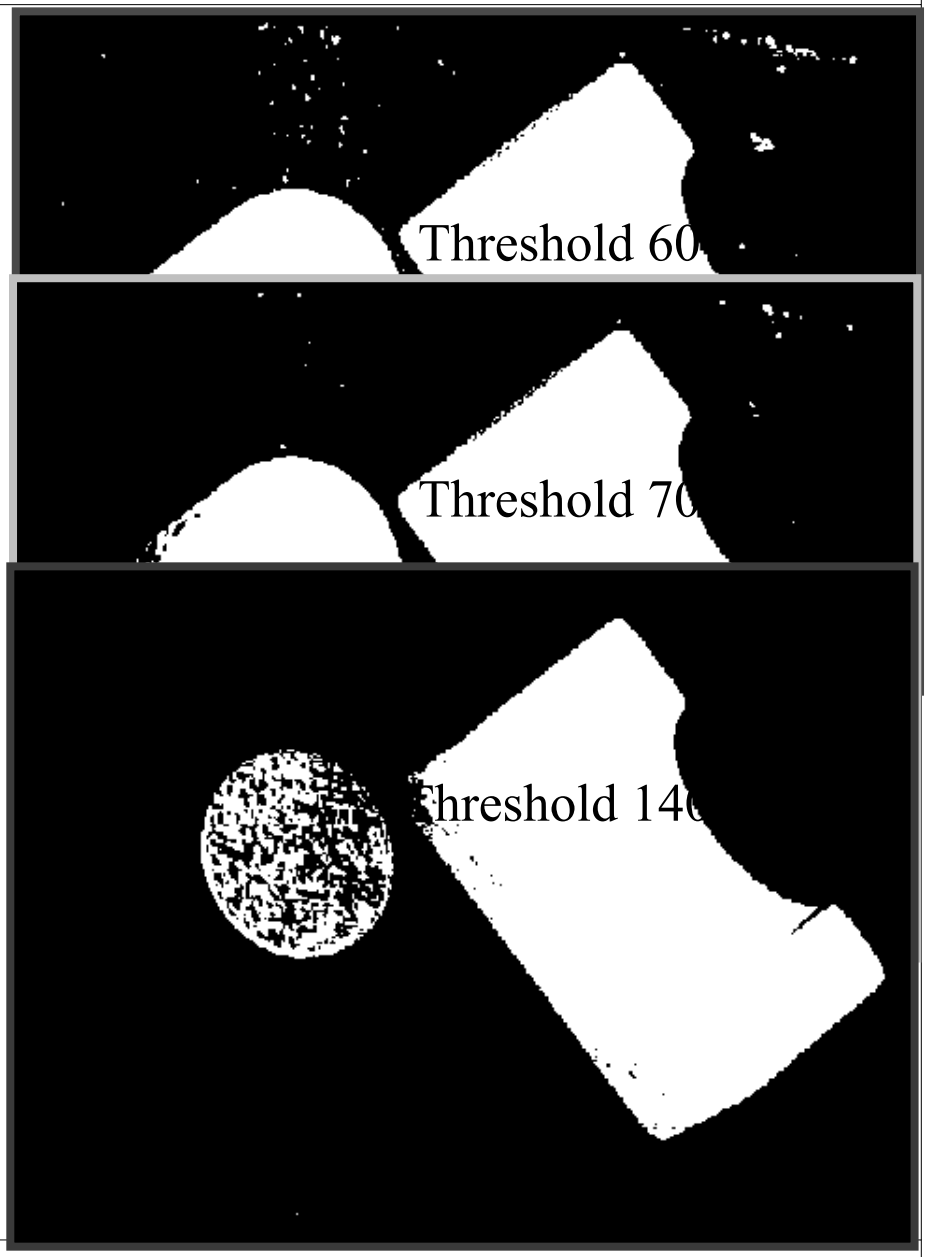
- Thresholding
  - Select a value for T that best separates the objects in the scene from the background
  - ¿How can the threshold T be computed?
    - ⇦Using image histogram
    - ⇦Problems
      - ☑ It may exist noise in the histogram
      - ☑ There may exist little peaks and valleys in the histogram

Thresholding

↖ Example:



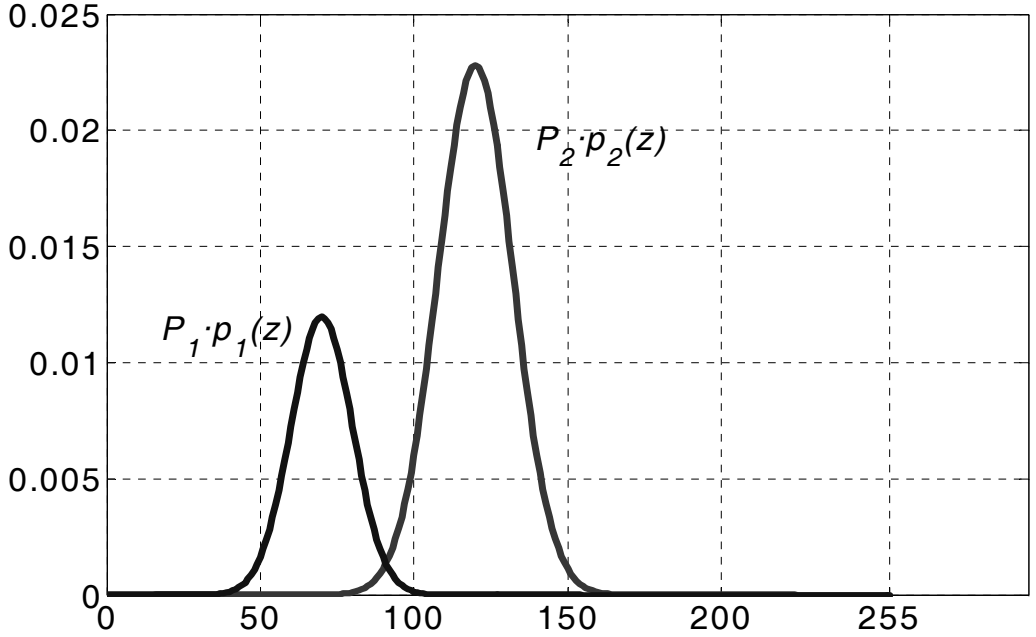




- General outline:
  - The histogram is formed by the probability distribution functions (pdf) of different objects in the scene.

$$p(z) = P_1 \cdot p_1(z) + P_2 \cdot p_2(z) \qquad p(g) = n(g) / n_T$$

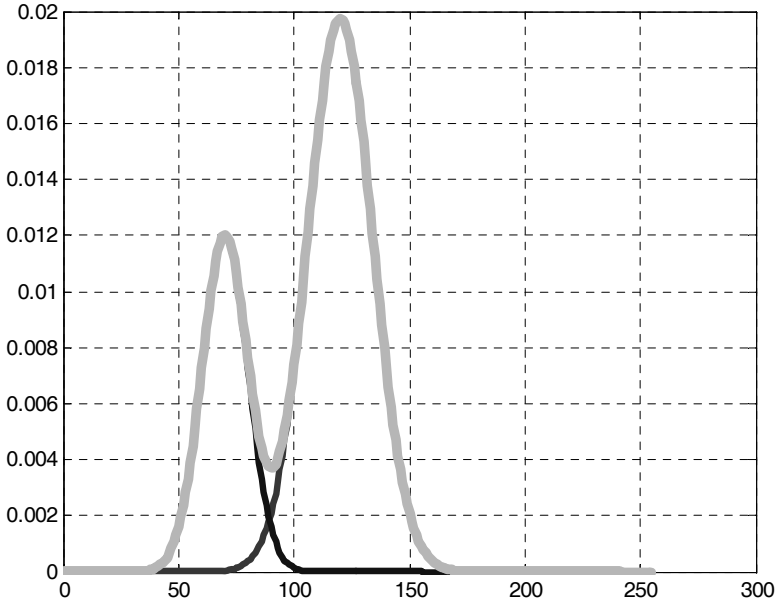
P_1 and P_2 are the *a priori* probabilities. $P_1 = n_1/n_T$ $P_2 = n_2/n_T$

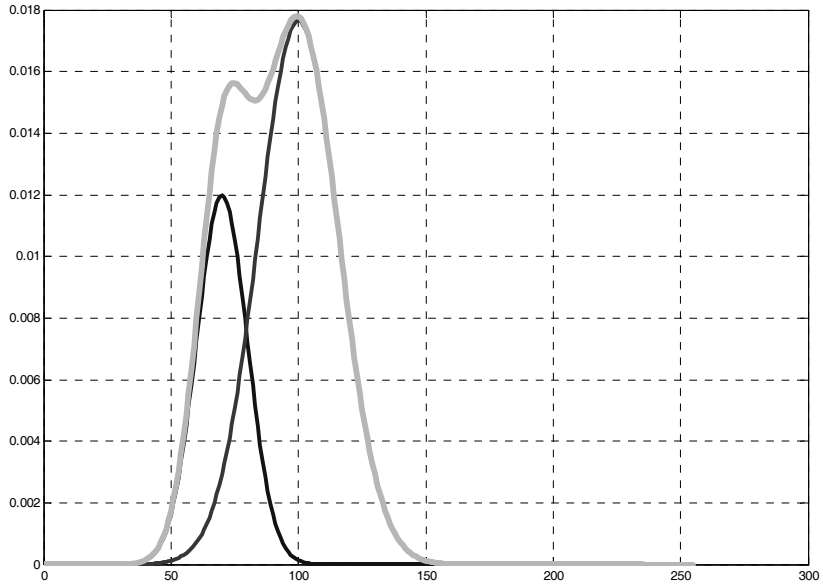


  - The optimum value T is: $P_1 \cdot p_1(T) = P_2 \cdot p_2(T)$
  - Problem: We don't know which pixel belongs to the object and which one belongs to the background: How can we estimate the pdf's??

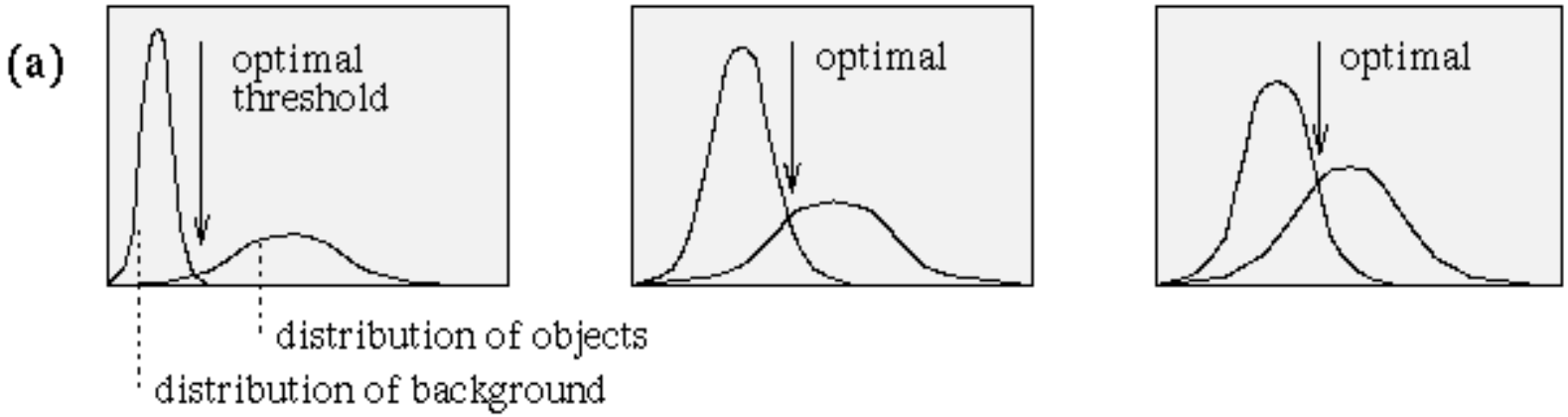
Thresholding: Automatic selection

- Looking for peaks and valleys in the histogram
  - Look for maxima in the histogram
  - Look for local minima between peaks in the histogram
- Problems: ¿?
  - Noise→false minima
  - The sum of pdf's does not have a valley at the optimum value.



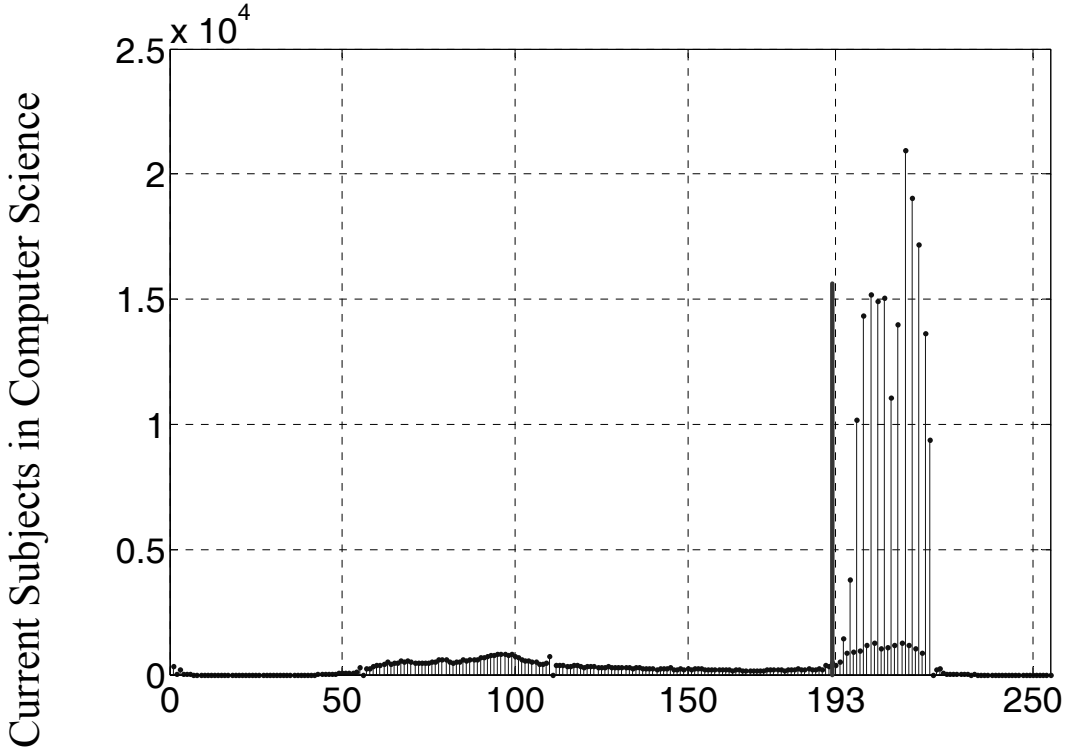


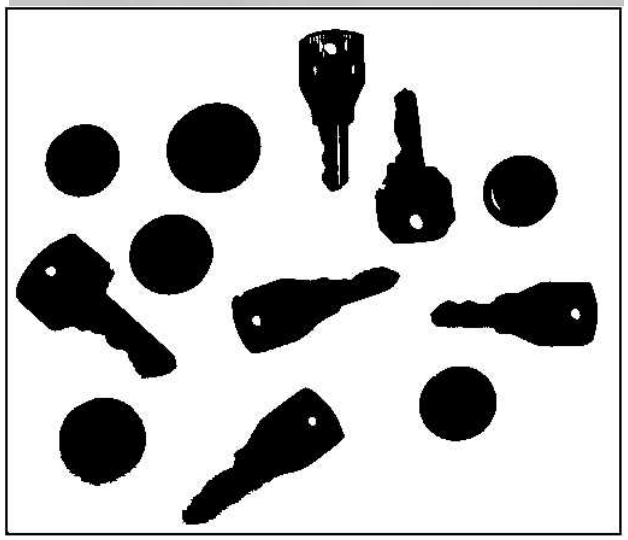
Thresholding: Automatic selection



Thresholding: Automatic threshold selection

- Global thresholding example: It is not obvious where to set T….





- Clustering (k-means)
  - We can look at the problem from a different point of view:
    - Suppose we've got two different groups of pixels. Each one at a particular range.
  - Then:
    - A threshold T separates the image into two groups: object (o) and background (b).
    - μ_o: Mean value of the pixels considered as object.
    - μ_b: Mean value of the pixels considered as background.
    - We look for a T such as:

$$\forall f(x,y) \geq T: \left| f(x,y) - \mu_b(T) \right| \geq \left| f(x,y) - \mu_o(T) \right|$$

$$\forall f(x,y) < T: \left| f(x,y) - \mu_b(T) \right| < \left| f(x,y) - \mu_o(T) \right|$$

Thresholding: Automatic selection

- Algorithm:
  1) Begin selecting $T^0 = B$, which separates the pixels into two groups.
  2) Calculate the mean value in each group:

$$\mu_b^i(T^i) = \frac{\sum_{f(x,y)<T} f(x,y)}{num.pixels\ b} \qquad \mu_o^i(T^i) = \frac{\sum_{f(x,y)\geq T} f(x,y)}{num.pixels\ o}$$

  3) Select a new threshold T^i:

$$T^{i+1} = \frac{\mu_b^i + \mu_o^i}{2}$$

  4) Goto 2).
  5) Repeat until T stabilizes.

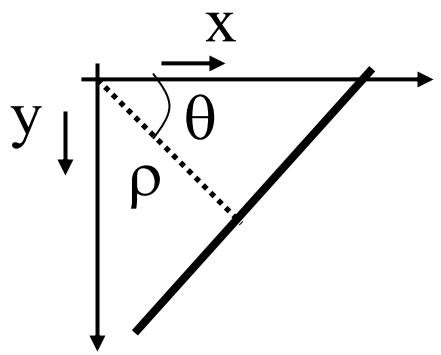
- Hough transform
  - It can be regarded as a global technique
  - It enables us to detect lines in an image
  - Input:
    - Binary image from gradient thresholding.
- Line detection

$$y = ax + b$$

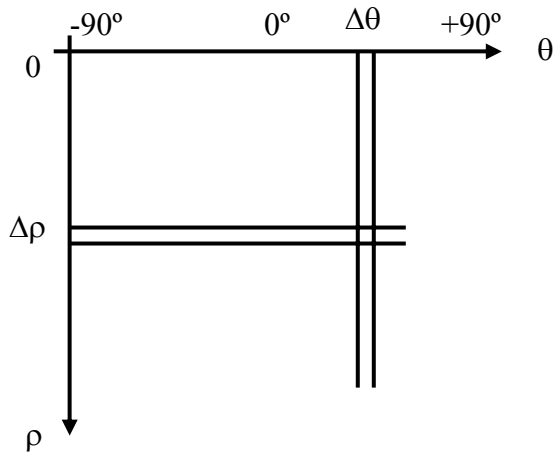
  - For a line ‘a’ and ‘b’ are constant
  - Given a set of points (x_i, y_i) belonging to the edge we would like to estimate the parameters ‘a’ and ‘b’.
  - What is the problem with this representation? ¿?

- An alternative way to represent a line:

$$\rho = x \cdot \cos(\theta) + y \cdot sen(\theta)$$



- The parameters to estimate now are ρ y θ. The new space of parameters is discretized.



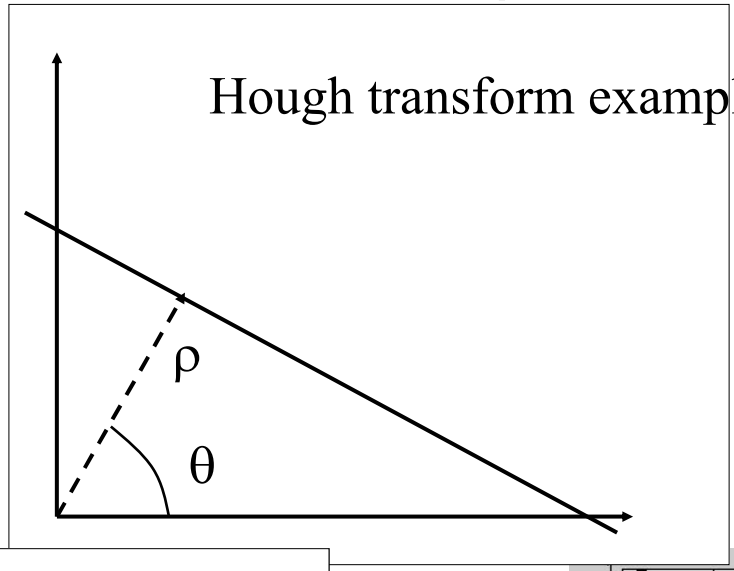
- Algorithm:
  1. Define increments for ρ and θ (e.g. $\Delta\theta$ = 0.1 rad)
  2. For each point (x_i, y_i) belonging to the edge, compute the following equation:

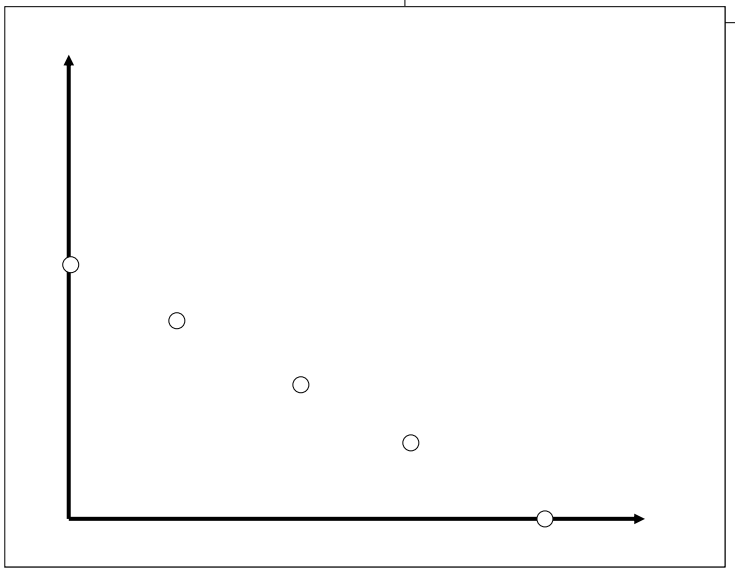
$$\rho = x_i \cos\theta + y_i sen\theta$$

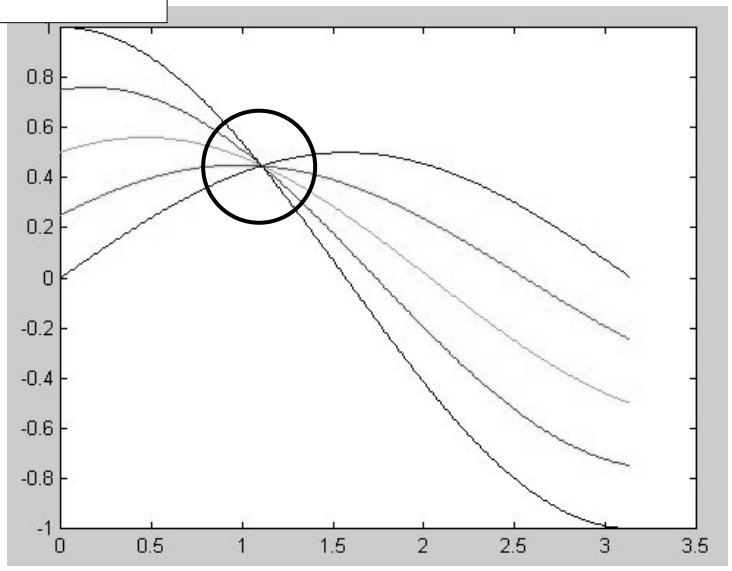
¿? What next?

3. Vote for all the ρ θ that comply with the prior equation.
   - ☑ The number of votes in each cell represents the number of points (x_i, y_i) that belong to a line with parameters (ρ, θ).
   - ☑ A threshold lets us select the lines in the image.

Hough transform example

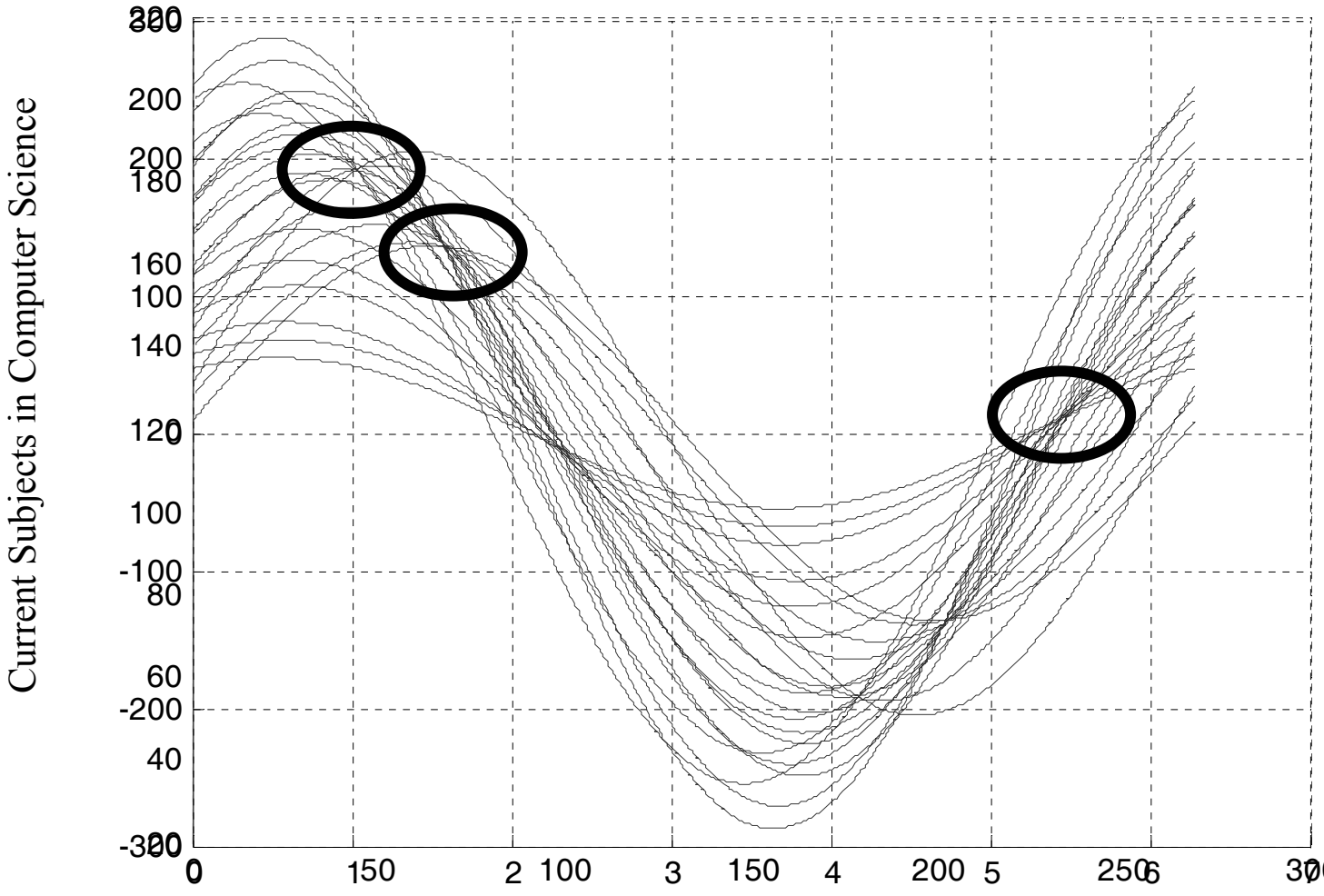






Boundary-based techniques

- Question: ¿?
  - ⇦How to extract n lines from the image?



ρ=140, θ= π/2

ρ=200,θ= π/4

ρ=10, θ= 7·π/4