SVDEC.8XP

by thornahawk

Introduction:

This TI 83+ program computes the singular value decomposition (SVD) $A=U\Sigma V^T$ of a given M×N matrix. The algorithm used is a slight modification of the Jacobi-like algorithm presented in (3), called the Hestenes-Nash algorithm. Usual methods for computing the SVD include the Golub-Kahan-Reinsch algorithm (2), which is not used here due to its length and complexity (although it is known that said algorithm is faster than the algorithm used by SVDEC). The theory and applications of the SVD are discussed in (1).

How to Use:

The input M×N matrix should be stored in [A] before executing the program. The program will indicate its progress by printing the number of "sweeps" already taken and the number of rotations performed in the sweep (The built-in limit for the number of sweeps is max(int(N/4),2Ø). This can be modified if necessary by modifying the appropriate line in the program.). When the number of rotations reaches zero, the program terminates returning an estimate of matrix rank in the variable L; the matrices U and V in matrices [A] and [I], respectively; and the singular values in the list ʟZ.

Suggestions and Known Issues:

–The built-in limit for the tolerance is 5E⁻13. This is fine for most applications, but can be changed by modifying the line 5E⁻13→E in the program as needed.

–An accompanying program, SVSOL, can be used after executing SVDEC for solving linear equations. This program will prompt for the equation's right hand side (as a list) and a tolerance (such that singular values smaller than it will be treated as 0), after which the (least squares) solution to the linear equation is returned. Make sure [A], [I], and ʟZ have not been modified in any way.

–The singular values returned may not be ordered.

–The 2-norm $\|A\|_2$ can be computed by max(ʟZ), and the 2-condition number $\kappa_2(A)$ by max(ʟZ)/min(ʟZ).

–For some difficult matrices, the built-in sweep limit can be exceeded (which is flagged by a "SWP XCD" error message). You can either increase the sweep limit, test if the decomposition returned is "good enough" for your application, or just use another program (!) for computing the SVD of your matrix.

References:

1. G.H. Golub and C.F. van Loan, *Matrix Computations*, The Johns Hopkins University Press, Baltimore, 3rd ed., 1996.

2. G.H. Golub and C. Reinsch, "Singular Value Decomposition and Least Squares Solutions", Numer. Math. **14**, 1970, 403-420.

3. J.C. Nash and S. Shlien, "Simple Algorithms for the Partial Singular Value Decomposition", Comp. J. **30**, 1987, 268-275.

I hope this program can be very useful. Please send suggestions, comments, and criticism to thornahawk@yahoo.com.