Spring Mass System Model: COE 352 Project 1

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1 SVD Function

For the matrix $\begin{bmatrix} 3 & 2 & 2 \\ 2 & 3 & -2 \end{bmatrix}$, the SVD function I programmed yielded $\begin{bmatrix} 0.70710678 & -0.70710678 \\ 0.70710678 & 0.70710678 \end{bmatrix}$, $\begin{bmatrix} 5. & 0. & 0. \\ 0. & 3. & 0. \end{bmatrix}$, and $\begin{bmatrix} -7.07106781e-01 & 2.35702260e-01 & -6.66666667e-01 \\ -7.07106781e-01 & -2.35702260e-01 & 6.66666667e-01 \\ -1.08807149e-17 & 9.42809042e-01 & 3.33333333e-01 \end{bmatrix}$ for the U, Σ, and V matrices respectively. In contrast, MATLAB's SVD black box function yielded the result $\begin{bmatrix} -0.7071 & 0.7071 \\ -0.7071 & -0.7071 \end{bmatrix}$, $\begin{bmatrix} 5 & 0 & 0 \\ 0 & 3 & 0 \end{bmatrix}$, and $\begin{bmatrix} -0.7071 & 0.2357 & -0.6667 \\ -0.7071 & -0.2357 & 0.6667 \\ 0.000 & 0.9428 & 0.3333 \end{bmatrix}$ for the U, Σ, and V matrices respectively. These results are very similar, with noticeable differences being sign differences and precision. My function yields the equivalent matrix $A*-1$ when U, Σ, and V^T are multiplied, while MATLAB's yields the original matrix A. It also appears that MATLAB's display defaults to four decimal points instead of Python's eight, and the uncertainties in numpy's eigenvalue/eigenvector modules makes it so a very small value (within floating point precision of zero) is displayed instead of zero.

2 Spring-Mass System with Two Free Ends

A spring-mass system with two free ends is unable to be precisely solved for using the SVD-decomposition method, and thus error-checking within the springSystem.py script does not allow for this to be an option. However, if I were to hardcode this in, with parameters `masses = [1,1,1]` and `spCs = [1,1]` (for masses and spring constants respectively), this yields the matrices $A = \begin{bmatrix} -1. & 1. & 0. \\ 0. & -1. & 1. \end{bmatrix}$, $C = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$, $A^T = \begin{bmatrix} -1. & 1. & 0. \\ 0. & -1. & 1. \end{bmatrix}$, and $K = \begin{bmatrix} 1. & -1. & 0. \\ -1. & 2. & -1. \\ 0. & -1. & 1. \end{bmatrix}$. Since K has at least one singular value that equals 0, no inverse of this matrix is able to be found, so this yields the result `Error: stiffness matrix K is not invertible. Try defining one or two fixed ends instead.`