Math 229: Applied Linear Algebra
Fall 2017

Professor Skardal
Trinity College

Computational Homework 3 Cover Page

Due Monday, Novermber 13 (at the beginning of class)

Name (Print): ____________________

This assignment contains 3 problems. Write your name in the space above and put your initials on the top of every page, in case the pages become separated.

- Email me your code (`persebastian.skardal@trincoll.edu`) in a single `.zip`-file named `lastname##.zip` with the subject line `lastname homework##`. (Replace `##` with the assignment number, e.g., `02` for the second assignment.). Your code should be neatly written and well commented. Organize your code appropriately into different `.m`-files for different problems.
- If a written portion is required, complete it NEATLY on 8.5 x 11 white paper. Assignments completed on lined paper will not be accepted.
- If multiple sheets of paper are necessary, staple your assignment before coming to class. Unstapled assignments will not be accepted.
- Include this cover page at the front of your assignment. Assignments missing this cover page will not be accepted.
- If plots or figures are requires, print and include them in this packet. Assignments missing the required plots and figures will be considered incomplete.
- Organize your assignment in the proper order. Assignments in the wrong order will not be accepted.
- Late homework will not be accepted.

Do not write in the space below.

Problem	1	2	3	Total
Points				
Score				

1. Write a MATLAB *function* called `GramSchmidt.m` that generates an orthonormal set of vectors $q_1, \ldots, q_N$ from a linearly independent set $v_1, \ldots, v_N$. Assume that the vectors $v_1, \ldots, v_N$ are organized as the columns of an $M \times N$ matrix A, and that $q_1, \ldots, q_N$ can be organized as the columns of an $M \times N$ matrix Q. Thus, your code should produce Q given A:

$$A = \begin{bmatrix} | & & | \\ v_1 & \cdots & v_N \\ | & & | \end{bmatrix} \quad \Rightarrow \quad Q = \begin{bmatrix} | & & | \\ q_1 & \cdots & q_N \\ | & & | \end{bmatrix}. \tag{1}$$

   Your code should take as an input the matrix A and output the matrix Q.

   A few notes: MATLAB can easily pull the column vectors our of a vector A. For instance, the command `v = A(:,3);` will grab the third column of `A` and save it as the vectors `v`.

   MATLAB also can compute the transpose easily. For instance, the command `AT = A';` will compute the transpose of `A` and save it in the variable `AT`.

   This can be used to compute an inner product. Recall that the inner product of two vectors U and V is given by $u^T v$. In MATLAB, if `u` and `v` are two column vectors, then the command `inner = u'*v;` computes the inner product and saves it in the variable `inner`.

2. Write a MATLAB function called `QRdecomp.m` that computes the QR decomposition of an $M \times N$ matrix A. Recall that Q is $M \times N$, orthogonal, and satisfies $Q^T Q = I$, and R is $N \times N$, upper triangular and is defined by $Q^T A = R$. You should use your function from above, `GramSchmidt` in this function! Your code should take as an input the matrix A and output two matrices, Q and R.

3. Now, consider NASA's Global Temperature Anomaly data given in the `GlobalTemps.txt` file on the website. (There is also a script called `PlotTemplate.m` that you can use to plot the data!) Letting (x_i, y_i) represent the year and global temperature, respectively, write a script called `TempFit.m` that calculates the line of best fit, $\alpha x + \beta = y$, and plots this along with the data itself.

   To solve the over constrained system that finds the line of best fit, use your function `QRdecomp` as well as your function `solveU` from a couple assignments ago. For help on plotting, see the MATLAB help documentation on `plot`. Look back into your notes to remember how to solve an overconstrained system with QR!