MATLAB ASSIGNMENT 1 (MAT 022A 001)

LAURA STARKSTON

Create a script (a .m file) to write your homework. The first three lines should indicate that this is MATLAB Assignment 1, your name, and your student ID as # notes (i.e. comments). Each problem should also clearly be enumerated with notes/comments. Make sure to try running your script before submitting it to make sure you do not have any errors. Submit the .m file to Canvas Assignments before 11:59pm on Monday October 28.

It is ok to read documentation or search online about MATLAB functions as you go through the assignment. However each student must write their own code. The purpose is become familiar with how to use MATLAB to perform calculations that we have been discussing in class and to learn the concepts from class in greater depth.

(1) Input the matrix

$$A = \begin{bmatrix} 1 & 2 & 5 \\ 2 & -1 & 0 \\ 2 & -1 & 4 \end{bmatrix}$$

and the vector

$$x = \begin{bmatrix} 2 \\ -1 \\ 3 \end{bmatrix}$$

then set b equal to the quantity Ax obtained by matrix multiplication.

Set $y = A\backslash b$. Use the MATLAB == command to confirm that x and y are equal and *output the result*. (What should the answer be that confirms they are the same?)

Check x and y are equal in another way by calculating $x - y$ (the result should be the vector of all 0's) and *output the result*.

(2) Input the column vector

$$d = \begin{bmatrix} 5 \\ 4 \\ -1 \end{bmatrix}$$

Calculate the solution x to $Ax = d$ by calculating $A^{-1}d$ (*output the result*)

(3) Input matrix

$$B = \begin{bmatrix} 3 & 1 & 2 \\ 1 & 2 & 3 \\ 3 & 1 & 4 \end{bmatrix}$$

then calculate the $B = LU$ decomposition using the $[L, U] = lu(B)$ function and *output the result*. In particular, find the lower triangular matrix L and the upper triangular matrix U.

Now input the matrix obtained by switching the rows of B:

$$C = \begin{bmatrix} 3 & 1 & 2 \\ 3 & 1 & 4 \\ 1 & 2 & 3 \end{bmatrix}$$

then calculate the $C = LU$ decomposition with $[L, U] = lu(C)$. What happens to L and U? Write in a comment an explanation for why L is not lower triangular for C.

(4) Here we will look closer at the LU decomposition:

(a) Input the matrix

$$M = \begin{bmatrix} 1 & -1 & 1 \\ 2 & 3 & 1 \\ -1 & 2 & 0 \end{bmatrix}$$

(b) Determine which row operation will turn the 2 in the second row, first column, into a 0. Input a matrix E which does that row operation. Calculate the matrix multiplication EM *(output the result).*

(c) Looking at the result EM, determine which row operation you need to perform next to make the entry in the third row, first column a 0. Input a matrix F which does that row operation. Calculate the matrix multiplication FEM *(output the result).*

(d) Looking at the result FEM, determine which row operation you need to perform next to make the resulting matrix upper triangular. Input a matrix G which does that row operation. Calculate the matrix multiplication defining $U = GFEM$ *(output the result).* The result should be upper triangular.

(e) Calculate using inverses and matrix multiplication the matrix $L = E^{-1}F^{-1}G^{-1}$ *(output the result).* Check that the result is lower triangular.

(f) Check that $M = LU$ using MATLAB's == function *(output the result).* (What should the result be that indicates they are equal?)

(g) Check in a different way that $M = LU$ by calculating the matrix $M - LU$ *(output the result)* and checking all the entries are 0.

(h) You found a decomposition of M into a lower triangular and upper triangular matrix. Now see what MATLAB will do if you calculate $[LL, UU] = lu(M)$ *(output the result).* Does it give the same answer?

(i) Calculate the matrix multiplication product of LL with UU and check it is equal to M using MATLAB's == function *(output the result).* Why would MATLAB give a different answer for the LU decomposition? (Write a comment explaining this.)