Math 244: MATLAB Assignment 6

Fall 2024, Sections 1-3

Instructor:	Matt Charnley
Recitation Instructor:	Dongyeong Ko
Due Date:	November 18, 2024

Introduction

You are encouraged to discuss this assignment with other students and with the instructor/recitation instructor, but the work you hand in should be your own.

This assignment provides an introduction to linear algebra using MATLAB. You will see how to store matrices in MATLAB, perform matrix operations, and compute properties of matrices using built-in MATLAB methods.

Supplemental Code

There are no supplemental methods required for this assignment. You should start from the `Lab6_FormatFile.mlx` base file, since it has a lot of information and format that will help with completing the assignment.

Resources

There are many resources available to help you with completing this assignment. The website

`https://sites.math.rutgers.edu/~mpc163/CompLabs/Matlab244_help.html`

contains some information about each of the lab assignments and a few particular issues that may come about when working on it. The links at the top of the page will take you to each individual lab. In addition, there are several video playlists that may help you with completing the assignment. The first outlines all of the assignments individually

`https://www.youtube.com/playlist?list=PLbKymuaXja9-vfhc0r067Cd5n4RNZf39N`

the next contains a description of each of the supplemental files that is provided with the assignments

`https://www.youtube.com/playlist?list=PLbKymuaXja9-Nx6PFQsuAZvPHhlovBhU5`

the third contains a review of the basics of MATLAB and how you will want to structure the assignments

`https://www.youtube.com/playlist?list=PLbKymuaXja9_nQzb7cOqNeqVpqWqBdQ0g`

and the last contains a collection of other potentially helpful videos

`https://www.youtube.com/playlist?list=PLbKymuaXja9_U49M6PGNQXjQHI5ANcubj`.

Your Task

1. Input the following vectors and matrices into MATLAB. You should store them as the same names that are given here.

$$A = \begin{bmatrix} 2 & 3 & -1 \\ -3 & 4 & 0 \end{bmatrix} \qquad B = \begin{bmatrix} 1 & 5 \\ 0 & -2 \\ -1 & 3 \end{bmatrix} \qquad C = \begin{bmatrix} 2 & -5 \\ 1 & 3 \end{bmatrix}$$

$$\vec{v} = \begin{bmatrix} 1 \\ 2 \\ 5 \end{bmatrix} \qquad \vec{w} = \begin{bmatrix} 2 \\ 4 \end{bmatrix} \qquad \vec{y} = \begin{bmatrix} 0 \\ 3 \\ 2 \end{bmatrix}$$

   After that, write lines of code to display the -1 from matrix A, the 3 from matrix B, and the 3 from $\vec{y}$. You will need to use parentheses to access the entries of these matrices and vectors.

2. Use MATLAB to compute each of the following matrix operations: AB, BA, BC, CA, $A\vec{v}$, $B\vec{w}$, $BA\vec{v}$, $A(\vec{v} - 3\vec{y})$. Make sure you show the output for each of these operations in the turn-in file.

3. Think about the product AC. Is is possible to compute this product? Try to compute this in MATLAB and write down the error that MATLAB gives you. (You will need to comment this line out afterwards so that the rest of your code will run.) In the comments for this question, mention whether/why it is or is not possible to compute this product, as well as the error that MATLAB gives you when you try.

4. Think about the linear combination $2\vec{v} + 3\vec{w}$. Is this possible? Try to compute it in MATLAB, and again, comment with the error that MATLAB gives.

5. Is it possible to compute A^2? See what happens when you try to compute it. Afterwards, compute `A.^2`, that is, include a dot before the exponentiation. What did this operation compute? Show and explain what the output is for `A.^2`. Think about what the values of A are, and what the values of `A.^2` are.

6. Compute C^2 and `C.^2`. Both of these should be possible, but will give different answers. What are the differences between these two matrices? What does each compute? Think of what you wrote for the previous problem.

7. Assume that we want to compute the dot product $\vec{v} \cdot \vec{y}$, which should be possible because they are both 3 component vectors. This can be done a few different ways, `sum(v.*y)` or `v'*y`. The operation $'$ computes the transpose of the matrix, swapping the rows and columns of a matrix. (It actually computes the conjugate transpose, which matters for complex numbers, but acts like a transpose for real matrices and vectors.) Compute the dot product both of the ways above, and also compute and show B' and $C'B'$. How does this last result compare to BC? Think about how B' relates to B.

8. MATLAB has built-in functions to compute determinants and eigenvectors. Look up the functions `det` and `eig`, and use these two to compute the determinant, eigenvalues, and eigenvectors of the matrix

$$M = \begin{bmatrix} -1 & -12 & -2 \\ 0 & 4 & 0 \\ 3 & 12 & 4 \end{bmatrix}$$

In a comment, type out all of the things that you discovered (that is, everything that you calculated).
Note: For the eigenvalues and eigenvectors, you will need to call the `eig` function with two outputs of the form `[V,D] = eig(...)` in order to see both the eigenvalues and eigenvectors.

9. In working out a problem by hand, you find that 2 is an eigenvalue for the matrix

$$N = \begin{bmatrix} -10 & -12 & 12 \\ 6 & 7 & -4 \\ -3 & -4 & 7 \end{bmatrix}$$

with corresponding eigenvector $\begin{bmatrix} -1 \\ 2 \\ 1 \end{bmatrix}$ (This means that you know this fact. You do not need to find the eigenvalues and eigenvectors of this matrix by hand.). Use MATLAB to compute the eigenvalues and eigenvectors of this matrix. How does the result that MATLAB gives you compare with what was found by hand?
Note: Use the same idea as the previous problem to determine what MATLAB thinks the eigenvector for eigenvalue 2 is. Compare this to the vector given here. What happens if you divide the vector from MATLAB by its smallest entry?

Deliverable

Once putting together all of the code and the necessary commentary into the blanks between them, run the entire file, click on the arrow under "Save," and select "Export to PDF." If the option is not there, try the "Export" button next to it. This will allow you to save all of the output as a single PDF file.

Look through the document to make sure that everything looks the way you want it to. If you have any code lines that run off the page, try to shorten them using variables or use `...` to create a line break. This assignment is due on **November 18, 2024** online by submitting through the appropriate Canvas site.