

# Fall 2014 - Math 401 Section 0401

## Applications of Linear Algebra

### MATLAB Project 0

Note: This project teaches you how to use MATLAB and present homework.

**M-files.** This is an important class of files that we will be using throughout the course in the MATLAB projects. The M-files are text files that you can create with a text editor, and they contain commands to be interpreted by MATLAB. An example of an M-file to solve the Problem 1 of this project is the following:

```
1 delete p0probl.txt % we delete the file just in case it existed
2 diary p0probl.txt
3 format compact
4 echo on
5
6 % Solution to
7 %   Matlab Project 1
8 %   problem       1
9
10 % We first enter the matrices A and B
11 A = [1, -2, 3; 4, 5, 6; 7, 8, -10]
12 B = [-1, 7, 2; -5, 6, 1; 7, -8, 11]
13
14 % Now we compute A+B and 3*A
15 A+B
16 3*A
17
18 % \text{As you already noticed, the symbol % is used to add comments.}
```

An important aspect of M-files is that their names must end with “.m” For the M-file shown in the example, I would use the name **p0probl.m**, but you can use the names you like! When you want MATLAB to follow the instructions in the M-file, you must type the filename without the extension .m on the Matlab prompt, and you have to be working in the directory where the files are stored. To *go* to a directory we use the cd command. This will be better understood with an example: Suppose that the file **p0probl.m** is in the directory **c:\math401\matlab**, then to run the script in that file you have to type the following:

```
1 >> cd c:\math401\matlab
2 >> p0probl
```

and MATLAB will output:

```

1 A =
2     1    -2     3
3     4     5     6
4     7     8    -10
5 B =
6    -1     7     2
7    -5     6     1
8     7    -8    11
9 ans =
10     0     5     5
11    -1    11     7
12    14     0     1
13 ans =
14     3    -6     9
15    12    15    18
16    21    24   -30

```

**Presenting Results.** You can present results by using the **publish** command or **M-books**, pasting MATLAB commands and graphics into LaTeX document, or simply using **diary files**. The latter are text files where MATLAB stores all what you see on the screen as you run command and/or invoke M-files. Suppose that now we modify **p0prob1.m** adding the line `diary p0prob1.txt` at the beginning and the line `diary off` at the end. Then, as a result, when you invoke `p0prob1` at the MATLAB prompt, MATLAB will show on the screen the same as before, but at the same time, it will save that information on the file **p0prob1.txt**. If the diary file already existed, Matlab would *append* the lines at the end. Including the command `echo on` at the beginning of the file will record all command used by the M-files in the diary file.

Here is a **summary of the steps used to prepare homework solutions**.

- (1) Create an M-file in your current working directory to hold the solution. Include `echo on` near the top of the file so you can see which commands are producing what output when you run the M-file.
- (2) Continue editing and running the M-file until you are confident that it contains the MATLAB commands that solve the problem.
- (3) Add comments to your M-files to explain the method being used to solve the problem and to interpret the results. Give titles to your figures.
- (4) Once the M-file is ready, publish the document or insert the `delete` and `diary` commands into the M-file (see example below).
- (5) Now run the M-file to produce the final solution. Do not print intermediate calculations (the command `;` at the end of a line avoids printing). Send the diary file or published document to a printer. Collect pages, staple them together and submit them.

To illustrate the results of this process, here is the final version of the M-file for problem 1.

file p0prob1.m

```

1 delete p0prob1.txt % we delete the file just in case it existed
2 diary p0prob1.txt
3 format compact
4 echo on
5
6 % Solution to

```

```

7 % Matlab Project 1
8 % problem 1
9
10 % We first enter the matrices A and B
11 A = [1, -2, 3; 4, 5, 6; 7, 8, -10]
12 B = [-1, 7, 2; -5, 6, 1; 7, -8, 11]
13
14 % Now we compute A+B and 3*A
15 A+B
16 3*A
17
18 % The results matlab gave for A+B and 3*A agree with our definition
19 % for adding matrices and multiplying by scalars.
20
21 echo off
22 diary off % it is important to do this, otherwise Matlab would
23 % continue to add lines to the diary file

```

And the diary file **p0prob1.txt** will look like file p0prob1.txt

```

1 % Solution to
2 % Matlab Project 1
3 % problem 1
4 % We first enter the matrices A and B
5 A = [1, -2, 3; 4, 5, 6; 7, 8, -10]
6 A =
7     1    -2     3
8     4     5     6
9     7     8    -10
10 B = [-1, 7, 2; -5, 6, 1; 7, -8, 11]
11 B =
12    -1     7     2
13    -5     6     1
14     7    -8    11
15
16 % Now we compute A+B and 3*A
17 A+B
18 ans =
19     0     5     5
20    -1    11     7
21    14     0     1
22 3*A
23 ans =
24     3    -6     9
25    12    15    18
26    21    24   -30
27
28 % The results matlab gave for A+B and 3*A agree with our definition
29 % for adding matrices and multiplying by scalars.
30 echo off

```

### Final Note

Each problem should be worked out in a separate M-file, and the results published or saved in a diary file. A printout of the published document or the diary file should be handed (one per student). Use

comment lines in your M-file to make appropriate comments and to indicate the problem number. Use the echo command to display the commands in your M-files in the command window, and thus in the diary file.

Try the following 4 problems to practice MATLAB commands, the publish command and diary files. You will need both for MATLAB Project #1, which will be graded.

**Problem 1:** Enter the matrices

$$A = \begin{bmatrix} 1 & -2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & -10 \end{bmatrix} \quad \text{and} \quad B = \begin{bmatrix} -1 & 7 & 2 \\ -5 & 6 & 1 \\ 7 & -8 & 11 \end{bmatrix}$$

Compute  $A + B$  and  $3A$ . Do the results agree with our definitions for adding matrices and multiplying matrices by scalars?

**Problem 2:** Enter the matrices

$$A = \begin{bmatrix} 1 & -2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & -10 \end{bmatrix}, \quad B = \begin{bmatrix} -1 & 7 & 2 \\ -5 & 6 & 1 \end{bmatrix}, \quad C = [7]$$

Compute  $A + B$ ,  $A + C$ ,  $C + B$ . Do the results agree with our definitions for adding matrices? Why, or why not?

**Problem 3:** Enter the vectors (column matrices)

$$u = \begin{bmatrix} 1 \\ -9 \\ 8 \\ 11 \end{bmatrix} \quad \text{and} \quad v = \begin{bmatrix} -11 \\ 13 \\ -7 \\ 10 \end{bmatrix}$$

Then compute the linear combinations  $2u + 3v$  and  $3u - 12v$ .

**Problem 4:** Enter the matrices

$$x = \begin{bmatrix} 2 \\ 5 \\ -8 \\ 3 \end{bmatrix} \quad \text{and} \quad v = \begin{bmatrix} -4 \\ 23 \\ 7 \\ -10 \end{bmatrix}$$

Then compute  $x \cdot y$  by forming the matrix product  $x' * y$ . Explain why this matrix product gives the correct answer. What does the prime do? What happens if we type  $x * y$ ? why? What is the result of typing  $x * y'$ ?

**Problem 5:** Let

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 2 & 3 & -5 \\ -1 & 3 & -3 \end{bmatrix}, \quad B = \begin{bmatrix} 3 & 2 & 1 \\ -1 & 5 & -3 \\ 2 & 3 & -3 \end{bmatrix}, \quad C = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 6 & 10 \end{bmatrix}.$$

- (a) Compute  $AB$  and  $BA$ , using matrix multiplication in MATLAB. Are they the same? Did you expect them to be the same? Explain.
- (b) Compute  $(AB)C$  and  $A(BC)$ . Are they the same? Did you expect them to be the same? Why?