Spring 2015 - Math 401 Section 0501
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 Problem 1 of this project is the following.

```
delete p0prob1.txt % we delete the file just in case it existed
diary p0prob1.txt
format compact
echo on

% Solution to
%     {\sc Matlab} Project 1
%     problem        1

% We first enter the matrices A and B
A = [1, -2, 3; 4, 5, 6; 7, 8, -10]
B = [-1, 7, 2; -5, 6, 1; 7, -8, 11]

% Now we compute A+B and 3*A
A+B
3*A

% \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 **p0prob1.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 Maltab 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 **p0prob1.m** is in the directory **c:\math401\matlab**, then to run the script in that file you have to type the following:

```
>>  cd   c:\math401\matlab
>>  p0prob1
```

and MATLAB will output

```
A =
     1    -2     3
     4     5     6
     7     8   -10
B =
    -1     7     2
    -5     6     1
     7    -8    11
ans =
     0     5     5
    -1    11     7
    14     0     1
ans =
     3    -6     9
    12    15    18
    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, Maltab 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**

```
delete p0prob1.txt % we delete the file just in case it existed
diary p0prob1.txt
format compact
echo on

% Solution to
```

```
%     {\sc Matlab} Project 1
%     problem        1

% We first enter the matrices A and B
A = [1, -2, 3; 4, 5, 6; 7, 8, -10]
B = [-1, 7, 2; -5, 6, 1; 7, -8, 11]

% Now we compute A+B and 3*A
A+B
3*A

% The results matlab gave for A+B and 3*A agree with our definition
% for adding matrices and multiplying by scalars.

echo off
diary off    % it is important to do this, otherwise {\sc Matlab} would
             % continue to add lines to the diary file
```

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

```
% Solution to
%     {\sc Matlab} Project 1
%     problem        1
% We first enter the matrices A and B
A = [1, -2, 3; 4, 5, 6; 7, 8, -10]
A =
      1    -2     3
      4     5     6
      7     8   -10
B = [-1, 7, 2; -5, 6, 1; 7, -8, 11]
B =
     -1     7     2
     -5     6     1
      7    -8    11

% Now we compute A+B and 3*A
A+B
ans =
      0     5     5
     -1    11     7
     14     0     1
3*A
ans =
      3    -6     9
     12    15    18
     21    24   -30

% The results matlab gave for A+B and 3*A agree with our definition
% for adding matrices and multiplying by scalars.
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)

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

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

Problem 4: Enter the matrices

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

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?