COE 301 Introduction to Computer Programming Fall, 2024

Homework 9 – Due: 11/06/2024 11:59 pm

Problem 1. (30 points) Short problems to practice syntax. Create one MATLAB script, which will have several parts. Note: If you separate parts of a script with "%%", it will create a "section", which you can run separately with Ctrl-enter or clicking "Run section". We will be giving most of the answers here simply as a way for you to practice using these new commands. **DO NOT** use loops.

Part A.
Create a row vector a that contains the following elements: 1, 2, 3, 4.
Create a column vector b that contains the following elements: 5, 6, 7.
Create a row vector c that contain 1, 2, 3, 4, 5, 6, 7 by concatenating a and b
Create a column vector d that contain 1, 2, 3, 4, 5, 6, 7 by concatenating a and b
Display the answer to the question "what is the MATLAB default data type for all numeric variables?" using the 'disp' function.
Check what is in your workspace. Note that you may use the "clear" command, which removes all variables from the workplaces:

Part B.
Use the 'zeros' function to make a row vector of 5 zeros
Use the 'ones' function to make a column vector of 8 ones
Use the colon operator : to create a vector that contains 2, 4, 6, 8, …., 100.
Use the colon operator : to create a vector that contains 100, 95, 90, …, 10, 5.
Use the 'rand' function to make a row vector of 100 uniformly distributed random numbers in the interval (-1.0,5.0).

Part C.
Make a row vector x of 101 points evenly spaced between -1 and 1 using `linspace`.
Make a variable y, which equals the square of each element of x.
Make a variable z, which equals the cube of each element of x.
Make a plot of x vs. x, y vs. x and z vs. x on the same figure.

Note: When describing plots, y vs. x means that y goes on the vertical axis, x goes on the horizontal axis). The MATLAB function plot takes the arguments plot(x, y,...);

Submit your .m file as "yourLastName_hw9_prob1.m". Report your figure (save your figure as a .tif or .jpeg file and insert the figure in the write-up. A screenshot of the figure is ok as well). **Do not submit MATLAB .fig figure files, as we cannot check them easily through canvas.**

Problem 2. (35 points) Create a vector x with n equally spaced values starting at 0 and ending at 2pi using `linspace`, plot sin(x) vs. x for the case n = 3. Now plot sin(x) vs. x for two additional cases n = 7 and n = 21 on the same plot. Label the x-axis and y-axis and add a legend to describe the three lines you have plotted. Use your intuition to explain why the result is a straight line when n equals 3.

Now define a vector t with n=21 equally spaced values starting at 0 and ending at 2pi, create a new plot

$$y = \sin(t)+\cos(5t)+0.5\sin(10t)+0.8\cos(20t)$$

Next plot y vs. t for the case n = 201 on the same plot and explain what you see. Note that you need to translate the mathematical express above to valid MATLAB code.

Note: When describing plots, the convention is "response" vs "input" (i.e. y goes on the vertical axis, t goes on the x axis). The MATLAB function plot takes the arguments plot(input, response,...).

Report your figures (save your figure as a .tif or .jpeg file and insert the figure in the write-up. A screenshot of the figure is ok as well) and explanations in the write-up. **Please do not submit MATLAB .fig figure files.**
Submit your .m file as "yourLastName_hw9_prob2.m".

Problem 3. (35 points) The *Central Limit Theorem* states that the sum of N independent and identically distributed random varaiables converges a normal distribution as N increases. In this problem, we will test this theorem through a numerical experiment. (1) Create a vector v1 that contains 10^6 samples that are uniformly distributed between [-0.5 and 0.5], Plot the histogram with 40 bins of this vector (This is the case N=1). (2) Create another vector v2 that contain 10^6 samples that are uniformly distributed between [-0.5 and 0.5], Plot the histogram with 40 bins of the sum of v1 and v2 (This is the case of N=2). (3) Repeat (2) for N = 3 and 6 and comment on what you see.

Report your histogram figures (save your figures as .tif or .jpeg files and insert the figure in the write-up. A screenshot of the figure is also ok), and your observations in the write-up. Please do NOT submit the .fig MATLAB figure files.

Submit your .m file as "yourLastName_hw9_prob3.m" with all the MATLAB commands you used.

Reference:
https://www.mathworks.com/help/matlab/ref/matlab.graphics.chart.primitive.histogram.html

Submission Instructions:

There should be 4 files in your submission:

1. A write up (any type- .txt, .docx, .pdf are all fine) that contains your answers to all questions in problem 1-3.
2. The .m file for problem 1.
3. The .m file for problem 2.
4. The .m file for problem 3.

Make sure your last name is included in the filename.

Optional Short answers questions. The following questions will not be graded. You may use them for preparing your next week's quiz.

(1) If a is a 3-by-1 vector and b is a 1-by-4 vector. What is the dimension of [a; b']? What is the dimension of [a' b]?

(2) Let x be a 1x2 row vector, and v is a 2x1 column vector.

```
x = [1  4]
y = [2; 1]
```

What is the result of the following expression? Please first compute the results by hand (show your derivations) and verify them using MATLAB (**please be careful on which one use element-wise multiplication**).

```
a) x * y
b) y' .* x
c) y'.^ x
```

(3) Write a code snippet to create a row vector of the powers of 2: 2^0 through 2^9. **Do not use loops and you are not allowed to type in all the elements as:**

```
x= [1  2  4  8  16  32  64  128  256  512];
```

(4) Write a snippet of MATLAB code **without loops** to make a vector with integers from 1 to 1000 and then make every other value in it negative as [1 -2 3 -4 … 999 -1000].

(5) Make a row vector 1000 uniformly distributed random numbers in the interval (0,1).