NEURL-GA 2207 -001 – Fall 2018
Math Tools for Cognitive Science and Neuroscience

MATLAB Homework i

This homework is required but not graded. You should receive an email from one of the TAs with a google drive folder. Please submit your hw to that google drive folder. The formatting will be explained in the final question on this assignment. For questions that require writing an answer, provide that answer as a comment in your matlab script. If you have questions, use the class piazza and/or email one of the TAs: `np1742@nyu.edu`, `tinavoelcker@gmail.com` , `perri@nyu.edu`.

1. **The basics.** Try the following quick exercises at the MATLAB command prompt

   (a) First type `clear all` in the prompt. This will make sure you have no variables in your workspace. Create a scalar variable a and set it equal to 5. We say the variable is "bound" to the value 5. When you type a, matlab looks up the the variable in an internal table, and hands back the value it finds there. If it doesn't find the variable, it gives an error (try typing `b` at the prompt). Now set it equal to the square root of itself: `a = sqrt(a)`. What happened to `a`?

   (b) Let's say we wanted to evaluate the following expression:

   $$z = a - (10 - 7e^{(5+\cos(\pi/3))})$$

   Enter the following into the MATLAB prompt: `z = 25-(100-7exp(5+cos(pi/3))`. You will get an error message. Use the up-arrow to bring this line back, and then use the left and right arrow keys to correct the error(s). Include the wrong command, the error message, and your fix.

   (c) Go to the help menu and click on MATLAB help. Do a search for the function `rand`. Alternatively, at the command prompt, you can type `help rand`. What does this function do? Use `rand` to create a 100-element vector. Store this in a variable x without printing all of the values to the screen (remember the semi-colon). Display this vector as a spike plot, like you saw in lecture, using the `stem` command. Type `help stem` to understand what the function does and learn its syntax.

   (d) You can select individual elements of $\vec{x}$ by indexing into the vector using the notation `x(k)` where `k` is the index of the element in $\vec{x}$ you wish to select. What is the 50th element of `x`? What happens if you type in `x(0)` or `x(101)`? Why?

   (e) You can select multiple elements of $\vec{r}$ by using the notation `x(j:k)` where n is the starting element and k is the ending element. Examine the last five elements of $\vec{x}$. What indices did you use for j and k?

2. **Vector math.** From doing problem 1, we now have several vectors and variables in our workspace. To see which variables exist and some information about them type `whos` at the command prompt. You'll see the names of the variables, and the type and size of object to which they're "bound". Clear your workspace now by using the command `clear all`. Check that the workspace is clear using `whos`. Open a new script by clicking on the "New Script" button, this should open a new window. In this window you can type lines of code that you can run using the "Run" button, making it easier to evaluate many expressions at once.

(a) Save the new script by clicking the "Save" button. This will open a new window where you can name the file and save it in a location on your computer. Place the new script in a folder titled `"hw#_LASTNAME"` and name the script `"hw#.m"`. At the top of this script put the following line `clear all`, `close all`. This will clear all variables and close all figures when you re-run the script. You can also type `clc` in the command prompt window to clear the screen for new output.

(b) In this new script, define a vector $\vec{x}$ using the following command `x = [3,2,5,1]`.

(c) Define a second vector $\vec{y}$ of size 4, by first pre-allocating space using the command `y=zeros(1,4)`. This creates a vector with all zeros. Assign the first, third, and fourth values to be -2,2,-4 respectively (Hint: use the indexing method from the problem 1).

(d) Compute $2\vec{x}$ (scalar multiplication).

(e) Compute $\vec{x} + \vec{y}$ (vector addition). Look at $\vec{x}$ and $\vec{y}$ and make sure the answer makes sense.

(f) We can compute the inner product between two vectors using the '*' operator. Try the following: `x*y`. This should give you an error. Fix this error and evaluate the inner product only using the '*' operator. Do not use the MATLAB function `dot`. (Hint: think about the dimension of y).

(g) The inner product you find should return a scalar value 0, what does this mean about these two vectors?

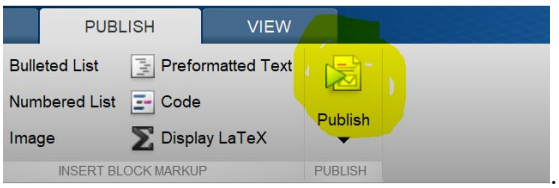
(h) Along with vector operations, MATLAB lets you do element-wise operations. Try typing in `z = x.*y`. What difference did the period make? What is the dimension of `z` (hint: use `size`)?

3. Plotting

(a) Use `rand` to create two 2-element vectors $\vec{a}$ and $\vec{b}$. Use the `plot` command to plot both vectors on the same graph. Hint: For a vector $\vec{a}$, to plot this as a line from the origin you will need to insert the origin: `plot([0, a(1)], [0,a(2)])`. You will also need the `hold` command.
Bonus: plot $\vec{x}$ in red, and $\vec{y}$ in blue and give the plot a title "Sample two vector plot".

4. Submission

(a) Save the file with the code from problems 2 and 3. Go to the top. Any answers that you need to write out for the problems should be included as comments in the file (using the "%" symbol). Additionally, indicate problems and sub-problems using the following sample on how to define sections in MATLAB. Problems are defined by `%%` and subproblems are defined by `%%` followed by `% *`. All other answers that you are reporting in text should be indicated using `%%` followed by `% text` to print the answer. Here is an example of what the beginning of this assignment should look like:

(b) After you are done with your script go to the top of the matlab editor and click on the "Publish" button as seen here: 

.

```
clear all, close all
%% Problem 2
%%
% * a)

%%
% * b)
x = [3,2,5,1]
%%
% here is how text answers should be written
```

This should evaluate your script and produce an html window that has the full code and plots evaluated in a nice format. It should look something like this:

Contents

- Problem 2
- Problem 3

```
clear all, close all
```

Problem 2

- a)
- b)

```
x = [3,2,5,1]
```

```
x =

     3     2     5     1
```

here is how text answers should be written

(c) Now your folder `"hw#_LASTNAME"` should contain the script `"hw#.m"` and a subfolder called "html". The "html" file in this folder will be the final published output. "Zip" the whole folder named `"hw#_LASTNAME"` and submit to your assigned google drive folder.