ESS 116 Lab 1

Introduction to MATLAB

General Instructions: Include your answers in a single PDF report containing your name and student number. Please also name your file as "Lab1_last_name.pdf", e.g., "Lab1_Pritchard.pdf". You are welcome to use your favorite document editor (e.g., MS Word), but convert it to PDF before submitting it. The report has to be uploaded on Canvas before Wednesday at noon. Late reports will not be accepted. If you have any difficulty uploading your report, send it directly to me by email before the deadline. Lastly, while you are welcome to talk with your fellow classmates about how to go about completing the assignment, you must do your own work. I should not see duplicate answers.

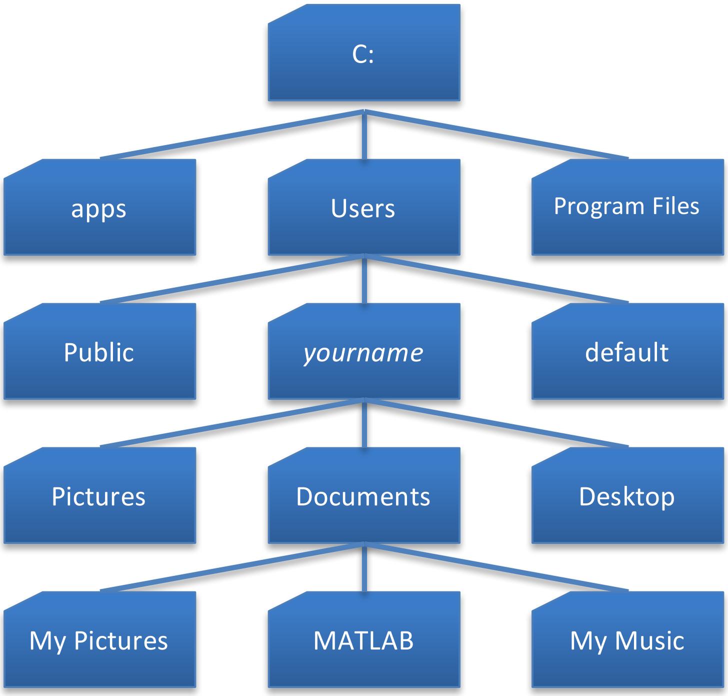
Goals

This lab exercise will introduce you to some basic concepts that are essential for understanding the software. We will also cover how to accomplish some basic file system operations using commands.

Part 1: Navigating The File System Via Commands

In this age of ubiquitous computing, the presence of a Graphical User Interface (GUI) in nearly all operating systems has made computers accessible to the masses, but at the same time has hidden most of what is going on inside a computer's operating system. As scientists, we want to assign repetitive tasks to computers to save time, money, and prevent human errors. Typically, automating a computational job requires knowing how to accomplish tasks by typing commands into a terminal window or other programming environment. This means that we must abandon our friend, the mouse, and delve into system commands, many of which we probably would normally do by using the mouse and clicking on various icons. This may seem frustrating at first, but do your best to use the mouse as little as is possible. This will be slow in the beginning, but will save you many hours and even days of work in the long term.

The first thing we must understand is how to navigate the directory structure (often called "folders") of a modern computer. Use the image below of a portion of the directory structure on our lab computers to answer the following questions. I recommend loading MATLAB and trying the commands to make sure your answers work properly.



1) Assume you are currently in the root directory ("C:\"). What is the MATLAB command to move to the directory called "Public" using a relative path?

-1

```
>>cd C:/Users/Public
```

Close, but this is an ABSOLUTE path (starts at the root). For a relative path, use: cd Users/Public

2) Assuming your command from 1) gave you no errors, it is always nice to double check to make sure you are in the directory that you mean to be in. What command will output your current working directory and what is the output?

```
>>pwd

ans = 'c:/Users/Public'
```

3) Assume you are in the "Users" folder. Write the command to change directories to the "Public" directory. Show this command first using a relative path and then with an absolute path.

```
>>cd Public
>>cd C:/Users/Public
```

4) Assume that in the Users directory there is a file called "foo.txt". Assuming you are in the Users directory, what command will copy this file to the "Public" directory? Show this command first using a relative path and then with an absolute path (for both source and destination).

```
>>copyfile foo.txt Public
>>copyfile c:/Users/foo.txt c:/Users/public
```

5) What is the absolute path to the current user's Windows 10 desktop (i.e. the stuff you see on your computer screen when no programs are open) on the lab computers?

-1
```
>>cd c:/Users/castelae/Desktop
```
Using cd will move you there, but this only asks for the directory itself

6) Assume that in the MATLAB directory there is a file called "foo.m". Assuming you are in the MATLAB directory, what command will copy this file to the "Desktop" directory? Show this command first with a relative path and then with an absolute path (for both source and destination).

```
>>copyfile foo.m ../../Desktop
>>copyfile C:/Users/castelae/Documents/Matlab/foo.m C:/Users/castelae/Desktop
```

Part 2: Listing Contents of Directories

Create a new directory called "Lab1" and change directory to it. Download the 1_Data.zip file from the Google Drive linked on the lab page of the course website and move it (either with the mouse or using the command line) into the Lab1 directory that you just created. Extract the zip file by double clicking on it in the "Current Folder" panel of MATLAB. Be patient because the directory contains 5,992 files, so it may take a few minutes to decompress... Go to the extracted "1_Data" directory. The following questions will show you some of the utility of using commands instead of mouse clicks when dealing with large numbers of files.

1) What MATLAB command displays the contents of the current directory?

```
>>ls
```

2) When dealing with large numbers of files, it is often useful to use so-called "wildcards" (*). To illustrate this, what MATLAB command displays the files ending in ".dat" in the current directory?

```
>>ls *.dat
```

3) Determine which files in the current directory begin with "4790". Write the MATLAB command, as well as the result below.

```
>> ls 4790*

ans = 479009.dat 479014.dat 479033.m
```

4) Determine which files in the "1_Data" directory have "2246" anywhere in the filename (in this exact order) and end in ".m". Write the MATLAB command and the result below.

```
>>ls *2246*.m

ans = 132446.m 244618.m
```

5) Now let's clean up this mess of files. What MATLAB command will delete every file in the current directory with any filename?

```
>>delete *
```

6) Now change directory up one level, so you are back in Lab1. You should see the "1_Data" folder. Now that the folder is empty, we can delete it. What is the MATLAB command to delete ONLY the "1_Data" directory?

```
>>rmdir '1_Data (1)'
```

Part 3: Using MATLAB

We are now going to create variables in MATLAB's workspace and call some functions to get more familiar with MATLAB.

1) How do you create a variable called "A" that is equal to 10 ?

```
>>A = 10
```

2) How do you create a variable called "B" that is equal to $5.32x10^{-8}$?

```
>> B = 5.32e-8
```

3) You can display all the variables in MATLAB's workspace using the "whos" command, paste here the output and explain what the different columns means (you can ignore "Attributes")

```
>> whos

  Name      Size            Bytes  Class     Attributes

  A         1x1                 8  double
  B         1x1                 8  double
  ans       1x15               30  char
```

-1

What does the "class" column tell us?

the columns are: Variable name, dimension of variable, memory footprint

4) We will talk more about vectors and matrices next week, but let's create a list with some values in it:

```
>>  A = [1.2 3.4 2.5 6.7 2.2 4];
```

"A" could be a list of CO$_2$ concentrations, or a temperature time series, etc. We would like to calculate the average value of this list. The MATLAB function to calculate an average is called "mean". If you know the name of a function in MATLAB but don't know how to use it, you can always write "help FUNCTIONNAME" in MATLAB prompt, so here it would be:

```
>>  help mean
```

Read the first lines of the documentations to figure out how to calculate the mean of A, and assign the output to a new variable called Amean and show the result:

-1

```
>>mean (A)
```

This computes the mean, but doesn’t save it to a variable:
Amean = mean(A)

```
ans = 3.3333
```

5) Now we would like to calculate the standard deviation of A, and store it in a new variable called Astd. The MATLAB function that computes standard deviations is called “std”.

```
>>std (A)
```

-1 **This computes the standard deviation, but doesn’t save it to a variable:**
Astd = std(A)

```
ans = 1.9138c
```

6) We would like to display the result of our average calculation. Any string can be displayed using “disp”:

```
>> disp('Hello World!')
Hello World!
```

We would like to use “disp” to say “The average of A is X.XXX”. Now the tricky part is that Amean is not a *string* but a *double*. We can convert a number to a string using the function “num2str”. We end up with 2 strings: `‘The average of A is ‘`, and `num2str(Amean)`. We can use the brackets “[]” to concatenate these two strings into one:

```
>> ['The average of A is ' num2str(Amean)]
```

Now combine this with disp to display “The average of A is X.XXX”

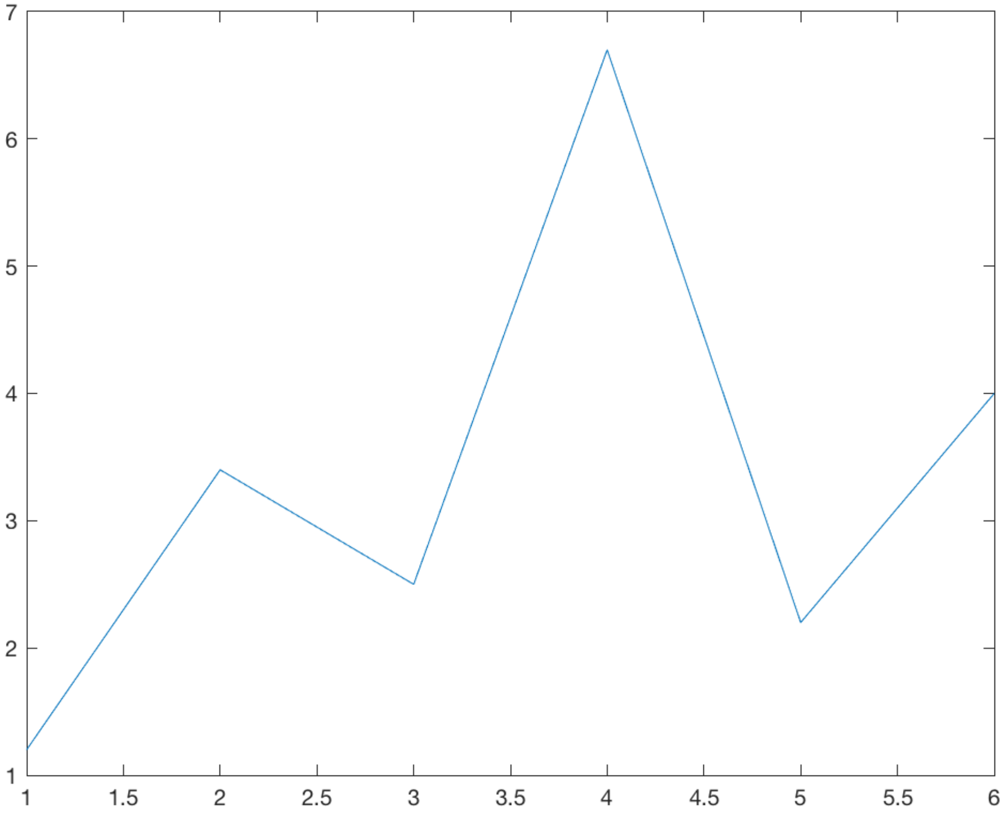
```
>>disp ([‘The average of A is ‘ num2str(Amean)])
```

7) To display the values of A in a graph, you can use the function “plot”:

```
>> plot(A)
```

save the figure in PNG format using the following command and include the image in your report.

```
>> print -dpng myfigure.png
```



Part 4: Fixing a faulty MATLAB script to make the big bucks

You have graduated ESS and have an exciting job interview for a lucrative data analyst positioned at The Climate Corporation. The hiring officer is interested in your MATLAB technical skillset on your resume and so has called you in for an in person interview. As part of the interview, he surprises you by providing you with a broken code (interview.m) that does not work the way its comments imply it is supposed to do. Find the bugs in the code to prove your technical aptitude and maximize your chances of being hired!

Go back to the Lab1 directory.

If you have not already downloaded it, grab a copy of the "interview.m" script from the Google Drive linked on the lab page of course website and move it to your Lab1 directory. There, you can run the script from MATLAB by calling its name:

```
>> interview
```

Obviously, it will stop because of an error that you need to fix. You can open `interview.m` using

```
>> edit interview.m
```

make the necessary changes to make it work, good luck!

Note: if you get the following error message “Subscript indices must either be real positive integers or logicals.” You might need to clear the variable `mean` once you have figured out why it was buggy. To do that, you can enter the following command in MATLAB’s command line

```
>> clear mean
```

Part 5: What to hand in

For this lab, you fixed a MATLAB script: interview.m, and should have one document with the answers to the other questions saved in a pdf format: *Lab1_LastName.pdf*. What you need to turn in to me is a single zip file with the script, and the pdf document that you created. To do this, MATLAB has a command that makes zip files. Use the following command, except replace “LastName” with your last name. Make sure that all of the files are in your pwd.

```
>> zip('lab1_LastName.zip',{`interview.m',‘Lab1_LastName.pdf’})
```

Beware! Sometimes when you copy and paste a command into MATLAB, it will change single quotes to apostrophes, and vice versa causing errors. So, always keep a look out for this (and I did mix both in the previous command on purpose). Once the zip file has been created, double check to make sure everything is included, then upload your zip file on canvas. This is how you will hand in most assignments in this course.