EENG 212-L1
EENG 221-M01
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Tutorial # 1

INTRODUCTION TO MATLAB

Goals:
-Introduce student to Matlab work environment.
-Create a m-file
-Perform arithmetic operations with Matlab.

1-Introduction:

Matlab is a software package for high-performance numerical computation and visualization. As an engineering tool, it can be used to do ,among other applications math and computation, modeling, simulation, prototyping, scientific and engineering graphics. While Matlab is primarily a numerical computation package, it can also do Symbolic algebra(computations are done in terms of symbols or variables rather than numbers) just like the other well known computation software packages such as Mathematica and Maple.
Matlab stands for MATrix LABoratory. Programming in Matlab is most of the time straight forward since every data object is assumed to be an array. Matlab has hundreds of build-in functions collected in toolboxes that provide tools for technical computation, graphics, and animation.
The toolboxes are organized by topics such as control systems, signal processing, statistics, neural networks, wireless communications and many other topics. The student version of Matlab has both control and signal processing toolboxes. In general, you will need to buy any extra toolbox from MathWorks.

2-Basics of Matlab:

2.1 Windows

Matlab has 3 basic windows:

-Command window: this is the main window. It is characterized by the prompt >> for the professional version and EDU>> for the student version.

-Graphics window: all graphics commands typed in the command window output the resulting graph to this window.

-Edit window: this is the environment where you create and edit your Matlab files, and save them as M-files (with extension .m). You can also run an m-file from this window or from the Matlab command by typing the name of the m-file.

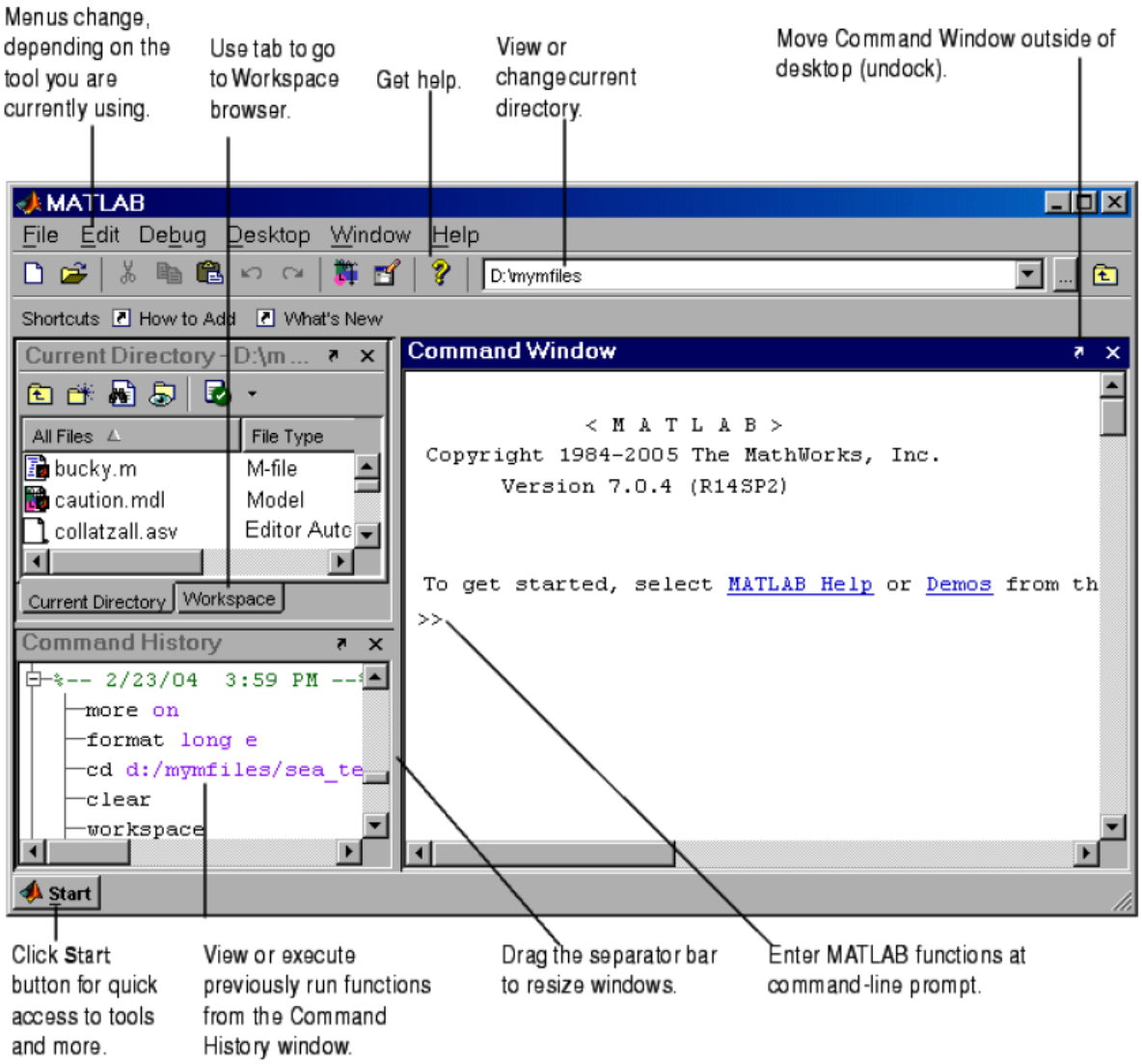

Figure 1: Command window in the latest version of Matlab

2.2 On-line help

Matlab provides on-line help with regard to build-in functions and their use. The Index field allows the user to enter the name of a function and learn for example the meaning of its arguments if any.

2.3 Input-Output

-You can input your Matlab commands from the main window or as an m-file. The use of m-files is highly suggested since debugging will not require rewriting the commands that do not require to be corrected.

-There is only one data type, it is the complex matrix. Real numbers and integers are considered special cases. When a real number is entered as a value of a variable, Matlab sets automatically

its imaginary part to zero.
-There is no need for dimension statement when using vectors and arrays. It is all done automatically.
-Matlab is case sensitive.
-Unless specified otherwise, the output is displayed directly on the main window or on the graphics window if it is a graph.
-Output format: this is controlled by the output format in use. Following are some of the possibilities in term of output format for the computations which are done using double precision:
format short, format short e, format long, format long e, format hex, format rat, format bank
-External Interface (Mex) files: Matlab accepts C and Fortan files; these files must have extension **.mex**

3-Variables

3.1 General Concept

Matlab has built in variables such as **pi**, **eps**, and **ans.** Their values are given by the Matlab interpreter. Comments always start with % and are ignored by Matlab.

```
>>eps          % epsilon
eps  =
          2.220e-16
>>pi           % famous  PI
ans =
        3.1416
```

3.2 Variable assignment

The arithmetic operators are:

+	addition
-	subtraction
*	multiplication (ex: 0.135*pi)
/	Left division (ex: 10\5)
\	Right division (ex: 10/5 , which is equivalent to 5\10)
^	exponentiation. (ex: 10^2)

Some built-in mathematical functions:

Function	**Meaning**	**Example**
sin	sine	sin(pi)=0.0
cos	cosine	cos(pi)=1.0
tan	tangent	tan(pi/4)=1.0
asin	arcsine	asin(pi/2)=1.0
acos	arccosine	acos(pi/2)=0.0
exp	exponential	exp(1.0)= 2.7183
atan	arctangent	atan(pi/4)=1.0
log	natural logarithm	log(2.7183) =1.0
log10	logarithm base 10	log10(1000)= 3.0

As a general rule, expressions are evaluated from left to right, with exponentiation operation having the highest order of precedence, followed by both multiplication and division, followed by both addition and subtraction. Do not hesitate to use parentheses (make sure the number is always even) to add more clarity to your expressions but also to change the order of precedence.

Example:
```
>>y=2*3^2 + 4*3;
```
will generate ans= 30. Of course the above could have been written as
```
>>y= 2* (3^2) + (4*3);
```

Example:
```
>>x=4;
>>y=2^2 +log(pi)*sin(x)
    y=
        3.1337
```

Variables are case sensitive. So x is distinct from X.
Values are assigned with the equality sign
```
>>y=23
>>s=y^2   % here Matlab has previously stored the value of y
```

Output can be suppressed by appending a semicolon to the command lines, however the value assigned to any variable is stored by Matlab for further user if any.

```
>>a=5;
>>b=2*a;
>>b=2*a
 b =
      10
```
In the above, when a semicolon is added at the end of the command line, no value is returned by Matlab.

To know the active variables, type

```
>>who
```

To remove the variable x, type
```
>> clear x
```
To save a variable y, type
```
>> save y
```
To save all variables, type
```
>>save mysession
```
To restore the session, type
```
>> load mysession.
```

3.3 Variable arithmetic

Any name can be used to declare a variable, however there are some rules:
-the maximum numbers of characters is limited to 32
-likewise variable names are case sentitive so **Ad1** is different from **ad1**
-variable names must start with a letter and they may contain letters, numbers and underscores but no spaces

More than one command can be entered on a single line, as long as they are separated by commas
>> x=2+4; y=-5; t=4^2;
Comments always start with a % symbol
>>y=3.14 % y=pi

Matlab has some special variable names that are reserved (although they can still be changed)
The following table lists them:

Special variable	**Value**
Ans	The default variable name used for results
Pi	3.14…
Eps	The smallest possible number such that, when added to one, creates a number greater than one on the computer
Flops	Count of floating point operations. (Not used in ver. 6)
Inf	Stands for infinity (e.g.: 1/0)
NaN	Not a number (e.g: 0/0) or ERROR
i (and) j	Imaginary Number used for Complex numbers.
Nargin	Number of function input arguments used
Nargout	Number of function output arguments used
Realmin	The smallest usable positive real number
Realmax	The largest usable positive real number

Also some names can not be used . They are used for conditional statements and looping.
There are: for, end, if, function, return, elseif, case, otherwise, switch, continue, else, try, catch, global, persistent, break.

3.4. Complex Numbers

a Complex number z =2 + j3 is entered in Matlab as z = 2 + 3*i or z= 2 + 3*j

and a complex number Z2 = 2V2exp[(Π/5)j)] is entered as Z2= 2*sqrt(2)*exp((pi/4)*j))

Ex: Complex number

```
>>z=1 -3j;
>>zamp=  (abs(z) )            % amplitude
>>zphase= (angle(z) )         % phase  angle
>>zreal= (real(z))            % real part of z
>>zimaginary = (imag (z))    %imaginary part of z
```

3.5 Double precision arithmetic

All arithmetic is done to double precision, which for 32 bit machines means to about 16 decimal digits of accuracy.

```
>>a =sqrt(2)
  a=
      1.4142
>>format long, c=sqrt(2)
  b=
      1.414221356237310
```

Try the following formats:

format short (default format)
format short e
format long e
format rat
format bank

The additional formats **format compact** and **format loose** control the spacing above and below the displayed numbers.

4-M Files

As the number of Matlab commands increases, the workspace area of Matlab is no longer the place to enter the commands as some editing and debugging might be required. Consequently you will need to create an m-file so that your Matlab program will be saved in the usually work directory, unless you change the path. From the file menu, select new, then m-file, and it will take you to the Matlab workspace editor where an m-file can be created , saved and executed (run file). An m-file can also executed from the main workspace area by typing its name without the extension. The output of any m-file (including errors) will be listed in the main workspace area and graphics window if any.

EXERCISES:

Do the following problems. This work will be collected a week from today and will be referred to as Tutorial 1. Use cut and paste procedure to create a word file that you will submit.

1- Compute the following quantities

* $\frac{3^5}{2^3 - 1}$

* $3\frac{\sqrt{5}-1}{(\sqrt{5}+1)^2} - 1$

*

$$\frac{4\sqrt{5-2\sqrt{6}}}{(\sqrt[4]{3}+\sqrt[4]{2})(\sqrt[4]{3}-\sqrt[4]{2})}$$

*

$$3 + \cfrac{1}{7 + \cfrac{1}{15 + \cfrac{1}{1 + \cfrac{1}{293}}}}$$

2- Generate the results for quantities in 1 using a specific format.

3- Exponential and logarithms: the quantities e^x, Ln x and log x are expressed as exp(x), log(x) and $\log_{10}(x)$

- e^4 , $\log_{10}(e^4)$, and $\log_{10}(10^3)$
- $e^{\pi\sqrt{123}}$
- Solve $4^x = 20$ (take ln of both side of equations and solve for x)
-

4- Trigonometry

The basic Matalb trig functions are sin, cos, tan, cot, sec, and csc, with inverse forms such arcsin and cotg are listed as asin , atan etc..

- Check the formula $e^x = \cos(x) + i\sin(x)$ (i:imaginary number) for $x=\prod/3$
- $\sin(\prod/4)$, $\cos(\prod)$

5- Complex numbers

With Matlab you can use as imaginary number the letters i and j and a complex number 2 + 5i can be input as 2+5i or 2+5*i

*compute exp(pi/2*i) and exp(pi/2i) ; if any difference , explain why.

* compute magnitude and phase of xy and x/y when $x = \frac{1}{2} + \frac{\sqrt{3}}{2}$ and y= $x = \frac{1}{2}(1+i)$

Explore help for command **abs** and **angle**

6- Create, save and execute a m-file with the following script that will plot y=sin(x) with $0 \leq x \leq 2\prod$, taking 100 linearly spaced points in the given interval.

```
x=linspace (0, 2*pi, 100);
plot(x,sin(x))
xlabel ('x'), ylabel('sin(x)
title( 'plot created by your name')
```

After running this file, the plot should display in the graphics window.