APSC 1001 Introduction to Matlab

Based on "Getting Your Hands Dirty With MATLAB by Dr. Kartik Bulusu

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1 What is MATLAB?

The name MATLAB stands for MATrix LABoratory. It is a software package for numerical com- putation and visualization with many built-in functions for technical computation, graphics and animation. Most of these functions are state-of-the art algorithms which provide excellent tools for linear algebra computations, data analysis, signal processing, numerical solution to ODEs etc.

The basic building block of MATLAB is the matrix. The fundamental data-type is the array. Special cases of this basic data-type are vectors, scalars, real and complex matrices. In MATLAB, you almost never have to declare the dimensions of a matrix. A novice MATLAB programmer has to have a grasp over the basics of matrix algebra, because MATLAB quite simply and precisely works with matrix operations.

2 Basics of MATLAB

In this section we look at the general structure of MATLAB the environment. MATLAB works through three basic windows:

2.1 Types of Windows

Command Window: When you launch the MATLAB program, it pulls up this window. It is characterized by the MATLAB command prompt " » ". All commands, including user-written pragrams, can be executed from this prompt.

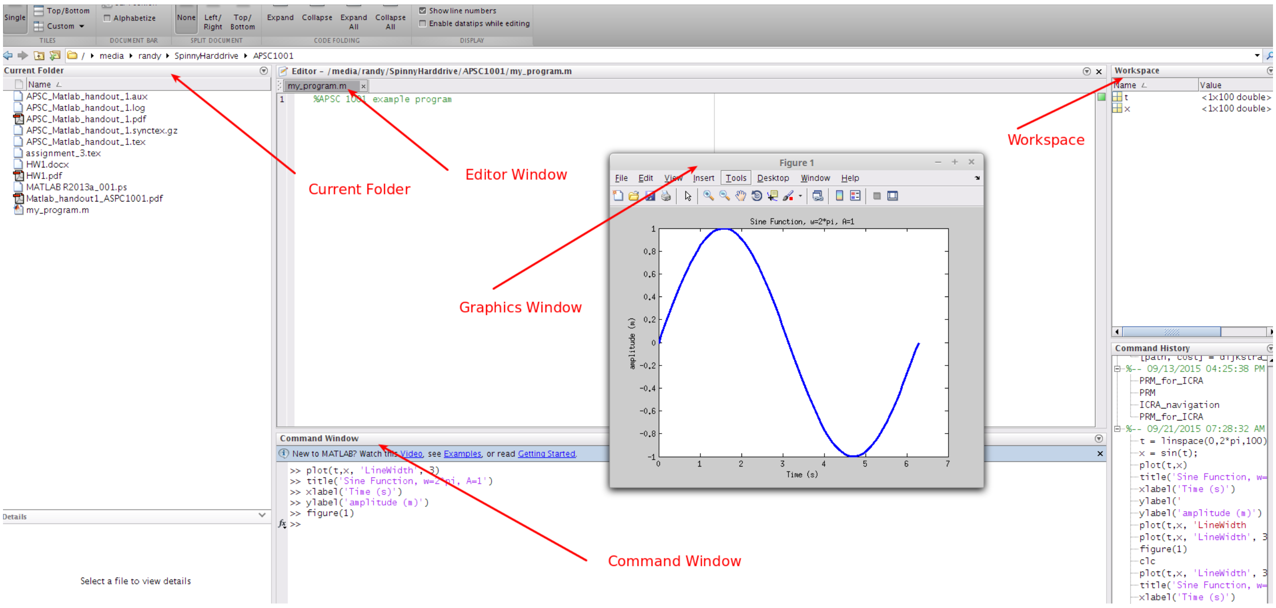
Graphics Window: The output of all graphics commands and plotting functions are shown in the graphics window or *Figure* window.

Edit Window: MATLAB provides a built-in editor where you can write, edit, create, and save your programs in files called *"m-files"*. Consequently, you can use any text editor to carry out these tasks. All MATLAB programs should have a "*.m" extension. For example, a sample file name is "*my_ program.m*".

There are two other important sections of the screen to be aware of:

Workspace: The workspace is where all current variables are shown, along information about the size and type of each variable.

Current Folder: Any files that you save will be located here. If you are running an .m file, it must be located in the current folder (or in the system path in MATLAB's settings).



☑ Show line numbers
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/ ▸ media ▸ randy ▸ SpinnyHarddrive ▸ APSC1001

Current Folder

Name
- APSC_Matlab_handout_1.aux
- APSC_Matlab_handout_1.log
- APSC_Matlab_handout_1.pdf
- APSC_Matlab_handout_1.synctex.gz
- APSC_Matlab_handout_1.tex
- assignment_3.tex
- HW1.docx
- HW1.pdf
- MATLAB R2013a_001.ps
- Matlab_handout1_ASPC1001.pdf
- my_program.m

Editor - /media/randy/SpinnyHarddrive/APSC1001/my_program.m

my_program.m

```
%APSC 1001 example program
```

Workspace

Name	Value
t	<1x100 double>
x	<1x100 double>

Command Window

New to MATLAB? Watch this Video, see Examples, or read Getting Started.

```
>> plot(t,x, 'LineWidth', 3)
>> title('Sine Function, w=2*pi, A=1')
>> xlabel('Time (s)')
>> ylabel('amplitude (m)')
>> figure(1)
fx >>
```

Command History

```
[path, cost] = dijkstra_
%-- 09/13/2015 04:25:38 PM
  PRM_for_ICRA
  PRM
  ICRA_navigation
  PRM_for_ICRA
%-- 09/21/2015 07:28:32 AM
  t = linspace(0,2*pi,100)
  x = sin(t);
  plot(t,x)
  title('Sine Function, w=
  xlabel('Time (s)')
  ylabel('
  ylabel('amplitude (m)')
  plot(t,x, 'LineWidth
  plot(t,x, 'LineWidth', 3
  figure(1)
  clc
  plot(t,x, 'LineWidth', 3
  title('Sine Function, w=
  xlabel('Time (s)')
```

Figure 2.1: Default setup of Matlab Windows. Windows can be rearranged, minimized, or broken out if desired.

3 Lesson 1: Creating and Working with Arrays of Numbers

An *array* is a list of numbers or expressions arranged in horizontal rows and vertical columns. When an array has one row or column, it is called a *vector*. An array with *m* rows and n columns is called a *matrix* of size $m \times n$. (Pratap, 1999)

There are many mathematical concepts associated with vectors and matrices that we won't cover in this course. Some of them you will cover in later courses, when you will appreciate that MATLAB can handle common operations such as determinant, inverse, rank, and various matrix decompositions.

In this lesson we deal only with one-dimensional arrays, or vectors. In later excercises, we will introduce two-dimensional arrays, or matrices. Follow the instructions below and type them in the command window after you have read through the excercises.

Note that any text following % symbol is a comment. While creating m-files or simply typing the script on the command window any text following the % is taken in MATLAB as comment and will not be executed in the program. It is a good practice to comment lines in your program so that when you revisit your code it will still make sense. From experience, this will save many long and painfully frustrating hours in the future.

Now it's time to practice programming:

- **Creating row and column vectors**

  ```
  >>x = [2 4 5] %x is a row vector with 3 elements
  x =
   2 4 5

  >>y = [2; 4; 5] %y is a column vector with 3 elements
  y =
   2
   4
   5
  ```

- **Simple arithmetic operations on vectors**

  ```
  >>z = [3 4 6];  %z is a row vector with 3 elements
  >>a = x + z  %two vectors o the same size can be added or subtracted
  a =
   5 8 11

  >>b = x + y
  ??? Error using ==> +
  Matrix dimensions must agree.
   %a row vector cannot be added to or subtracted from a column vector.
  ```

- **Doing *array* operations** Term by term multiplication happens using the array operator, represented by a dot before the arithmetic operator (e.g. '.*').

```
>>a = x.*z  %multiply each term in two vectors of the same size
%using the array operator (.*)
a =
 6 16 30

>>b = 2*a   %the array operator is not required to multiply by a scalar
b=
 12 32 60
```

- **Using trigonometric or simple math functions with array arguments**

```
>>x = [0 pi/4 pi/2];
>>y = sin(x)
y =
 0 0.7071 1

>>z = sqrt(y)
z =
 0 0.8409 1
```

References

[1] Pratap, R., *Getting Started with MATLAB 5 - A Quick Introduction for Scientists and Engi- neers*, Oxford University Press, 1999.

[2] Kreyszig, E., *Advanced Engineering Mathematics*, 8th ed., John Wiley & Sons, Inc., 1999.