MATLAB

Chapter I : Introduction to the Matlab environment

1. Introduction :

MATLAB (MATrixLABoratory) is an interactive programming environment for scientific computing, programming and data visualization.

It is widely used in the fields of engineering and scientific research, as well as in higher education institutions. Its popularity is mainly due to its strong and simple interaction with the user but also to the following points:

- ✓ Its functional richness: with MATLAB, it is possible to perform complex mathematical manipulations by writing few instructions. It can evaluate expressions, draw graphs and run classic programs. And above all, it allows the direct use of several thousand predefined functions.
- ✓ The ability to use toolboxes (toolboxes): which encourages its use in several disciplines (simulation, signal processing, imaging, artificial intelligence,...etc.).
- ✓ The simplicity of its programming language: a program written in MATLAB is easier to write and read compared to the same program written in C or PASCAL.
- ✓ Its way of managing everything as matrices, which frees the user to deal with data typing and thus avoid the problems of transtyping.

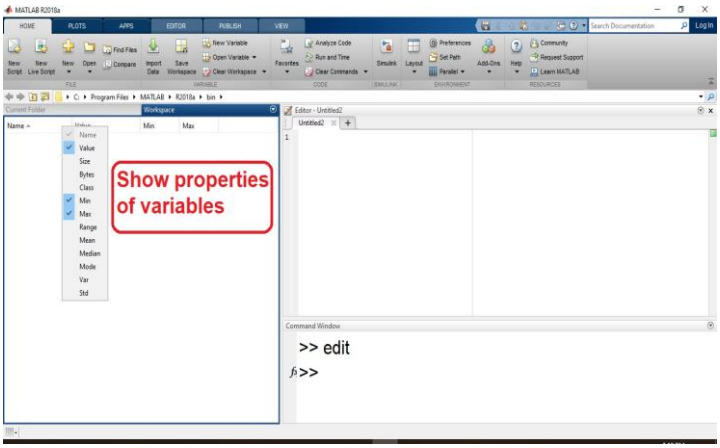
Originally MATLAB was designed to make mainly calculations on vectors and matrices hence its name '**Mat**rix**Lab**oratory', but subsequently it was improved and increased to be able to deal with many more areas.

MATLAB is not the only scientific computing environment available because there are other competitors, the most important of which are Maple and Mathematica. There are even free software that are clones of Matlab like Scilab and Octave.

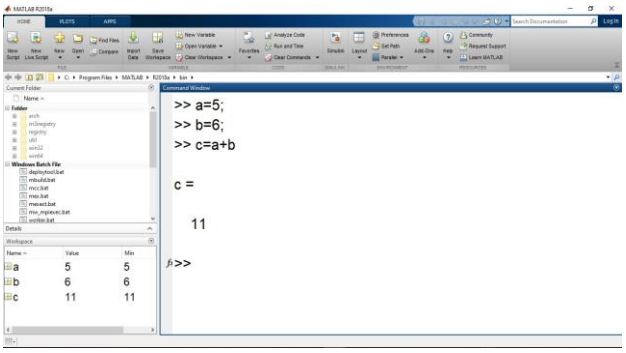
1. L'environnement MATLAB

Currently MATLAB is at version 7.x and at startup it displays several windows. Depending on the version you can find the following windows :

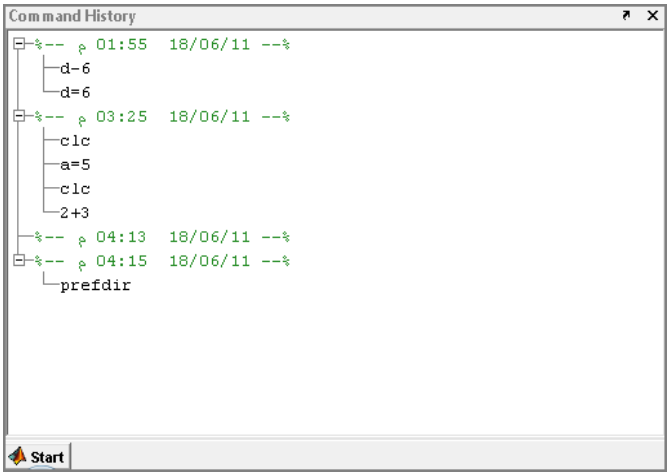
- ***Current Folder:*** indicates the current directory and existing files.



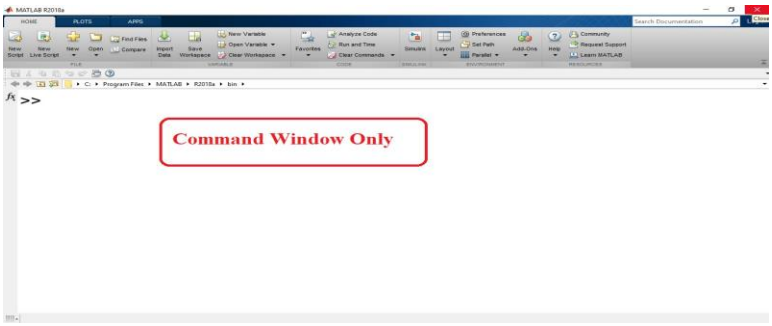
- ***Workspace:*** indicates all existing variables with their types and values.



- ***Command History***: keeps track of all commands entered by the user.



- ***Command Window***: we use to formulate our expressions and interact with MATLAB, and this is the window we use throughout this chapter.



The MATLAB interface corresponds to this one.

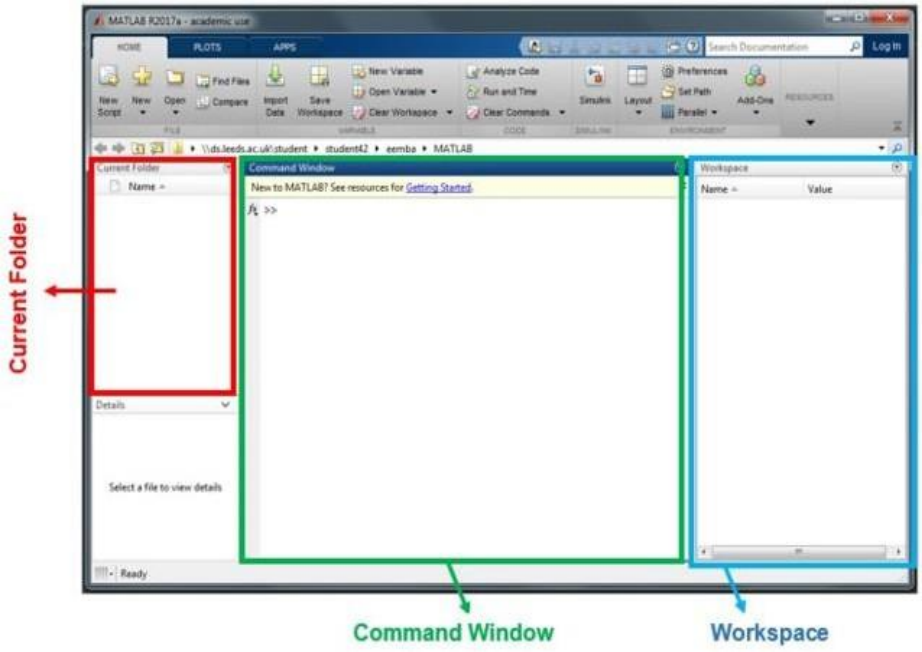
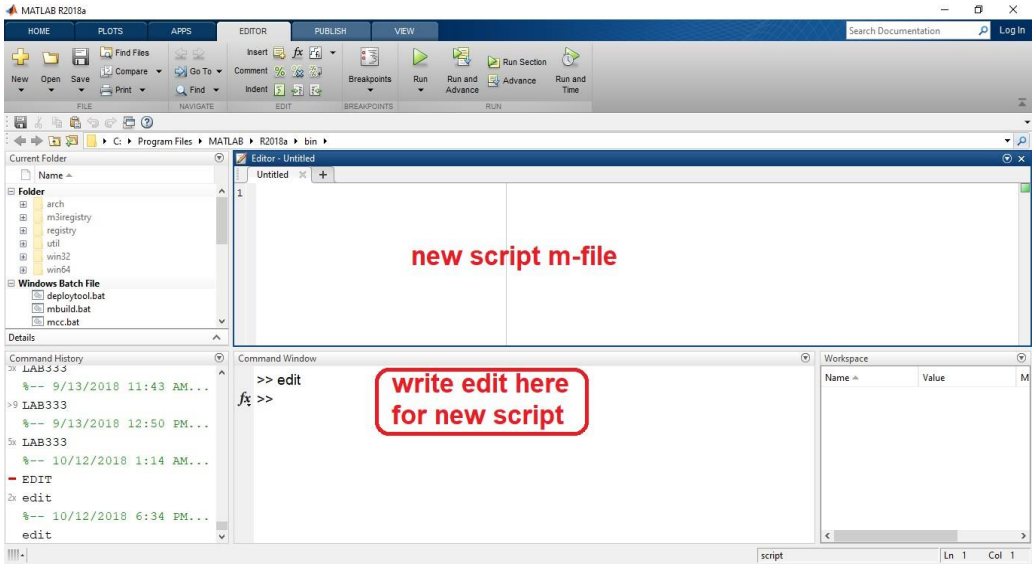


Figure 1 : MATLAB environnement



2.1 First interaction with MATLAB

The easiest way to use MATLAB is to write directly to the command window (Command Window) right after the cursor (prompt) **>>**

To calculate a mathematical expression just write it like this :

```
>> 5+6                          Then click on the Enter key to see the result
ans =
            11
```

If we want an expression to be calculated but without displaying the result, we add a semicolon '**;**' at the end of the expression as follows:

```
>> 5+6 ;
>>
```

To create a variable we use the simple structure: 'variable = definition' without worrying about the type of the variable.
For exemple :

```
>> a=10 ;
>>u=cos(a) ;
>>v=sin(a) ;
>>u^2+v^2
      ans =
            1
>> ans+10
      ans =
            11
>>
```

It is possible to write several expressions in the same line by making them separated by commas or semicolons. For example:

```
>> 5+6, 2*5-1, 12-4

      ans =
            11
      ans =
            9
      ans =
            8
>> 5+6; 2*5-1, 12-4;
      ans =
            9
>>
```

The name of a variable must contain only alphanumeric characters or the symbol '_' (underscore) and must start with an alphabet. We must also pay attention to capital letters because the MATLAB is case-sensitive (**A** and **a** are two different identifiers).
The basic operations in an expression are summarized in the following table:

operation	meaning
+	addition
-	subtraction
*	multiplication
/	division
\	Left division (or reverse division)
^	power
'	The transposed
(et)	Parentheses specify the order of evaluation

To see the list of variables used, either look at the window '***Workspace'*** either we use the commands '***whos'*** or '***who'***.

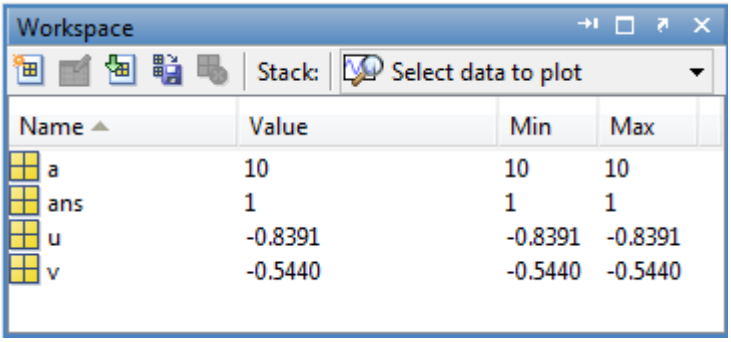
whos gives a detailed description (variable name, type and size), but ***who*** just give the names of the variables.

For example, in this course we used 3 variables ***a***, ***u*** and ***v***:

```
>>who
      Your variables are:
      aans  u    v

>>whos
      Name       Size              Bytes  ClassAttributes
      a          1x1                   8  double
      ans        1x1                   8  double
      u          1x1                   8  double
      v1x1                 8  double
```

The use of these two commands can be omitted cardes variable information are visible directly in the workspace window.



2.2 The numbers in MATLAB

MATLAB uses conventional decimal notation, with an optional decimal point '.' and the sign '+' ou '–'for signed numbers. Scientific notation uses the letter '*e*' to specify the power scale

factor of 10. Complex numbers use characters 'i' et 'j' (indifferently) to design the imaginary part. The following table gives a summary :

type	***Exemples***
Entire	5 -83
Real in decimal notation	0.0205 3.1415926
Real in scientific notation	1.60210e-20 6.02252e23(1.60210×10^{-20} et 6.02252×10^{23})
Complex	5+3i -3.14159j

MATLAB always uses real numbers (double precision) to make the calculations, which allows to obtain a calculation accuracy of up to 16 significant digits.

But it should be noted the following points:

- The result of a calculation operation is displayed by default with four digits after the decimal point.
- To display more numbers use the command ***format long*** (14 digits after the decimal point)***.***
- To return to the default view, use the ***format short.***
- To display only 02 digits after the decimal point, use the ***format bank.***
- To display the numbers as a ration, use the ***format rat***.

control	meaning
format short	displays numbers with 04 digits after the decimal point
format long	displays numbers with 14 digits after the decimal point
format bank	displays numbers with 02 digits after the decimal point
format rat	displays the numbers as a ration (a/b)

Exemple :

```
>> 8/3
       ans =
              2.6667

>>format long

>> 8/3
       ans =
              2.66666666666667
>>format bank

>> 8/3
       ans =
              2.67
>>format short

>> 8/3
       ans =
              2.6667

>> 7.2*3.1
       ans =
```

```
            22.3200

>>format rat

>> 7.2*3.1
      ans =
            558/25

>> 2.6667
ans =
   26667/10000
```

vpa function can be used to force the compute to have more significant decimals by specifying the desired number of decimals.

Exemple :

```
>>sqrt(2)
      ans =
            1.4142

>>vpa(sqrt(2),50)
      ans =
            1.4142135623730950488016887242096980785696718753769
```

2.3 The main constants, functions and commands:

MATLAB defines the following constants :

constant	its value
Pi	π=3.1415…
exp(1)	e=2.7183…
I	= $\sqrt{-1}$
J	= $\sqrt{-1}$
Inf	∞
NaN	Not a Number (Pas un numéro)
Eps	$\varepsilon \approx 2 \times 10^{-16}$.

Frequently used functions include:

function	its meaning
sin(x)	l the sine of x(en radian)
cos(x)	l Cosine of x (en radian)
tan(x)	the tangent of x (en radian)
asin(x)	the sine arc of x (en radian)
acos(x)	the cosine bow of x (en radian)
atan(x)	the bow tangent of x (en radian)
sqrt(x)	the square root of x ➔$\sqrt{x}$
abs(x)	the absolute value of x ➔ |x|
exp(x)	$=e^x$
log(x)	natural ogarithm of x ➔$ln(x)=log_e(x)$

log10(x)	logarithm based on 10 of x ➔ $\log_{10}(x)$
imag(x)	the imaginary part of the complex number x
real(x)	the actual part of the complex number x
round(x)	round a number to the nearest integer
floor(x)	round a number to the smallest integer ➔max{n|n≤x, n entire }
ceil(x)	round a number to the largest integer ➔min{n|n≥x, n entire}

MATLAB offre beaucoup de commandes pour l'interaction avec l'utilisateur. Nous nous contentons pour l'instant d'un petit ensemble, et nous exposons les autres au fur et à mesure de l'avancement du cours.

control	its meaning
who	Displays the name of the variables used
whos	Displays information about the variables used
clear x y	Deletes the x and y variables
clear,clear all	Deletes all variables
clc	Clears the control screen
exit, quit	Close the MATLAB environment
format	Sets the output format for numeric values `format long` : displays numbers with 14 digits after the decimal point `format short`: displays numbers with 04 digits after the decimal point `format bank` : displays numbers with 02 digits after the decimal point `format rat` : displays the numbers as a ration (a/b)

2.4 The priority of operations in an expression:

The evaluation of an expression runs from left à to right considering the priority of the operations indicated in the following table:

operations	priority (1=max, 4=min)
The parentheses ^ (and)	1
Power and the transposed ^and ‘	2
Multiplication and division * and /	3
Addition and subtraction + and -	4

For exemple **5+2*3 = 11** and **2*3^2 = 18**

Summary exercise:

Create an x variable and set it to 2, then write the following expressions:

$3X^3-2X^2+4X$

- $\frac{e^{1+x}}{1-\sqrt{2x}}$
- $|\sin^{-1}(2x)|$
- $\frac{\ln(x)}{2x^3}$ -1

Solution :

```
>> x=2 ;
```

```
>> 3*x^3-2*x^2+4*x ;
>>exp(1+x)/(1-sqrt(2*x)) ;
>>abs(asin(2*x)) ;
>>log(x)/(2*x^3)-1 ;
```