University of Batna 2
Faculty of Mathematics and computer science
Department of computer science

Numerical Methods Practical Works

Oussama HARKATI

2nd year of a bachelor's degree in computer science

2023-2024

Practical Work "01"

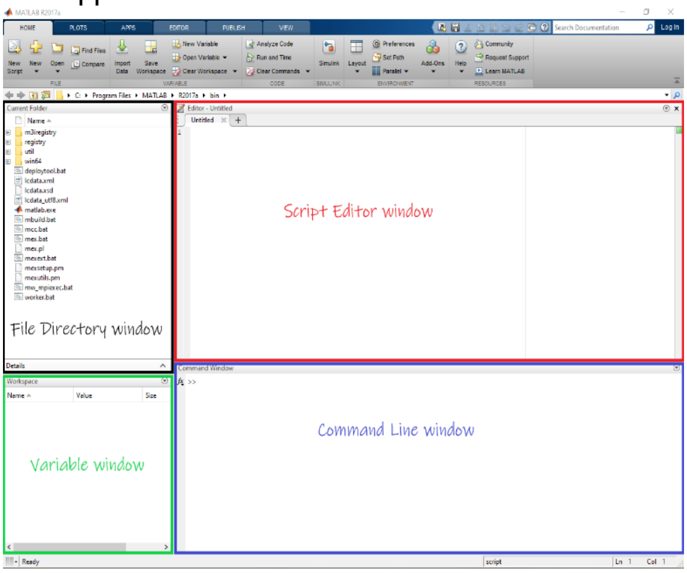
I. The MATLAB environment.

I.1 Introduction.

MATLAB, or "matrix laboratory", is a numerical computation software produced by MathWorks (www.mathworks.com). MATLAB is a simple, highly efficient language, optimized for matrix processing and numerical computation. The MATLAB environment is a super-complex calculator with an interpreted environment.

I.2 MATLAB interface.

When MATLAB is started, a window like this appears.



MATLAB has the following panels:

- File Directory Window: This panel gives you access to project folders and files.
- Command Line Window: This is the main area where commands can be entered at the command line. It is indicated by the command prompt (>>).
- Variable Window (Workspace): The workspace displays all variables created and/or imported from files.
- Script Editor Window: This panel is used to create and edit scripts.

II. Basic syntax.

II.1 Starting point.

Execute the following commands:

Commands	Results
>> 5+5	ans = 10
>> x =15-10	x = 5
>> 7/0	ans = Inf
>> x=10; >> y=25	y = 25
>> %15*4	
>> a = 2; b = 7; c = a * b	c = 14

Remarks

1. By default, all calculations are assigned to the ans variable.
2. You can assign variables in a simple way.
3. Variables such as "Inf" are already predefined in MATLAB.
4. The semicolon (;) indicates the end of the instruction.
   However, if you wish to hide the MATLAB output for an expression, add a semicolon after the expression.
5. The (%) symbol is used to indicate a comment line.
   You can also write a comment block as follows %{comment %}.
6. You can have several assignments on the same line.

II.2 Command history

In the command window, type the expressions

Commands	Results
>> sin (pi/2)	ans = 1
>> 732 * 20.3	ans = 1.4860e+04
>> x = sqrt(16)	x = 4
>> clear >> clc	

Now click on ↑ on the keyboard.

Remark

MATLAB saves the command history. You can recover previously entered instructions, modify them and reuse them using the arrows ↑ → ↓ ← on the keyboard.

II.3 Variables.

In the MATLAB environment, variables are considered as matrices. Variable names consist of a letter followed by a number of letters, digits or underscores (_).
MATLAB is case-sensitive.

II.3.1 Data types.

Type the following expressions

Commands	Results
>> 'Hello World!'	ans = 'Hello World!'
>> n = 2345; >> a = double(n)	a = 2345
>> b = uint32 (789.50)	b = 790
>> c = 5678.92347; >> d = int32 (rn)	d = 5679
>> 20 == 0	ans = 0

MATLAB offers several fundamental data types. Each data type stores data in the form of a matrix.

Data type	Description
int8	Signed integers on 8 bits.
uint8	Unsigned integers on 8 bits.
int16	Signed integers on 16 bits.
uint16	Unsigned integers on 16 bits.
int32	Signed integers on 32 bits.
uint32	Unsigned integers on 32 bits.
single	Numerical data with simple precision.
double	Numerical data with double precision.
logical	logical values 1 (True) or 0 (False)
char	Strings

MATLAB does not require any type declarations or dimension statements. When MATLAB encounters a new variable name, it creates the variable and allocates the appropriate memory space. If the variable already exists, MATLAB replaces the original contents with new ones.

Remark

The character string is a line vector, to create it we write the characters between two quotation marks.

II.3.2 Special variables.

Type the following expressions.

Commands	Results
>> pi	ans = 3.1416
>> 3i	ans = 0.0000 + 3.0000i
>> x = ans/0	x = NaN

MATLAB supports the following special variables and constants.

Name	Meaning
ans	The most recent response.
i, j	The imaginary number $\sqrt{-1}$.
Inf	Infinite number.
NaN	Not a Number.
pi	π.

II.4 Commands.

II.4.1 The command “format”

Type the following expressions

Commands	Results
>> pi	ans = 3.1416
>> format long	
>> pi	ans = 3.141592653589793
>> x = 7 + 10/3 + 5	x = 15.333333333333334
>> format rat	
>> 4.678 * 4.9	ans = 2063/90

By default, MATLAB displays numbers with four decimal values. This is short format. However, if you want more precision, you need to use the format command.

Command	Description
short	The short format command displays 4 digits after the decimal point.
long	The long format command displays 15 digits after the decimal point.
short e	Displays in exponential form with four decimal places plus exponent.
long e	Displays in exponential form with 15 decimal places plus exponent.
rat	Give the closest rational expression resulting from a calculation.

There are still other commands, but we're interested in these format commands.

Exercise 01

Use MATLAB to evaluate the following expressions:

(a) 1/0

(b) 0/0

(c) 22/7

(d) 22/7 with format long

II.4.2 Session management commands.

Type the following expressions

Commands	Results
>> clear >> clc	

>> a = 15*8
>> b = exp(15)
>> c = 15-9
	a = 120
	b = 3.2690e+06
	c = 6

>> who	Your variables are: a b c
>> whos	Name Size Bytes Class a 1x1 8 double b 1x1 8 double c 1x1 8 double
>> clear b	
>> who	Your variables are: a c
>> exist b	ans = 0

MATLAB commands for managing a session.

Command	Goal
clc	Erase command window.
clear	Deletes variables from the memory.
exist	Checks for the existence of a file or variable.
global	Declares a global variable.
help	Looking for help.
lookfor	Search for help by keyword.
quit	Stop MATLAB.
who	Display current variables.
whos	Display current variables (long display).

II.4.3 Input and output commands

MATLAB provides the following input and output commands

Command	Goal
disp	Displays the contents of an array or string.
fscanf	Read data from a file.
format	Controls the display format on the screen.
fprintf	Writes entries for the screen or file.
input	Displays prompts and waits for input.

II.5 Operators.

MATLAB supports the following elementary operations:

1. Arithmetic operators.
2. Relational operators.
3. Logical operators.
4. Bitwise operations.
5. Set operators.

This tutorial focuses on the first three.

II.5.1 Arithmetic operators.

Operator	Description
+	Addition.
-	Subtraction.
*	Matrix product.
/	Right division
\	Left division
^	Matrix power.
.*	Product element by element.
./	Right division element by element.
.\	Left division element by element.
.^	Element by element power.

Example

Commands	Results

>> a = 10;
b = 20;
c = a + b
d = a - b
e = a * b
f =a / b
g = a \ b
x = 7;
y = 3;
z = x ^ y
	c = 30
	d = -10
	e = 200
	f = 0.5000
	g = 2
	z = 343

Exercise 02

Use one MATLAB line to evaluate the following expression:

$$\sqrt{\frac{(4.172+9.131844)^3-18}{-3.5+(11.2-4.6)*(7-2.91683)^{-0.4}}}$$

Exercise 03

1) Using MATLAB calculator evaluate C_4^{13} where $C_p^n = \frac{n!}{(n-p)!p!}$.

2) Use the help command to get information about the command "nchoosek"

3) Use this command to verify your answer.

II.5.2 Relational operators.

Operator	Description
<	Less than
<=	Less than or equal to
>	Greater than
>=	Greater than or equal to
==	Equal to
~=	Different from

II.5.3 Conditional operators.

Operator	Description
&&	Logical AND
| |	Logical OR
~	Logical NOT
xor (A, B)	Logical exclusive Or

III. Saving your work.

Type the following expressions

Commands	Results
>> pi	ans = 3.1416
>> a = log(10)	a = 2.3026
>> x = a^2+15*a-1	x = 38.8407
>> save mywork.mat	
>> clear >> clc	
>> load mywork.mat	

Remarks.

1. The save command is used to save all workspace variables, in the form of a file with the .mat extension, in the active directory.
2. The load command is used to restore already saved variables.

IV. Script files

So far, we've used the MATLAB environment as a calculator. MATLAB is also a very powerful programming language.
MATLAB lets you write series of commands to a file and execute the file as a complete unit,

IV.1 Script file (M-files).

Script files are program files with the .m extension. In these files, you write a series of commands that you wish to execute together. Scripts do not accept input or return output. They operate on data in the workspace.

IV.2 Create and edit M-files.

To create script files, you need a text editor. You can open the MATLAB editor in one of two ways.

1) Using the command prompt

   Type edit in the command prompt. This will open the editor. Or edit <fileName> to edit an existing file.

   If you are creating the file for the first time, MATLAB will ask you to confirm it.

2) Using IDE

   Choose NEW -> Script.

   This also opens the editor and creates a file named Untitled.

   You can name and save the file after typing the code.

Example

In the script editor window, type:

Commands	Results

>> a = 5; b = 7;
c = a + b
d = c + sin(b)
	c = 12
	d = 12.6570

Remark

To execute a script, simply type its name in the command window, or press the green Run button in the editor tab.

V. Conditional instructions.

V.1 if…end

Syntax

```
if <condition>
    statement(s) will execute if condition is true
end
```

Example

In the script editor window, type:

Commands

a = 10;
if a < 20
      fprintf (a is less than 20\n');
end
fprintf ('the value of a is: %d\n', a);

Results
a is less than 20 the value of a is: 10

V.2 if…else…end

Syntax

```
if <condition>
    statement(s) will execute if condition is true
else
    statement(s) will execute if the condition is false
end
```

Example

In the script editor window, type:

Commands

a = 100;
if a < 20
      fprintf ('a is less than 20');
else
      fprintf ('a is greater than 20\n');
end
fprintf ('the value of a is: %d\n', a);

Results

```
a is greater than 20
the value of a is: 100
```

V.3 if…elseif…elseif…else…end

Syntax

```
if <condition 1>
    Executes when expression 1 is true.
elseif <condition 2>
    Executes when expression 2 is true.
elseif <condition 3>
    Executes when expression 3 is true.
else
    Executes when none of the conditions are true.
end
```

Example

In the script editor window, type:

Commands

```
a = 100;
if a == 10
     fprintf ('the value of a is 10\n');
elseif(a==20)
     fprintf ('the value of a is 20\n');
elseif a == 30
     fprintf ('the value of a is 30\n');
else
     fprintf ('None of the values match \n');
     fprintf ('The exact value is: %d\n', a);
end
```

Results

```
None of the values match
The exact value is: 100
```

V.4 The switch instruction

Syntax

```
switch <switch expression>
    case <condition 1 >
        <statements>
    case < condition 2>
        <statements>
    …
    …
    Otherwise
        <statements>
end
```

Example

In the script editor window, type:

Commands

```
grade = 'B';
switch(grade)
        case 'A'
            fprintf ('Excellent! \n');
        case 'B'
            fprintf ('Well done \n');
        case 'C'
            fprintf ('Well done \n');
        case 'D'
            fprintf ('You passed \n');
        case 'F'
            fprintf ('Better try again \n');
        otherwise
            fprintf ('Invalid grade \n');
end
```

Results

```
Well done
```