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Programming (Matlab)
Chapter One:
MATLAB Basics

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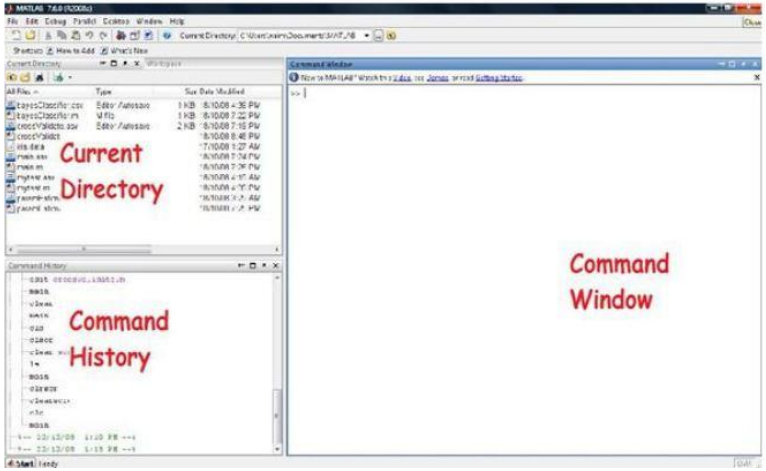
1.1 Introduction

- MATLAB logo, MATLAB Desktop window will launch: title bar, a menu bar, a tool bar and five embedded windows, one of which is hidden.
- The largest and most important window is the **Command Window** on the center.
- The **Command History Window**, the **Current Directory Browser** and the **Workspace Browser**.



- Command prompt (>>).
- If the Command Window is "**Active**," its title bar will be **dark**, and the prompt will be followed by a **cursor** (a blinking vertical line).

The Matlab Environment

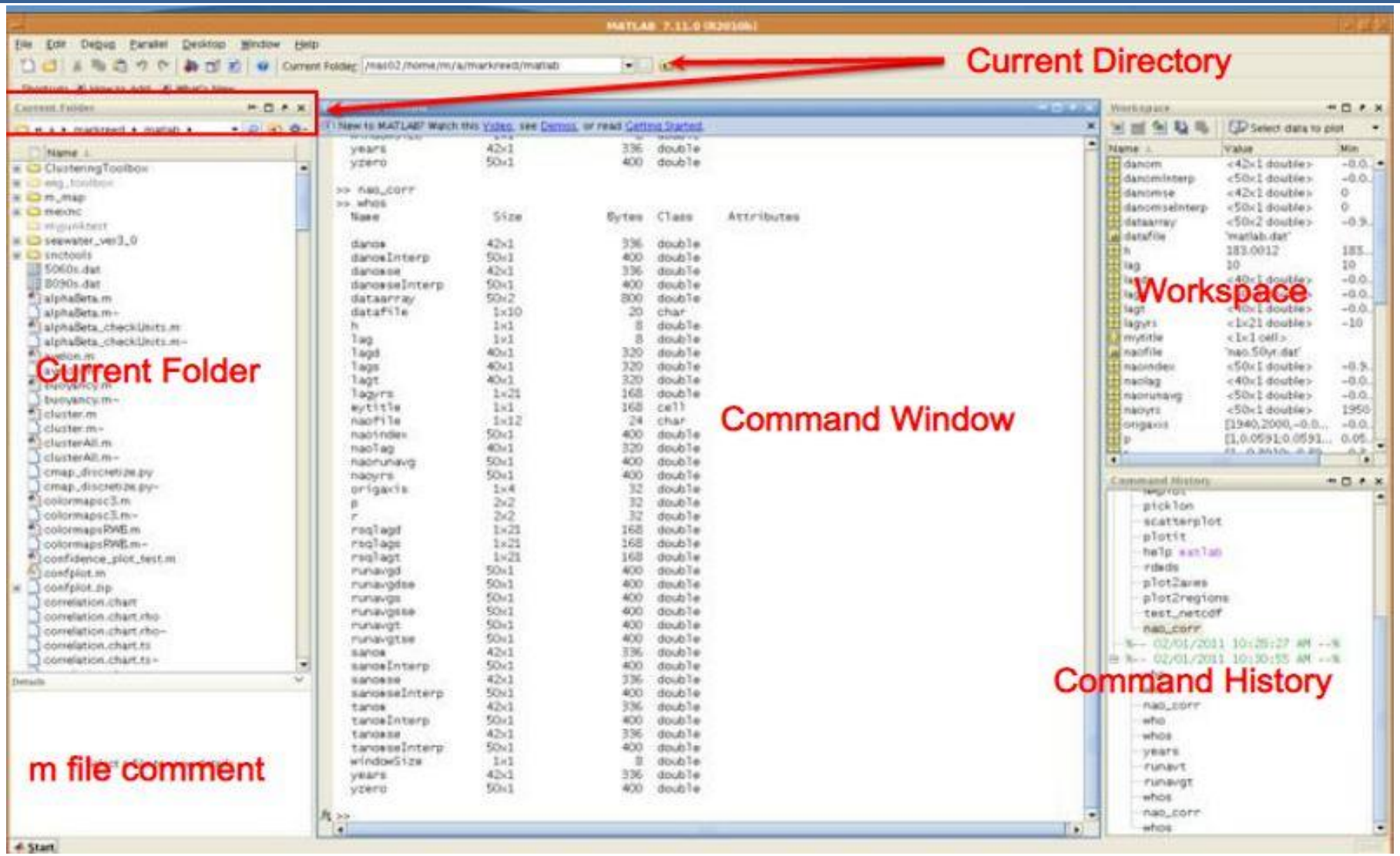


Figure 1-1 The MATLAB desktop

1.2 A Matlab Calculator

- To begin, you can use Matlab for simple arithmetic problems. Symbols like + (plus), - (minus), * (multiply), and / (divide) all work as you would expect.
- In addition, ^ is used for exponentiation. For example, if you type:

>> **75 - 32 * 2 + 4 / 2** → **(Enter)**

>> **2+2**

>> **factor**(123456789),

>> **sin**(pi/3).

>> **x + 6 = 90**

>> **x= 90 – 6**

>> **x = x +4**

>> **x = 34^2**

>> **x = 2**

>> **t = x + a**

…….?

1.2.1 The order of precedence

Operation	Algebraic form	Matlab	Example
Addition	$a + b$	$a + b$	3+4
Subtraction	$a - b$	$a - b$	14 - 11
Multiplication	$a \times b$	$a^{*}b$	$3.14^{*}0.85$
Right division	$a \div b$	a/b	48/8
Left division	$b \div a$	$a\backslash b$	8\56
Exponentiation	a^{b}	$a\hat{}\,b$	$5\hat{}\,2$

$$5\left(\frac{3}{4}\right)+\frac{9}{5}\ \textbf{\textit{and}}\ 4^{3}\left[\frac{3}{4}+\frac{9}{(2)3}\right]$$

```
>> 5*(3/4) + 9/5 .....

ans =

    5.5500
```

Precedence	Operator
1	Parentheses
2	Power, Left to Right
3	Multiplication & Division, Left to right
4	Addition &Subtraction, Left to right

Some Notes

- **Note:** that MATLAB prints the answer and assigns the value to a variable called ans. If you want to perform further calculations with the answer, you can use the variable *ans* rather than retype the answer.

```
>> u = cos(10)

u =

   -0.8391
```

```
>> v = sin(10)

v =

   -0.5440
```

```
>> u^2 + v^2

ans =

    1
```

- **Note:** Trigonometric functions in MATLAB use radians, not degrees.

- **Note:** MATLAB displays only **5 digits** by default. To display more digits, type **format long (15 digits)**. Type **format short** to return to **5-digit** display.

- **Recovering from Problems:** If you make an error in an input line, MATLAB will normally print an error message.

Notes

- **Note** that MATLAB places a marker (a vertical line segment) at the place where it thinks the error might be; however, the actual error may have occurred earlier or later in the expression.

- **Note** The **UP- and DOWN-ARROW** keys allow you to scroll back and forth through all the commands you've typed in a MATLAB session, and are very useful when you want to correct, modify, or reenter a previous command.

- **Aborting Calculations:** If MATLAB gets hung up in a calculation, or seems to be taking too long to perform an operation, you can usually abort it by typing **CTRL+C**.

Example

1. Find the temperature (T_f) from the following equation, if you know $T_c = 40$: $\boldsymbol{T_f = \frac{9}{5} T_c + 32}$

Answer: >> T_c= 40;

>> $T_f = 9/5 * TC + 32$ T_f = 104

2. Calculate $\boldsymbol{z = exp(-a)sin(x) + 10\sqrt{y}}$ for $\boldsymbol{a = 5, x = 2, y = 8}$.

Answer:

```
>> a=5;  x=2;  y=8;
>> z=exp(-a)*sin(x)+10*sqrt(y)
z=
```

1.3 Help

help general **>>help factor** **>>more on** **>>more off**

Help Browser: While help in the Command Window is useful for getting quick information on a particular command, more extensive documentation is available via the MATLAB **Help Browser.**

❖ **Different way of invoke, one is following:**

>>**doc** sin

- **Lookfor** command searches the first line of every MATLAB help file for a specified string (use lookfor -all to search all lines)

>>**lookfor** factor

- You can type **demo**(or selecting it in help browser) to try some of MATLAB's online demonstrations.
- Methods to exit MATLAB: type **quit** at the prompt, click on (×), **close** icon, Alt+F4.

1.4 Symbolic Computation

- Type help symbolic to make sure that the Symbolic Math Toolbox is installed on your system.
- To perform symbolic computations, you must use **syms** to declare the variables.

```
>> syms x y
>> (x - y)*(x - y)^2

ans =
(x-y)^3
```

```
>> expand(ans)

ans =
x^3-3*x^2*y+3*x*y^2-y^3
```

```
>> factor(ans)

ans =
(x-y)^3
```

- The command **expand** told MATLAB to multiply out the expression.
- **Factor** forced MATLAB to restore it to factored form.
- MATLAB has a command called **simplify**, which you can sometimes use to express a formula as simply as possible. For example,

```
>> simplify((x^3 - y^3)/(x - y))

ans =
x^2+x*y+y^2
```

1.4 Symbolic Computation

- When you work with symbolic expressions you often need to **substitute** (using **subs**) a numerical value, or even another symbolic expression, for one (or more) of the original variables in the expression.

For example:

```
>> d = 1, syms u v        >> w = u^2 - v^2        >> subs(w, u, 2)
>> subs(w, v, d)          >> subs(w, v, u + v)    >> subs(w,[u v],[4 3])
```

- **Example:** Replace a with 4 from this $z = a + b$,
- **Ans:** >> syms a b; >> subs(a+b,a,4); >> $ans: z = 4 + b$;
- **Note** when you enter multiple commands on a single line separated by commas, MATLAB evaluates each command and displays the output on separate lines.

1.4 Symbolic Computation

- **Exact Arithmetic:** MATLAB uses floating-point arithmetic for its calculations.
- You can do **exact** arithmetic with symbolic expressions.

>> **cos(pi/2)** **% really cos(π/2)=0** ans = 6.1232e-17

- The inaccuracy is due to MATLAB gives an approximation to π accurate to about **15** digits, not its exact value.
- If you don't specify the number of digits, the **default** setting is 32.

1.4 Symbolic Computation

Note One should be **wary** of using **vpa** on an expression that MATLAB must evaluate before applying variable-precision arithmetic.

3^45 gives a floating-point approximation

vpa(3^45) gives an answer that is correct only in its first 16 digits

vpa('3^45') gives the exact answer.

Matlab Functions

Function	Description	Mathematical Expression
sin(u)	Sinus	$\sin(u)$
cos(u)	Cosinus	$\cos(u)$
exp(u)	Exponential	E^u
log(u)	Natural logarithm	$\ln(u)$
10^u	Power of base 10	10^u
log10(u)	Common (base 10) logarithm	$\log(u)$
u^2	Power 2	u^2
sqrt(u)	Square root	$u^{0.5}$
1/u	Reciprocal	$1/u$

Punctuation Marks

Punctuation marks	
Punctuation	
apostrophe	(’ ')
brackets	([ ], ( ), { }, 〈 〉)
colon	(:)
comma	(, ‘、)
dash	(–, —, ⸺, ⸻)
ellipsis	(…, ..., . . .)
exclamation mark	(!)
full stop / period	(.)
hyphen	(‐)
hyphen-minus	(-)
question mark	(?)
quotation marks	(‘ ’, “ ”, ' ', " ")
semicolon	(;)
slash / stroke / solidus	(/, ⁄)

Examples

1. Evaluate the symbolic expression $f = 2x^2 - 3x + 1$ at the point x = 1/3.

Ans: >> syms x; >> f = 2*x^2 - 3*x + 1; >>subs(f, 1/3); $f = 2/9$.

2. substitute the value x = 3 in the symbolic expression of $\boldsymbol{f = x^2 y + 5x\sqrt{y}}$.

Ans: >> syms x y; >> f = x^2*y+5*x*sqrt(y); >> subs(f,x,3);

ans; 9*y+15*y^1/2.

Examples

3. Try to write the following in command window:

$5\left(\frac{3}{4}\right)+\frac{9}{5}$ and $4^3\left[\frac{3}{4}+\frac{9}{(2)3}\right]$

$C = \sqrt{A^2 + B^2}$

$2^5/(2^6 - 1)$

e^4

$\ln(e^4)$

$\log10(e^4)$

$e^{\pi\sqrt{121}}$

$\cos(\pi/4) + \sin^2(\pi/3)$

$\log_e(e^3) + \log_{10}(e)$

$\text{area} = \pi * (\pi/3)^2$

$g = e^{(3\sqrt{131})}$

$c = \ln(e) + \ln(e^3)$

$h = \log(5) + \log_e(5) + \log_2(5)$

$d = \log(e) + \log(e^3$

$e = \pi$

$f = \cos(\pi/4)$

Examples

4. `>> expand((x-1)*(x+4))`

   `ans = x^2 +3*x - 4`

```
expand(cos(x+y))
ans =

cos(x)*cos(y)-sin(x)*sin(y)
```

```
>> syms y
>> expand((y-2)*(y+8))
ans =

y^2+6*y-16
```

```
>> collect(x*(x^2-2))
   ans =

   x^3-2*x
```

```
>> syms t
>> collect((t+3)*sin(t))
```

$$x^2 - y^2 = (x + y)(x - y)$$

```
>> simplify((x^4-81)/(x^2-9)) ans =

                                x^2+9
```

```
>> simplify(exp(2*log(3*x))) ans =

                                9*x^2
```

```
>> simplify(cos(x)^2-sin(x)^2)
ans =     2*cos(x)^2-1
```