Computer Application II

Lecture (01)

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Introduction

- Formerly used by specialists in signal processing and numerical analysis. MATLAB in recent years has achieved wide-spread and acceptance throughout the engineering community.
- Many engineering schools now require a course based entirely or in part on MATLAB.
- MATLAB is programmable and has the same logical, relational, conditional and loop structures as other programming languages such as FORTRAN, C, BASIC and PASCAL.

Introduction

- In some schools a MATLAB course has replaced the traditional Fortran course and MATLAB is the principal computational tool used throughout the curriculum.
- In some technical specialties, such as signal processing and control systems, it is the standard software package for analysis and design.
- The popularity of MATLAB is partly due to its long history, and thus its well developed and well tested.
- People trust its answers

Introduction

- Its popularity is also due to its user interface, which provides an easy-to-use interactive environment that includes extensive numerical computation visualization capabilities.
- Its compactness is a big advantage.
- For example, you can solve a set of many linear algebraic equations with just three lines of code, a feat that is impossible with traditional programming languages.

Starting MATLAB

- To start MATLAB on a MS windows system, double-click on the MATLAB icon.
- The default appearance of the desktop is shown, three windows appear, these are the Command Window, the Command History Window, and the Launch Pad Window.

Starting MATLAB

- In the Command window. MATLAB displays the prompt {double caret} (>>) to indicate that it is ready to receive instructions.
- The Launch Pad Window lists the toolboxes and other MATLAB related programs, such as Simulink, that are installed on the computer.

Starting MATLAB

- The Command History Window shows all the previous keystrokes entered in the command window.
- To divide 8 by 10, type 8/10 and press ENTER (the symbol / is the MATLAB symbol for division).
- Your entry and the MATLAB response looks like the following on the screen:

Starting MATLAB

```
>> 8/10

ans =

0.8000
```

Starting MATLAB

- MATLAB has assigned the answer to a variable called ans, which is an abbreviation for answer.
- A variable in MATLAB is a symbol used to contain a value.
- You can use the variable ans for further calculations; for example, using the MATLAB symbol for multiplication (*):

Starting MATLAB

$$>> 5*ans$$

$$ans =$$

Starting MATLAB

- You can use variables to write mathematical expression and you can assign the result to a variable of your own choosing, say r, as follows:

$$r=8/10$$

$$r =$$

$$0.800$$

Starting MATLAB

- If you now type *r* at the prompt, you will see:

```
>> r

r =

0.8000
```

- Thus verifying that the variable *r* has the value *0.8*.
- You can use this variable in further calculations:

```
>> s=20*r

s =

   16
```

Variable Names

- The term workspace refers to the names and values of any variables in use in the current work session.
- Variable name must begin with letter and must contain less that 32 characters; the rest of the name can contain letters, digits, and underscore characters.

Variable Names

- MATLAB is case-sensitive. Thus the following names represent five different variables: speed, Speed, SPEED, Speed_1, and Speed_2.

Commands for Managing the Work Session

Command	Description
clc	Clears the command window
clear	Removes all variables from memory
clear var1, var2	Removes the variables var1 and var2 from memory
exist ('name')	Determines if the file or variable exists having the name 'name'
quit	stops MATLAB
who	Lists the variable currently in memory
whos	Lists the current variables and sizes, and indicated if they have imaginary parts
:	Colon; generates an array having regularly spaced elements
,	Comma; separates elements of an array
;	Semicolon; suppresses screen printing; also denotes a new row in an array
...	Ellipsis; continues a line

Special Variables and Constants

Command	Description
ans	Temporary variable containing the most recent result
eps	Specifies the accuracy of floating point precision
i, j	The imaginary unit
inf	Infinity
nan	Indicates an undefined numerical result
pi	The number π

Order of Precedence

- A scalar is a single number. A scalar variable is a variable that contains a single number.
- MATLAB uses the symbols + – * / ^ for addition, subtraction, multiplication, division, and exponentiation (power) of scalars.

Order of Precedence

- MATLAB has another division operator, called left division, which is denoted by the backslash (\). The left division operator is useful for solving sets of linear algebraic equations as we will see later.

Order of Precedence

- The mathematical operations represented by the above symbol follow a set of rules called precedence. Mathematical expressions are evaluated starting from the left, with the exponentiation operation having the highest order precedence, followed by multiplication and division with equal precedence, followed by addition and subtraction with equal precedence.

Order of Precedence

- Parentheses can be used to alter this order. Evaluation begins with the innermost pair of parentheses, and proceeds outward.

Order of Precedence

Precedence	Operation
First	Parentheses, evaluated starting with the innermost pair
Second	Exponentiation, evaluated from left to right
Third	Multiplication and division with equal precedence, evaluated from left to right
Fourth	Addition and subtraction with equal precedence, evaluated from left to right

The Assignment Operator

- The = sign in MATLAB is called the assignment or replacement operator.
- It works differently than the equals sign you know from the mathematics.
- When you type x=3, you tell MATLAB to assign the value 3 to the variable x.

The Assignment Operator

- In MATLAB we can also type something like this: x=x+2. This tells MATLAB to add 2 to the current value of x, and replace the current value of x with this new value:
- The variable on the left-hand side of the = operator is replaced by the value generated by the right-hand side. Therefore, one variable, and only one variable, must be on the left-hand side of the = operator.

The Assignment Operator

- In MATLAB you cannot type 6=x or expression like x+2=20:
- Another restriction is that the right-hand side of the = operator must have a computable value. For example, if the variable y has not been assigned a value, then the following will generate an error message in MATLAB x=5+y

Computing with MATLAB

- MATLAB has hundreds of built-in functions such as *sin (x)*, where x has a value in radians.
- Same for *cos (x)*, *exp (x)*, natural logarithm *log (x)*, the base 10 logarithm by typing *log10 (x)*:
- The inverse sine, or arcsine, is obtained by typing *asin (x)*. It returns an answer in radians, not degree:
- One of the strengths of MATLAB is its ability to handle collections of number, called arrays, as if they were a single variable.
- An example of array is $x = [0, 1, 3, 6]$, and $y = [6, 3, 1, 0]$:
- The elements of the array must be separated by commas or spaces.
- We can add the two arrays x and y to produce another array z by typing the single line $z=x+y$:

Computing with MATLAB

```
>> x=[0, 1, 3,  6];
>> y=[6, 3, 1, 0];
>> z=x+y
z =
    6    4    4    6
```

- In most other programming languages, this operation requires more than one command. Because of this capability for handling arrays, MATLAB program can be very short.

Computing with MATLAB

- You need not type all the numbers in the array if they are regularly spaced.
- Instead, you type the first number and the last number, with spacing in the middle, separated by colons.
- For example, the numbers 0, 1, 2, …, 10 can be assigned to the variable u by typing *u= [0: 1: 10]*:

```
>> u= [0: 1: 10]
u =
    0    1    2    3    4    5    6    7    8    9   10
```

- To compute *w= 5sin u* for *u= 0, 1, ..., 10*, the session is:

```
>> u=[0:1:10];
>> w=5*sin(u);
```

Computing with MATLAB

- The single line w=5*sin(u), computed the formula w=5sin u 11 times, once for each value in the array u, to produce an array w that has 11 values.
- This illustrates some of the power of MATLAB to perform many functions with just a few commands.
- Because we typed a semicolon at the end of each line in the above session. MATLAB does not display the results on the screen.
- The values are stored in the variables u and w.
- You can see all the u values by typing u after the prompt or, for example, you can see the seventh value by typing u(7) as follows:

Computing with MATLAB

```
>> u(7)
ans =
6
```

- You can see the w values the same way:

```
>> w(7)
ans =
-1.3971
```

- You can use the length function to determine how many values are in an array:

```
>> m=length(w)
m =
11
```