Introduction to MATLAB

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Session 1

Introduction to MATLAB

- **MAT**rix **LAB**oratory
- High level programming language
- Basic Building Block : **Matrix**
- Fundamental Data Type : **Array**

Introduction to MATLAB

- MATLAB supports following Platforms:
  - Windows
  - Linux
  - Unix
  - Mac

- http://www.mathworks.com

Tutorial 1

- Print 'Welcome To MATLAB'
- Find sum of two numbers
- Escape Characters: \n, \t, \b
- Specifiers : %c, %d, %f, %g, %s, %u

General MATLAB Commands

help	lists HELP topics
who	lists variables currently in workspace
whos	lists variables currently in workspace with their size
clc	Clear command window.
clear	removes all variables from workspace
clear all	removes all variables, functions
exit	exit from MATLAB.

Script File

Creating Script File

File → New → Script **or** Ctrl + N

Saving a script file

File → Save **or** Ctrl + S

Executing a script file

Debug → Save file and Run **or** F5

Operators

- **Arithmetic Operators**
  - +, -, *, /, ^
- **Relational Operators**
  - <, >, <=, >=, ==, ~=
- **Logical Operators**
  - &, |, ~, xor

Tutorial 2

- Input radius of circle and find area

- Input distance in km and convert into m, cm, inches, feet

IF statement

if expression

  statements

elseif expression

  statements

else

  statements

end

Example : To find if entered letter is vowel

```
a=input('enter a value: ','s');
if a=='a'||a=='e'||a=='i'||a=='o'||a=='u'
 'Vowel'
elseif a=='A'||a=='E'||a=='I'||a=='O'||a=='U'
 'Vowel'
else
 'Not a Vowel'
end
```

Tutorial 3

- Input a number,

  If the no is divisible by 5 & not divisible by 10 then print '1' otherwise '0' using if else

- Input salary to calculate bonus:

  if s>50000=25% if 25000<s<50000 = 40% and if s<25000 = 50% using if else

SWITCH statement

```
switch switch_expr
        case case_expr,
          statement, ..., statement
        case {case_expr1, case_expr2,...}
           statement, ..., statement
        otherwise,
          statement, ..., statement
end
```

Example : To find if entered letter is vowel

```
a=input('enter a value: ','s');

switch a
        case {'a','A'}
          disp('Vowel')
        case {'e','E'}
          disp('Vowel')
        case {'i','I'}
          disp('Vowel')
        case {'o','O'}
          disp('Vowel')
        case {'u','U'}
          disp('Vowel')
        otherwise
          disp('Not a Vowel')
end
```

Tutorial 4

- Write a menu driven program using switch-case to find **area** of the following shapes:
  - Circle
  - Triangle
  - Rectangle

  Based on the option input the required parameters and calculate the corresponding area

FOR statement

for variable = Initialization : Update statement : Condition

statement,

...,

...,

statement

end

Example : Factorial of a number

```
a=input('enter a value: ');
f=1;

for i=1:1:a
    f=f*i;
end

f
```

Tutorial 5

- Input a number and print table of that no. using for loop.

While statement

while expression

statement

.

.

statement

end

Example : Factorial of a number

```
a=input('enter a value: ');
f=1;

while (a~=0)
    f=f*a;
    a=a-1;
end
 f
```

Tutorial 6

- Input a no. and Find if it is a palindrome or not

Exponential, Logarithms, Trigonometric Functions

- **Exponential Function:**
  - exp(x)
- **Logarithm Functions:**
  - log(x), log10(x)
- **Trigonometric Functions:**
  - sin, cos, tan, sec, csc, cot

Example

e^3	exp(3)
$\log_{10}(e^3)$	log10(exp(3))
$\sin \frac{\Pi}{6}$	sin(pi/6)

Session 2

Working with Arrays

- **Vector**
  - Array is of 1-row or 1-column
- **Matrix**
  - Array with M-rows & N-columns

Matrix

- Row Matrix
- Column Matrix

- Continuation :
  - Ellipsis (…)

Column Matrix

```
>> y=[1 ;2 ;3]

y =

     1
     2
     3
```

Row Matrix

```
>> x=[1 2 3]
x =
     1     2     3

>> z=[2, 1, 0]
z =
     2     1     0
```

Arithmetic Operators

Array Operators

+	Addition
-	Subtraction
.*	Multiplication
./	Division
.^	Exponentiation

Matrix Operators

+	Addition
-	Subtraction
*	Multiplication
/	Division
^	Exponentiation

Tutorial 7

- **Array** addition, multiplication, division, subtraction
- **Matrix** addition, multiplication, division, subtraction,

\ Left Division

- Used to solve matrix equation

- x=A\b
- Same as x=inv(A).b

- To solve Ax=b

Tutorial 8

- **A=[1:3; 4:6;7:9]**

- Perform following:
  - A(row, column)
  - Size
  - Length
  - Sub-matrix
  - Transpose
  - Inverse
  - Append row or column

- Do the following operation on matrix G.

$$G = \begin{bmatrix} 2 & 6 & 0 & 0 & 0 & 0 \\ 3 & 9 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 2 & 0 & 0 \\ 0 & 0 & 3 & 4 & 0 & 0 \\ 0 & 0 & 0 & 0 & -5 & 5 \\ 0 & 0 & 0 & 0 & 5 & 3 \end{bmatrix}$$

  - Delete last row and last column of matrix
  - Extract first 4x4 sub matrix from G
  - Replace G(5, 5) with 4
  - What do you get when you type G(13) and hit return
  - What happens if you type G(12, 1) =1 and hit return.

- G=[2 6 0 0 0 0;3 9 0 0 0 0;0 0 1 2 0 0;0 0 3 4 0 0;0 0 0 0 -5 5;0 0 0 0 5 3];
- G(6,:)=[ ]; G(:,6)=[ ];
- A=G(1:4,1:4);
- G(5,5)=4;

Utility matrices & Functions

- **Zeros = creates zeros matrix**
- **Ones = creates ones matrix**
- **Eye = creates identity matrix**
- **Rand = creates random matrix**
- **rot90 = Rotate 90^0**
- **Fliplr = flip left to right**
- **Flipud = flip up to down**
- **Tril = extract lower triangle**
- **Triu = extract upper triangle**

Round –off functions

- Floor = round towards nearest lower int
- Ceil = round towards nearest higher int
- Round = round towards nearest int
- Rem = remainder
- Sign = sign
- Fix = round towards zero

Example

- Equation of st line: $y=mx+c$
- Where, m and c are constants given as $m=0.5$; $c=-2$
- And x co-ordinates are given as follows $x= 0, 1.5, 3, 4, 5, 7, 9, 10$

Solution

- >> x= [0, 1.5, 3, 4, 5, 7, 9, 10]
- >> m=0.5
- >> c=-2
- >> y=m*x+c

Plot : Linear plot

plot(X,Y)	plots vector Y versus vector X
plot(Y)	plots the columns of Y versus their index
plot(X,Y,S)	where S is a character string made
plot(X ,Y,'c+:')	plots a cyan dotted line with a plus at each data point
plot(X,Y, 'y-',X,Y, 'go')	plots the data twice, with a solid yellow line interpolating green circles at the data points

Linearly Spaced Values

```
>> linspace(0,10,5)

ans =

    0    2.5000    5.0000    7.5000   10.0000
```

Plot3 function

Example

Plot the circular helix

$0 \leq t \leq 20$

$x(t)=\sin(t)$

$y(t)=\cos(t)$

$z(t)=t$

Solution

```
t=linspace(0,20,100);
x=sin(t);
y=cos(t);
z=t;
plot3(x,y,z)
```

Overlay plots

- Example

$$0 \leq x \leq \Pi$$

$$y = \cos(x)$$

$$z = 1 - \frac{x^2}{2} + \frac{x^4}{24}$$

Solution

```
X=linspace(0,pi,100);

Y=cos(X);

Z=1-(X.^2./2)+ (X.^4./24);

plot(X,Y,'*',X,Z,'r+')
```

Line Function

- Syntax
  - line(X,Y)
  - line(X,Y,Z,'*PropertyName*',propertyvalue,...)

Line Style

Symbol	Line Style
–	Solid line (default)
'--	Dashed line
:	Dotted line
–.	Dash-dot line
none	No line

Line Width

- Width is given in points
- 1 point = $^{1}/_{72}$ inch
- Default value = 0.5 points

Marker

Marker Specifier	Description
'+'	Plus sign
'o'	Circle
'*'	Asterisk
'.'	Point
'x'	Cross
'square' or 's'	Square
'diamond' or 'd'	Diamond
'v'	Downward-pointing triangle

Marker

Marker Specifier	Description
'^'	Upward-pointing triangle
'>'	Right-pointing triangle
'<'	Left-pointing triangle
'pentagram' or 'p'	Five-pointed star (pentagram)
'hexagram' or 'h'	Six-pointed star (hexagram)
'none'	No marker (default)

Tutorial 9

Plot the circle using line function

$0 \leq t \leq 20$

$x(t)=\sin(t)$

$y(t)=\cos(t)$

Solution

```
t=linspace(0,20,100);

x=sin(t); y=cos(t);

line(x,y,'Marker','o','Color','r','LineWidth',4,'
   LineStyle','-')

%axis([-1 1 -1 1]);axis('equal')

title('Circle of unit radius');
```

Write a script file for animating the circular motion of a bead

Solution

Step 1:

```
clc; clear; close;

t=linspace(0,2*pi,1000);
x=cos(t); y=sin(t);

hbead=line(x(10),y(10),'marker','o','markersize',30,'erase','xor');

axis([-1 1 -1 1]);axis('equal')

title('Circle of unit radius');
```

Xdata

- Vector of ***x*-coordinates defining the line**

- YData and ZData must be the same length and have the same number of rows

YData

- Vector of **y-coordinates defining the line**

- XData and ZData must be the same length and have the same number of rows

Erase Mode

- **normal | none | xor | background**
- Controls the technique MATLAB uses
  - To **draw** line objects and
  - To **erase** line objects

Solution

Step 2:

```
for i=2:length(t)
    set(hbead,'xdata',x(i),'ydata',y(i))
    drawnow
end
```

set Function

- Handles Graphics object properties
- set(H, '*PropertyName*', Property Value,...)

Drawnow function

- Causes figure windows & their children to **update**
- **Flushes** system **event queue**

```
clc; clear; close;

t=linspace(0,2*pi,1000);
x=cos(t); y=sin(t);
hbead=line(x(10),y(10),'marker','o','markersize',30,'erase','xor');

axis([-1 1 -1 1]);axis('square')

for i=2:length(t)
    set(hbead,'xdata',x(i),'ydata',y(i))
    drawnow
end
```

Tutorial 10

- Plot $Y = \sin(X)$, $0 \leq X \leq 2\Pi$ taking 100 linearly spaced points in given interval.

  Label axes & put "plot created by your name" in title.

Solution

```
x=linspace(0,2*pi,100);
y=sin(x);
plot(x,y)
xlabel('x axis')
ylabel('y axis')
title('plot created by Anuja')
```

Creating & Executing Function File

Function

- Syntax:

```
function [out1, out2, ...] =
myfun(in1, in2, ...)
```

Example : Factorial of a number

```
function [f]=factr(n);
clc;

for i=0:n
if i==0
    f=1;
else
    f=i*factr(i-1);
end
end
```

I/O functions

fopen	Opens an existing file or creates A new file
fclose	Closes an open file
fprintf	Writes formatted data to A file
fscanf	Reads formatted data from A file

Tutorial 11
Copy content from 1 file to other file

```
clc
fid = fopen('work1.txt','w');
fid1 = fopen('testa1.txt','r');

a=fscanf(fid1,'%s');
fprintf(fid,'%s',a);

fclose(fid);
fclose(fid1);
```

Creating GUI

File → New → GUI **→ blank GUI → ok**

Tutorial 12

- Create a simple calculator

Toolboxes

- Curve Fitting Toolbox
- Statistics Toolbox
- Aerospace Toolbox
- Partial Differential Equation Toolbox
- Signal Processing Toolbox