

Overview, MATLAB Syntax

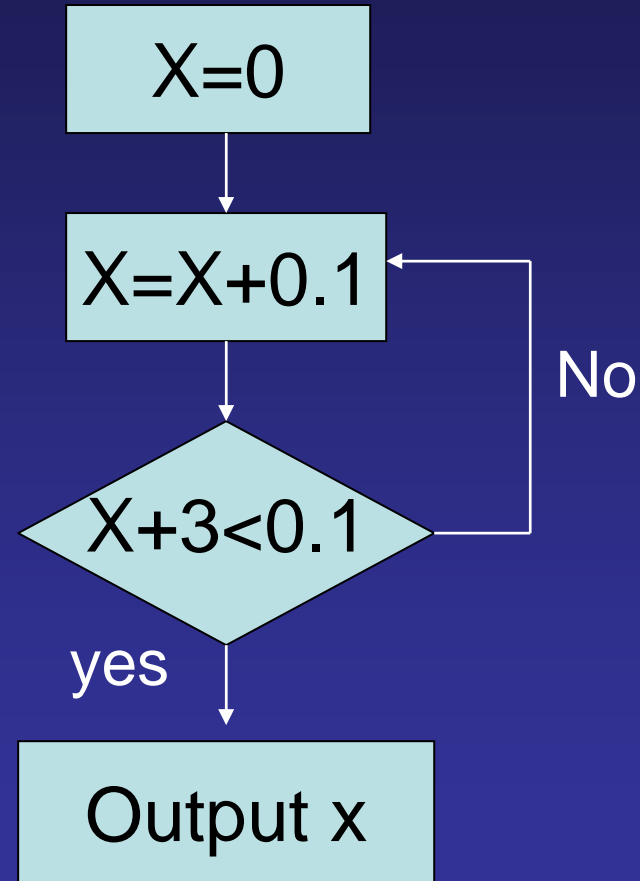
Computation

$$1+2=3$$

$$\sin(30)=0.5$$

$$\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix} \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix} = \begin{bmatrix} 7 & 10 \\ 15 & 22 \end{bmatrix}$$

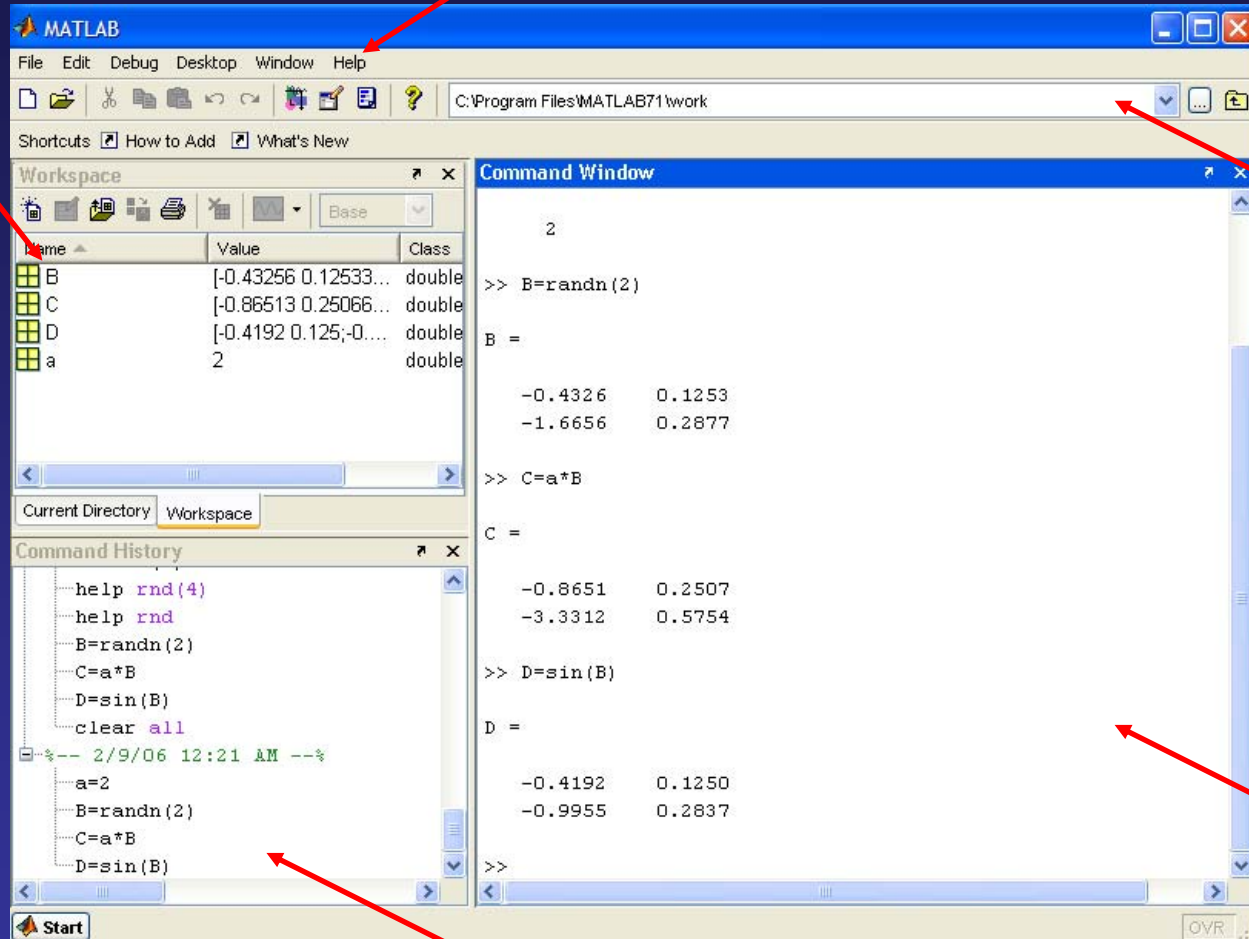
Programming



MATLAB Desktop

Workspace
(variable list)

Help Button



Working
Directory

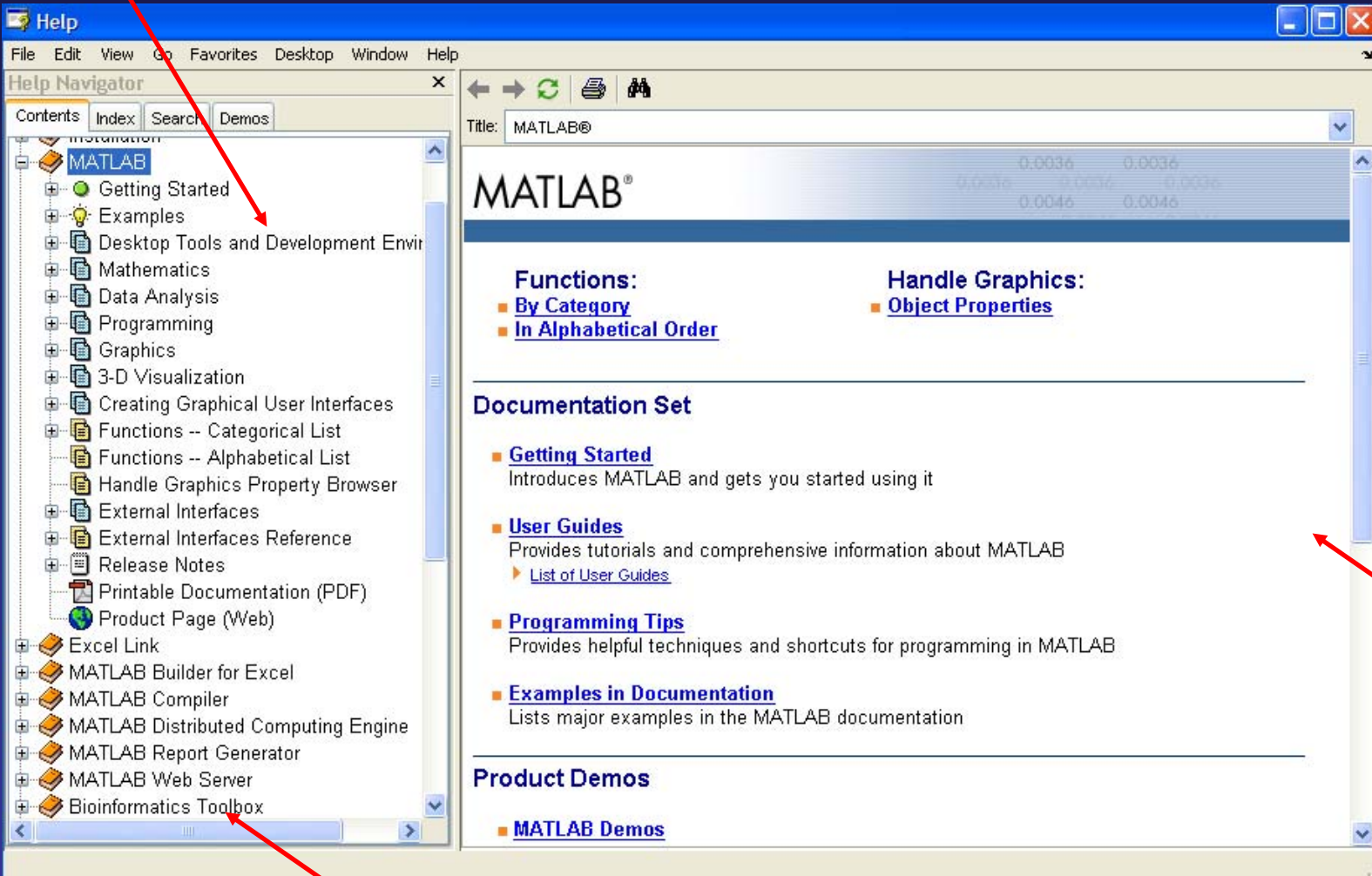
Command
Window

Command
History

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Basic MATLAB functions

MATLAB Help Window

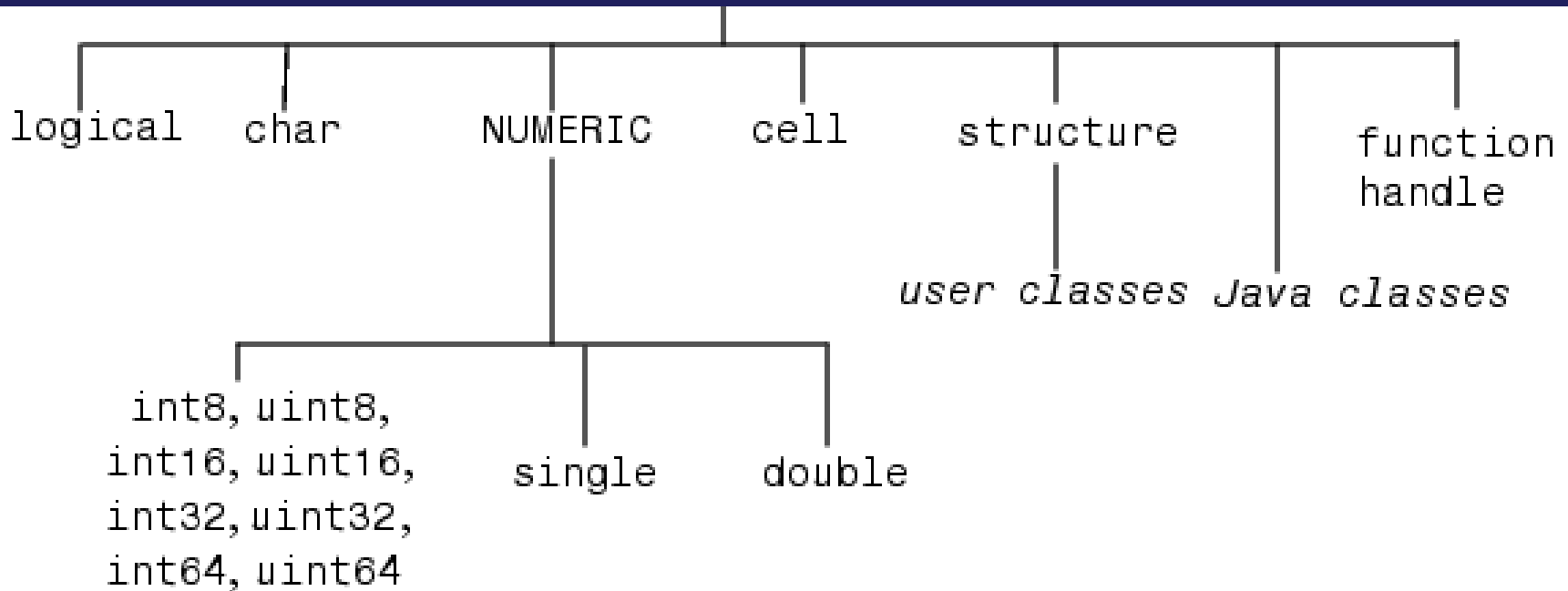


Info
Window

MATLAB Tool Boxes

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MATLAB Data Types



MATLAB Data Structure

Everything in MATLAB are matrix!

$A=5;$ A is a 1×1 matrix

$A=[1\ 3\ 4\ 5];$ A is a 1×4 matrix

$A = [12\ 62\ 93\ -8\ 22; 16\ 2\ 87\ 43\ 91; -4\ 17\ -72\ 95\ 6];$
 A is a 5×3 matrix

Note: (1) Putting “;” behind a statement suppresses output
(2) Rows in a matrix is separated by “;” inside
(3) MATLAB command “whos” gives all the defined variables

What is a variable?

Matrix indexing: $A(2,3) = 87$

Basic Linear Algebra

$$m \cdot \begin{bmatrix} a & c \\ b & d \end{bmatrix} = \begin{bmatrix} ma & mc \\ mb & md \end{bmatrix}$$

$$\begin{bmatrix} a & c \\ b & d \end{bmatrix} \pm \begin{bmatrix} e & g \\ f & h \end{bmatrix} = \begin{bmatrix} a \pm e & c \pm g \\ b \pm f & d \pm h \end{bmatrix}$$

$$\begin{bmatrix} a & c \\ b & d \end{bmatrix} \cdot \begin{bmatrix} e & g \\ f & h \end{bmatrix} = \begin{bmatrix} ae + cf & ag + ch \\ be + df & bg + dh \end{bmatrix}$$

$$A = \begin{bmatrix} a & c \\ b & d \end{bmatrix}$$

$$A \cdot A^{-1} = I = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \quad A^{-1} = \frac{1}{ad - bc} \begin{bmatrix} d & -c \\ -b & a \end{bmatrix}$$

$$[a \quad b \quad c]' = \begin{bmatrix} a \\ b \\ c \end{bmatrix}$$

Scalar multi

Add/sub

Matrix multi

Inverse

Transpose

MATLAB Operators – numeric

Operator	Description
+	Addition
-	Subtraction
.*	Multiplication
./	Right division
.\	Left division
+	Unary plus
-	Unary minus
:	Colon operator
.^	Power
.'	Transpose
'	Complex conjugate transpose
*	Matrix multiplication
/	Matrix right division
\	Matrix left division
^	Matrix power

$$A = [1 \quad 2], B = \begin{bmatrix} 3 \\ 4 \end{bmatrix}, C = [5 \quad 6]$$

$$A + C = [6 \quad 8]$$

$$A * C \text{ bad!}$$

$$A * B = 11$$

$$A .* C = [5 \quad 12]$$

$$A ./ C = [0.200 \quad 0.333]$$

$$A .\ C = [5 \quad 3]$$

MATLAB Operators – Relational, Logical

Relational

Operator	Description
<	Less than
<=	Less than or equal to
>	Greater than
>=	Greater than or equal to
==	Equal to
~=	Not equal to

Logical

```
A = [0 1 1 0 1];  
B = [1 1 0 0 1];
```

Operator	Description	Example
&	Returns 1 for every element location that is true (nonzero) in both arrays, and 0 for all other elements.	A & B = 01001
	Returns 1 for every element location that is true (nonzero) in either one or the other, or both arrays, and 0 for all other elements.	A B = 11101
~	Complements each element of the input array, A.	~A = 10010
<u>xor</u>	Returns 1 for every element location that is true (nonzero) in only one array, and 0 for all other elements.	xor(A,B)=10100

One more MATLAB Operator – Sequence

“:” is the sequence operator that denote a range

$$A = 2:5 \quad A = [2 \ 3 \ 4 \ 5]$$

$$A = 2:3:11 \quad A = [2 \ 5 \ 8 \ 11]$$

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$$

$$B = A(2,:) \quad B = [4 \ 5 \ 6]$$

$$C = A(:,2) \quad C = \begin{bmatrix} 2 \\ 5 \\ 8 \end{bmatrix}$$

$$D = A(2:3,:) \quad D = \begin{bmatrix} 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$$

$$A(:,2) = [] \quad A = \begin{bmatrix} 1 & 3 \\ 4 & 6 \\ 7 & 9 \end{bmatrix}$$

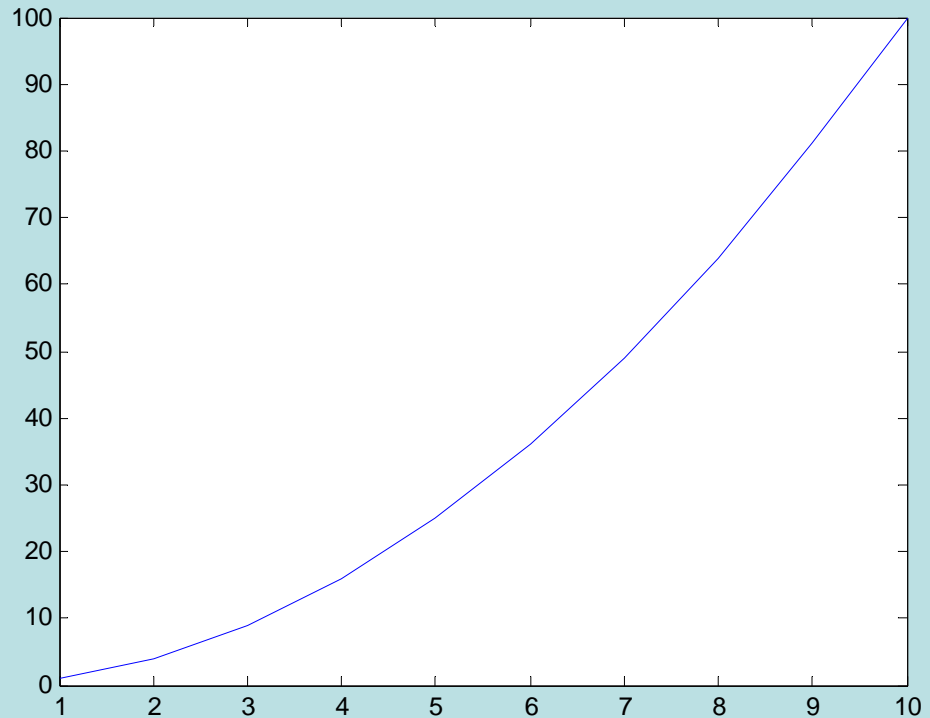
It is very useful to create, decimate, and generate submatrix

Basic Graphic Output in MATLAB

$X = [1 \ 2 \ 3 \ 4 \ 5 \ 6 \ 7 \ 8 \ 9 \ 10]$

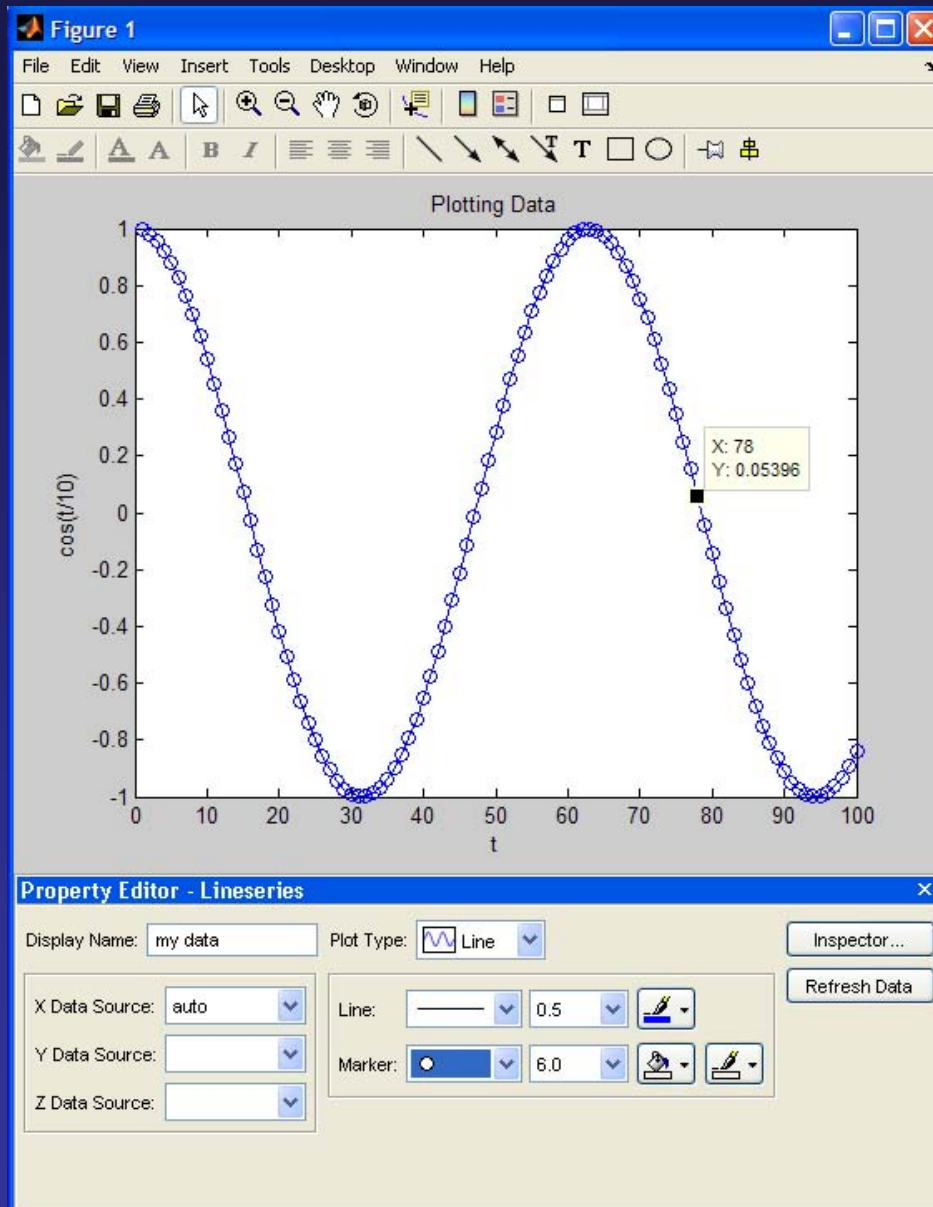
$Y = [1 \ 4 \ 9 \ 16 \ 25 \ 36 \ 49 \ 64 \ 81 \ 100]$

`plot(X,Y)`



More Graphic Output

```
t=1:1:100;  
plot(t,cos(t/10));
```



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Cite as: Peter So, course materials for 2.003J / 1.053J Dynamics and Control I, Fall 2007. MIT OpenCourseWare (<http://ocw.mit.edu>), Massachusetts Institute of Technology. Downloaded on [DD Month YYYY].

A couple more very useful graphic commands

- (1) hold on/hold off – determines whether the next plot command overwrites or not
- (2) figure – Creates new figure window
- (3) From the figure window, under “edit menu”, the “copy figure” option allows you to copy the figure to the clipboard and then you can cut and paste it into other programs such as MSWord.

Programming

What is programming?

Programming is the preparation of a step-by-step instruction for a computer to follow

When is programming “profitable”

- *repetitive computation
- *automation/real time control
- *reusable “code” – objects

Programming languages

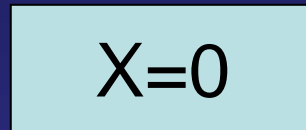
C, C++, C#, java, m-lab script

Anatomy of a program

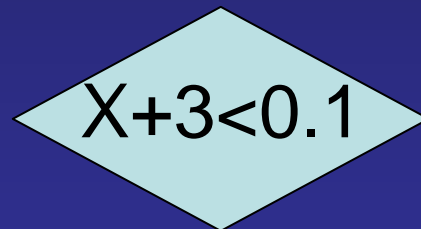
Flow chart – a graphic representation of the logical sequence of instructions

Algorithm – a sequence of instructions designed to solve a specific problem

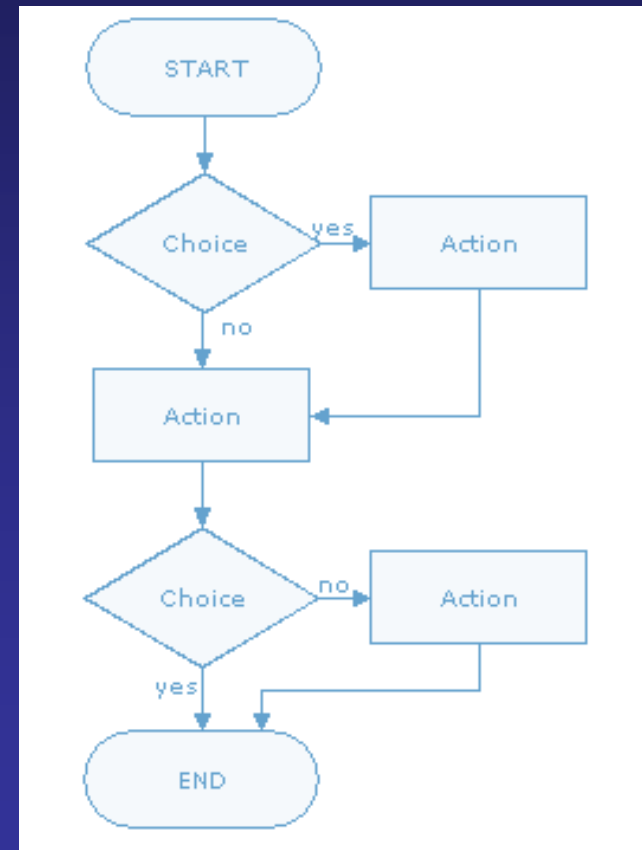
Action



Decision



Terminal

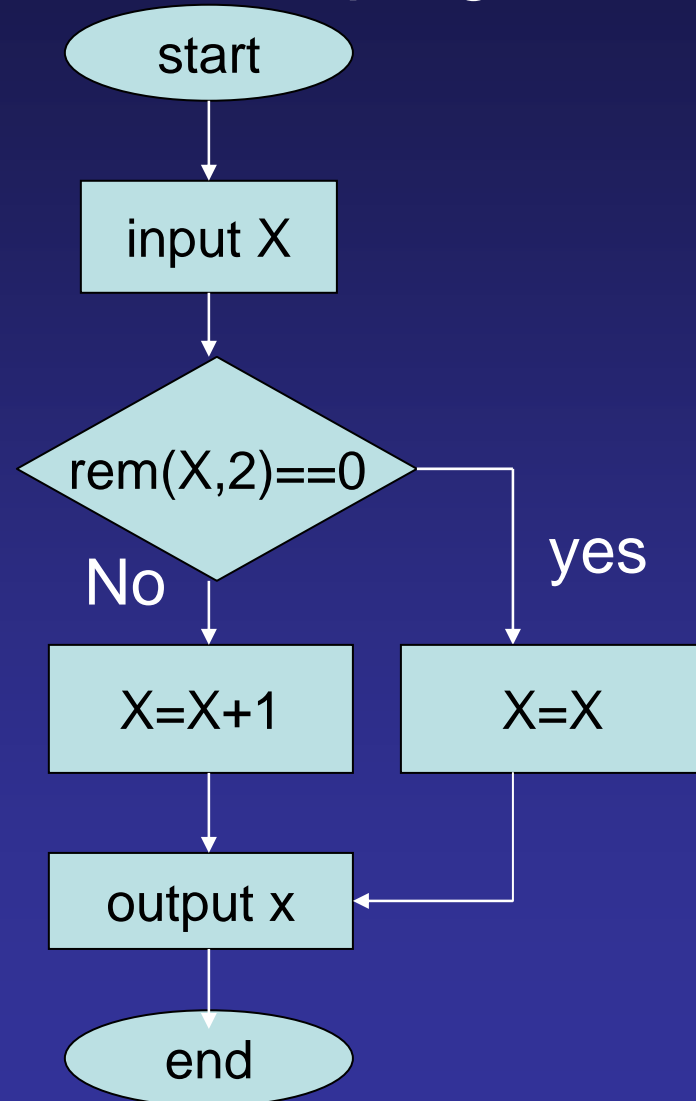


Conditionals

Conditional is a branching point in the program.

Depending on specific condition, the program can take different actions.

Example: a simple program that add 1 to odd integer input and do nothing to even integer input



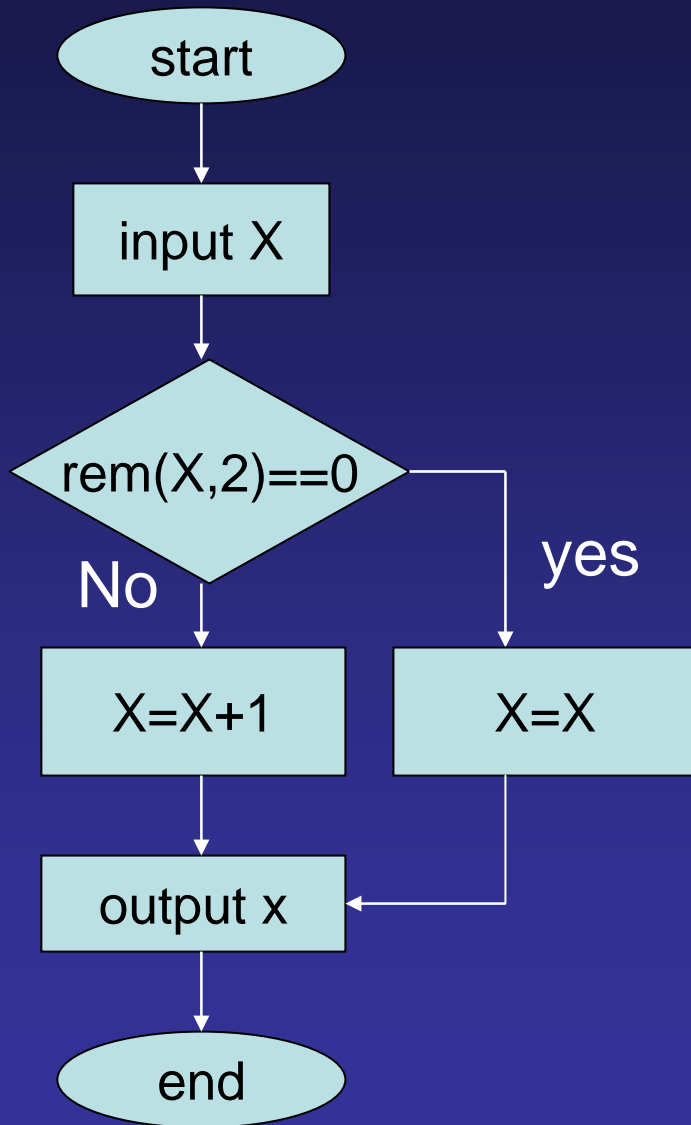
Programming in MATLAB

Step 1: Create a m-file (xxx.m)
[MATLAB Menu: file->new]

Step 2: Input sequence of MATLAB instructions

Step 3: Save (in working directory) and run
[Editor Menu: debug->save & run]

MATLAB realization of program



```
x=input('input integer: ');
```

```
if (rem(x,2) == 0)
```

```
    x=x;
```

```
else
```

```
    x=x+1;
```

```
end
```

```
x
```

Conditional: If, else, end

```
if logic condition  
    action1;  
    action1;  
else  
    action2;  
    action2;  
end
```

Check out also **elseif**

Repetition

Example: fill a 1-D matrix A with length 10 with 2s.

