

# APPLICATIONS OF MATLAB IN ENGINEERING

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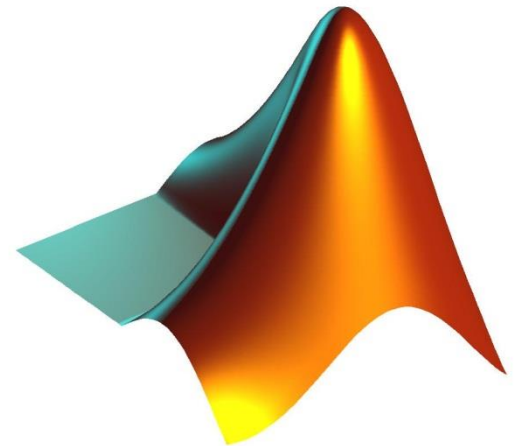
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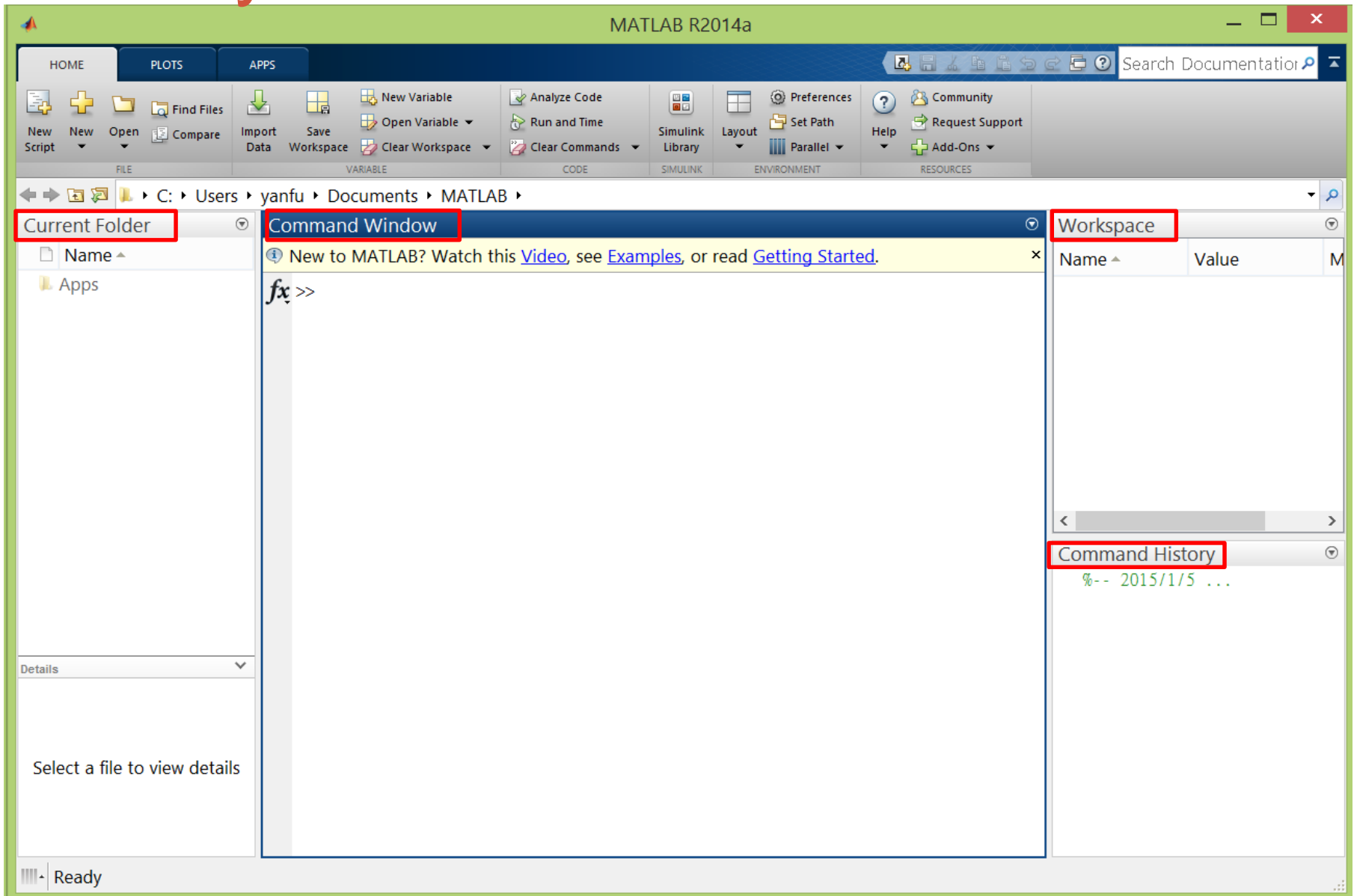
Fall 2015

Today:

- Introduction
- MATLAB as calculator
- Array operation



# Ready to Launch?



# MATLAB Programming Modes

- Command line (in command window)
- Scripts (.m files)

# MATLAB as A Calculator

- Operators:  $+$   $-$   $*$   $/$   $^$
- Result is computed, and displayed as `ans`
- Precedence rules:
  - Left-to-right within a precedence group
  - Precedence groups are (highest first):
    1. Parenthesis (`()`)
    2. Power (`^`)
    3. Multiplication and division (`*`, `/`)
    4. Addition and subtraction (`+`, `-`)

# Exercise

- Calculate:

- $\cos\left(\sqrt{\frac{(1+2+3+4)^3}{5}}\right)$

- $\sin(\sqrt{\pi}) + \ln(\tan(1))$

- $2^{3.5 \times 1.7}$

- $e^{\sin(10)}$

- Your best friend – on-line help

# Elementary Math Functions

- Function list:  
<http://www.mathworks.com/help/matlab/functionlist.html>
  - [Arithmetic](#)
  - [Trigonometry](#)
  - [Exponents and Logarithms](#)
  - [Complex Numbers](#)
  - [Cartesian Coordinate System Conversion](#)

# Embedding Functions

- Functions may be embedded into other functions,

```
sin(cos(pi))
```

||

```
cos(pi)  
sin(ans)
```

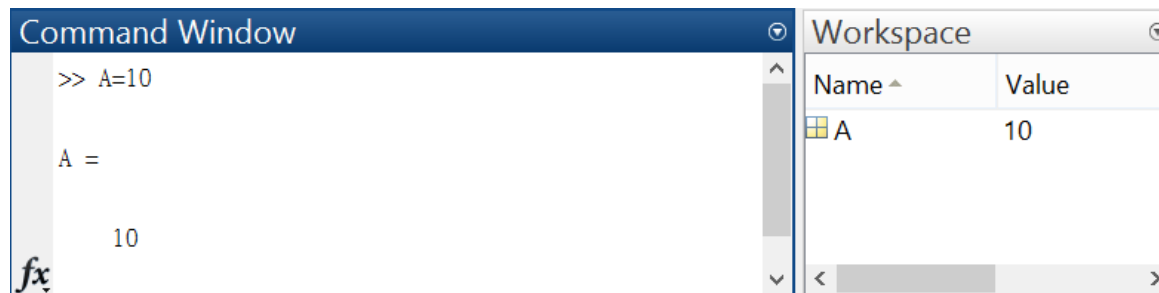
- Many lines of code can be condensed into one single command

# Variables

- Variables do NOT need to be declared before assignment
- A single “equal” sign (=) is the assignment operator:

```
>> LHS = RHS
```

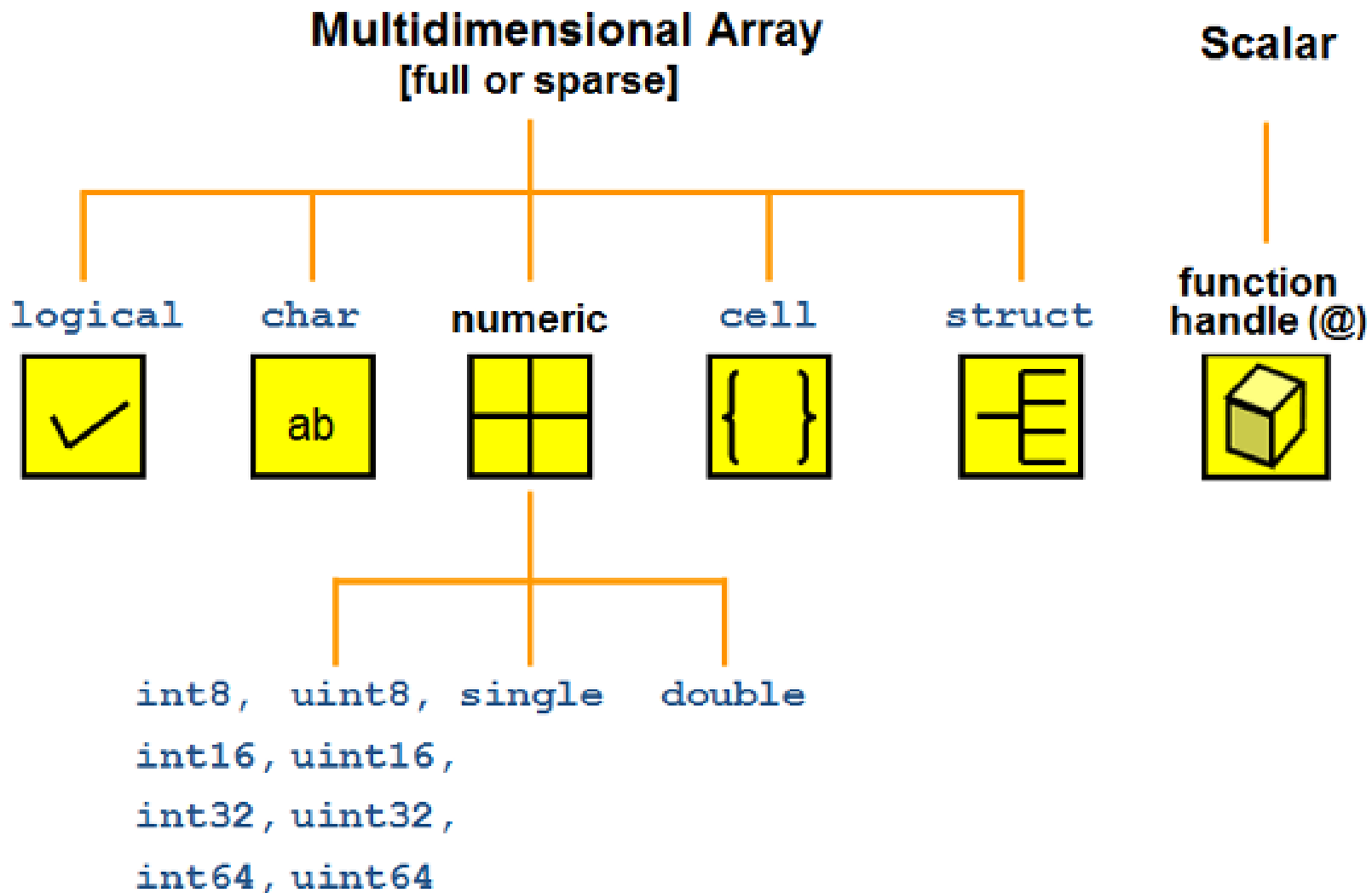
```
>> A = 10
```



1. Upper case/lower case make difference?
2. Can variable names can begin with a number?



# Numeric Variable (Data) Type



# Special Variables and Constants

- `ans`
- `i, j`: complex number
- `Inf`:  $\infty$
- `eps`: `2.2204e-016`
- `NaN`: not a number
- `pi`:  $\pi$

- To list keywords:

```
>> iskeyword
```

- What's the answer from MATLAB after typing?

```
>> x = 1/0
```

```
>> x = log(0)
```

```
>> x = inf/inf
```

# MATLAB Calling Priority

High

Variable

Built-in function

Subfunction

Private function:

- MEX-file
- P-file
- M-file

Low ↓

```
cos='This string.';  
cos(8)
```

```
clear cos  
cos(8)
```

# Numeric Display “Format”

```
>> format long
```

Style	Result	Example
short	Short, fixed-decimal format with 4 digits after the decimal point.	3.1416
long	Long, fixed-decimal format with 15 digits after the decimal point for double values, and 7 digits after the decimal point for single values.	3.141592653589793
shortE	Short scientific notation with 4 digits after the decimal point.	3.1416e+00
longE	Long scientific notation with 15 digits after the decimal point for double values, and 7 digits after the decimal point for single values.	3.141592653589793e+00
bank	Currency format with 2 digits after the decimal point.	3.14
hex	Hexadecimal representation of a binary double-precision number.	400921fb54442d18
rat	Ratio of small integers.	355/113

# Exercise

- Calculate:

$$\frac{3}{13} + \frac{4}{14} + \frac{5}{15} =$$

1. 232/273

2. 233/273

3. 131/275

4. 132/2730

a. 0.84981384981682

b. 0.84981484981683

c. 0.84981584981684

d. 0.84981684981685

# Command Line Terminal

- Observe the difference between

```
>> a = 10
```

```
>> b = 10;
```

- `;` at the end of a command suppresses output to the terminal
- `↑` display previous commands

# Some Useful Functions

- `clc`: clear command window display
- `clear`: remove all variables in the workspace
- `who`: variables in the workspace
- `whos`: variable information of the workspace

# Array (Vector and Matrix)

- Row vector:

```
>> a = [1 2 3 4]
```

- Column vector:

```
>> b = [1; 2; 3; 4]
```

- Try:

```
>> a*b
```

```
>> b*a
```

- Key in the following matrix in MATLAB:

$$A = \begin{bmatrix} 1 & 21 & 6 \\ 5 & 17 & 9 \\ 31 & 2 & 7 \end{bmatrix}$$



# Array Indexing

- Select a certain subset of elements inside a matrix

$$A = \begin{bmatrix} 1 & 21 & 6 \\ 5 & 17 & 9 \\ 31 & 2 & 7 \end{bmatrix}$$

- What's the answer from MATLAB after typing?

```
>> A(8)
```

```
>> A([1 3 5])
```

```
>> A([1 3; 1 3])
```

```
>> A(3,2)
```

```
>> A([1 3], [1 3])
```

# Replacing Entries

- Change the following elements in the matrix:

$$A = \begin{bmatrix} 1 & 21 & 6 \\ 5 & 17 & 9 \\ 31 & 2 & 7 \end{bmatrix} \Rightarrow \begin{bmatrix} 1 & 76 & 6 \\ 5 & 17 & 9 \\ 31 & 0 & 7 \end{bmatrix} \Rightarrow \begin{bmatrix} 1 & 0 & 0 \\ 5 & 0 & 0 \\ 31 & 0 & 7 \end{bmatrix}$$

# Colon Operator

- Want to create a long array: `A = [1 2 3 ... 100]`
- Creates vectors or arrays, and specify for iterations

- Syntax: 

<code>j:k</code>	$\Rightarrow$	<code>[j, j+1, j+2, ..., j+m]</code>
<code>j:i:k</code>	$\Rightarrow$	<code>[j, j+i, j+2i, ..., j+m*i]</code>

- What's the answer from MATLAB after typing?

```
>> B = 1:5
```

```
>> B = 1:2:5
```

```
>> B = [1:5; 2:3:15; -2:0.5:0]
```

```
>> str = 'a':2:'z'
```

# Indexing Using Colon Operator

$$A = \begin{bmatrix} 1 & 0 & 0 \\ 5 & 0 & 0 \\ 31 & 0 & 7 \end{bmatrix} \quad \rightarrow \quad \begin{bmatrix} 1 & 0 & 0 \\ 5 & 0 & 0 \end{bmatrix}$$

- How do we delete a row or a column of  $A$ ?
- **Exercise: try the expression**

```
>> A(3, :)
```

```
>> A(3, :) = []
```

# Array Concatenation

- Arrays can be formed through concatenation as long as the rectangular shape is preserved

$$\begin{array}{c}
 \mathbf{C} \\
 \left[ \begin{array}{cccc} 2 & 1 & 1 & 1 \\ 3 & 2 & 3 & 4 \\ -2 & 2 & 2 & 2 \end{array} \right] \\
 (3,4)
 \end{array}
 =
 \begin{array}{c}
 \mathbf{A} \\
 \left[ \begin{array}{cc} 2 & 1 \\ 3 & 2 \\ -2 & 2 \end{array} \right] \\
 (3,2)
 \end{array}
 ,
 \begin{array}{c}
 \mathbf{B} \\
 \left[ \begin{array}{cc} 1 & 1 \\ 3 & 4 \\ 2 & 2 \end{array} \right] \\
 (3,2)
 \end{array}$$

- Create matrices A, B, C, and D and concatenate them into F:

$$\mathbf{F} = \begin{array}{c}
 \mathbf{A} \\
 \mathbf{C} \\
 \mathbf{D}
 \end{array}
 \begin{array}{|cc|cc}
 \hline
 1 & 2 & 9 & 9 \\
 3 & 4 & 9 & 9 \\
 \hline
 5 & 6 & 7 & 8 \\
 \hline
 -2 & -1 & 0 & 1 \\
 \hline
 \end{array}
 \mathbf{B}$$

# Array Manipulation

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

- Operators on array:  $+$   $-$   $*$   $/$   $^$   $.$   $'$
- Type the following command and observe the results:

```
>> x1=A+a
```

```
>> y1=A+B
```

```
>> x2=A/a
```

```
>> y2=A*B
```

```
>> x3=A./a
```

```
>> y3=A.*B
```

```
>> x4=A^a
```

```
>> y4=A/B
```

```
>> x5=A.^a
```

```
>> y5=A./B
```

```
>> C=A'
```

# Array Manipulation

Symbol	Operation	Form	Examples
+	Scalar-array addition	$A+b$	$[6,3]+2=[8,5]$
-	Scalar-array subtraction	$A-b$	$[8,3]-5=[3,-2]$
+	Array addition	$A+B$	$[6,5]+[4,8]=[10,13]$
-	Array subtraction	$A-B$	$[6,5]-[4,8]=[2,-3]$
*	Matrix multiplication	$A*B$	$[3,5]*[4,8]'=52$
.*	Array multiplication	$A.*B$	$[3,5].*[4,8]=[12,40]$
./	Array right division	$A./B$	$[2,5]./[4,8]=[2/4,5/8]$
.\	Array left division	$A.\B$	$[2,5].\[4,8]=[4/2,8/5]$
.^	Array exponentiation	$A.^B$	$[3,5].^[2,4]=[3^2,5^4]$

# Some Special Matrix

- `eye (n)` :  $n \times n$  identity matrix
- `zeros (n1, n2)` :  $n1 \times n2$  zero matrix
- `ones (n1, n2)` :  $n1 \times n2$  matrix with every entry as 1
- `diag ()` : diagonal matrix



# Some Matrix Related Functions

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 0 & 5 & 6 \\ 7 & 0 & 9 \end{bmatrix}$$

- Type the following command and observe the results:

```
>> max(A)
```

```
>> sort(A)
```

```
>> max(max(A))
```

```
>> sortrows(A)
```

```
>> min(A)
```

```
>> size(A)
```

```
>> sum(A)
```

```
>> length(A)
```

```
>> mean(A)
```

```
>> find(A)
```

# End of Class

