APPLICATIONS OF MATLAB IN ENGINEERING

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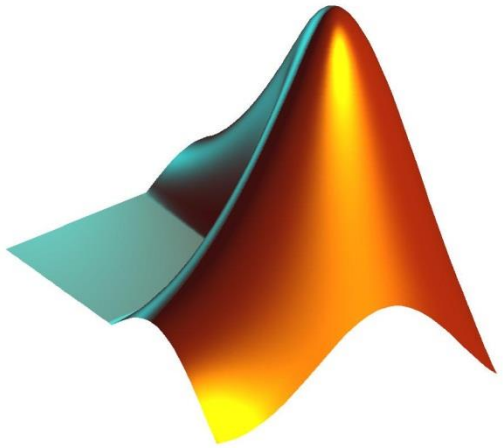
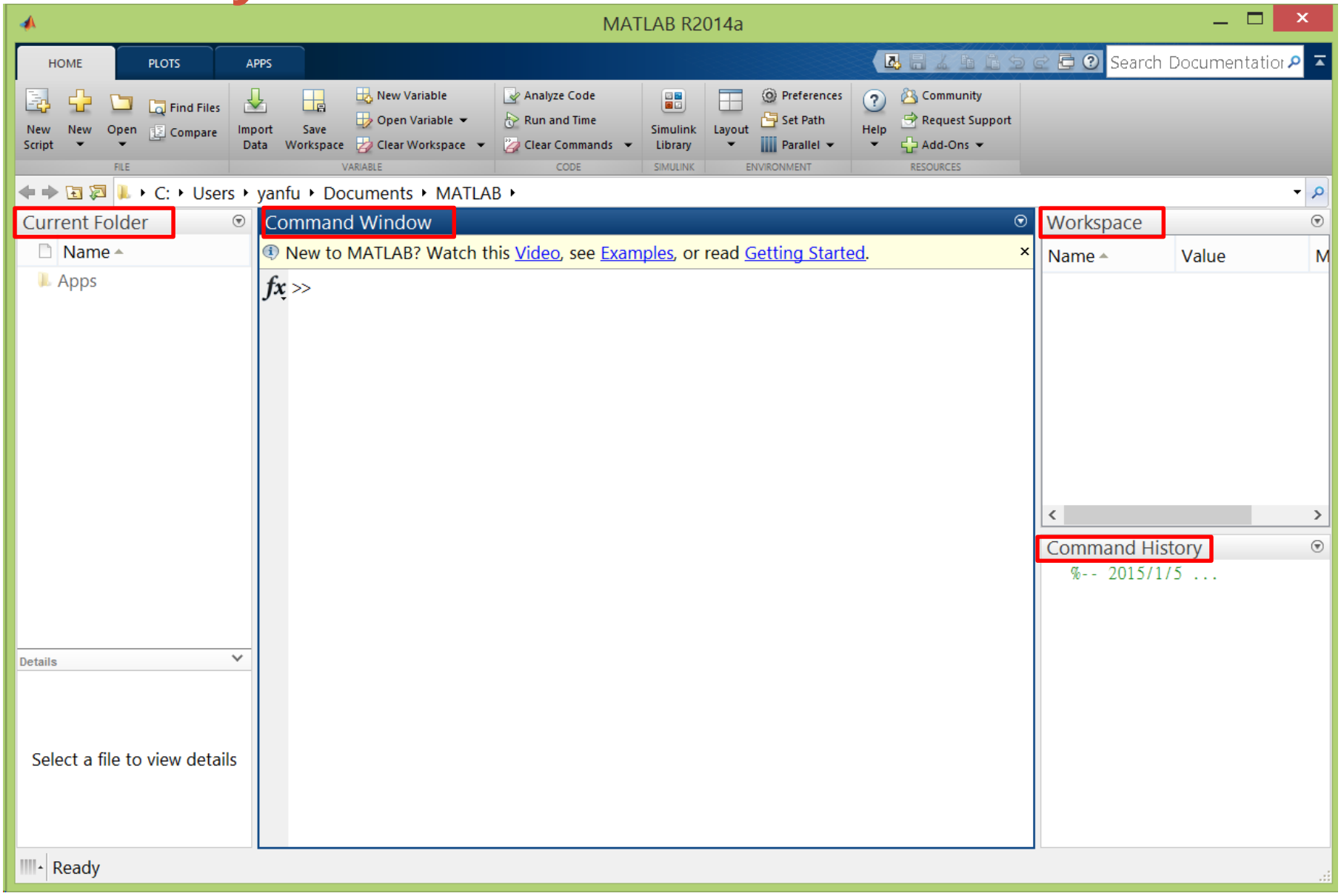
Today:

- 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

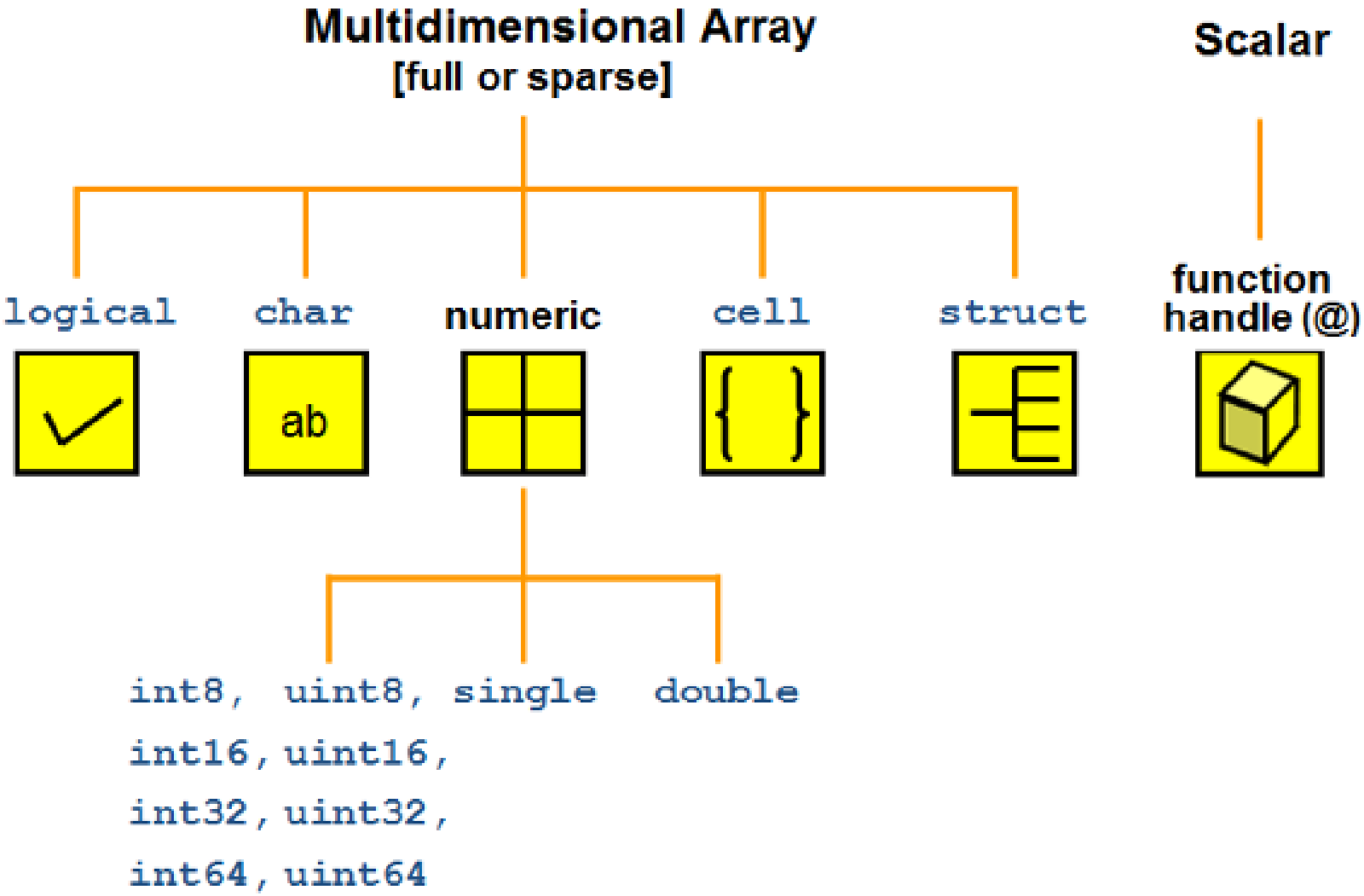
- Variables do NOT need to be declared before assignment
- A single “equal” sign (=) is the assignment operator:

```
>> 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`: ∞
- `eps`: 2.2204e-016
- `NaN`: not a number
- `pi`: π

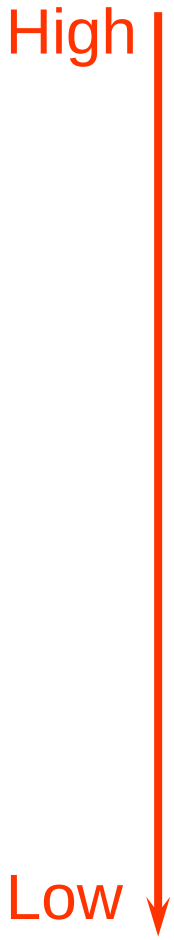
- To list keywords:

```
>> iskeyword
```

- What's the answer from MATLAB after typing?

```
>> x = 1/0
>> x = log(0)
>> x = inf/inf
```

MATLAB Calling Priority



Variable

Built-in function

Subfunction

Private function:

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

```
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 fordouble 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 fordouble values, and 7 digits after the decimal point for single values.	3.141592653589793 e+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	a. 0.84981384981682
2. 233/273	b. 0.84981484981683
3. 131/275	c. 0.84981584981684
4. 132/2730	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:

`j:k`	⇒	`[j, j+1, j+2,..., j+m]`
`j:i:k`	⇒	`[j, j+i, j+2i, ..., j+m*i]`

- 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

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

$$\begin{bmatrix} 1 & 0 & 0 \\ 5 & 0 & 0 \end{bmatrix}$$

- 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

$$\underset{(3,4)}{\mathbf{C}} = \underset{(3,2)}{\mathbf{A}}, \underset{(3,2)}{\mathbf{B}}$$

$$\begin{bmatrix} 2 & 1 & 1 & 1 \\ 3 & 2 & 3 & 4 \\ -2 & 2 & 2 & 2 \end{bmatrix} = \begin{bmatrix} 2 & 1 \\ 3 & 2 \\ -2 & 2 \end{bmatrix}, \begin{bmatrix} 1 & 1 \\ 3 & 4 \\ 2 & 2 \end{bmatrix}$$

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

F =

A	1	2	9	9	B
	3	4	9	9	
C	5	6	7	8	
D	-2	-1	0	1	

Array Manipulation

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

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

```
>> x1=A+a
>> x2=A/a
>> x3=A./a
>> x4=A^a
>> x5=A.^a
>> C=A'
```

```
>> y1=A+B
>> y2=A*B
>> y3=A.*B
>> y4=A/B
>> y5=A./B
```

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×n identity matrix
- `zeros(n1,n2)`: n1×n2 zero matrix
- `ones(n1,n2)`: n1×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)
>> max(max((A))
>> min(A)
>> sum(A)
>> mean(A)
>> sort(A)
>> sortrows(A)
>> size(A)
>> length(A)
>> find(A)
```

End of Class