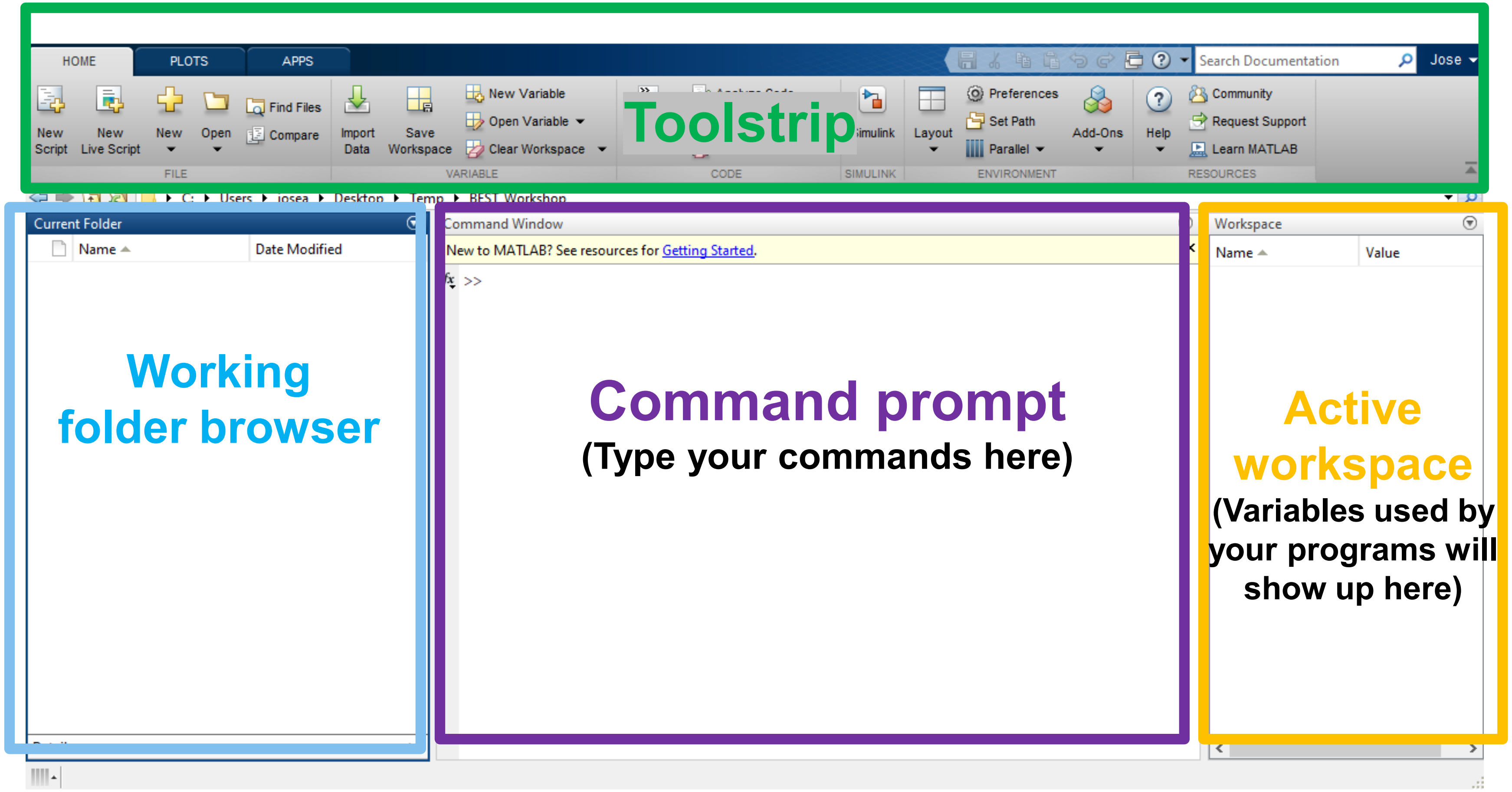
Introduction to Mobile Robotics with MATLAB and Simulink
Unit 1: Intro to MATLAB

By MathWorks Student Competition team

MATLAB Interface

- Once you open MATLAB you will see the interface on the right. Here is the breakdown if what you will find:



New to MATLAB? See resources for Getting Started.

```
>>
```

Toolstrip

Working folder browser

Command prompt

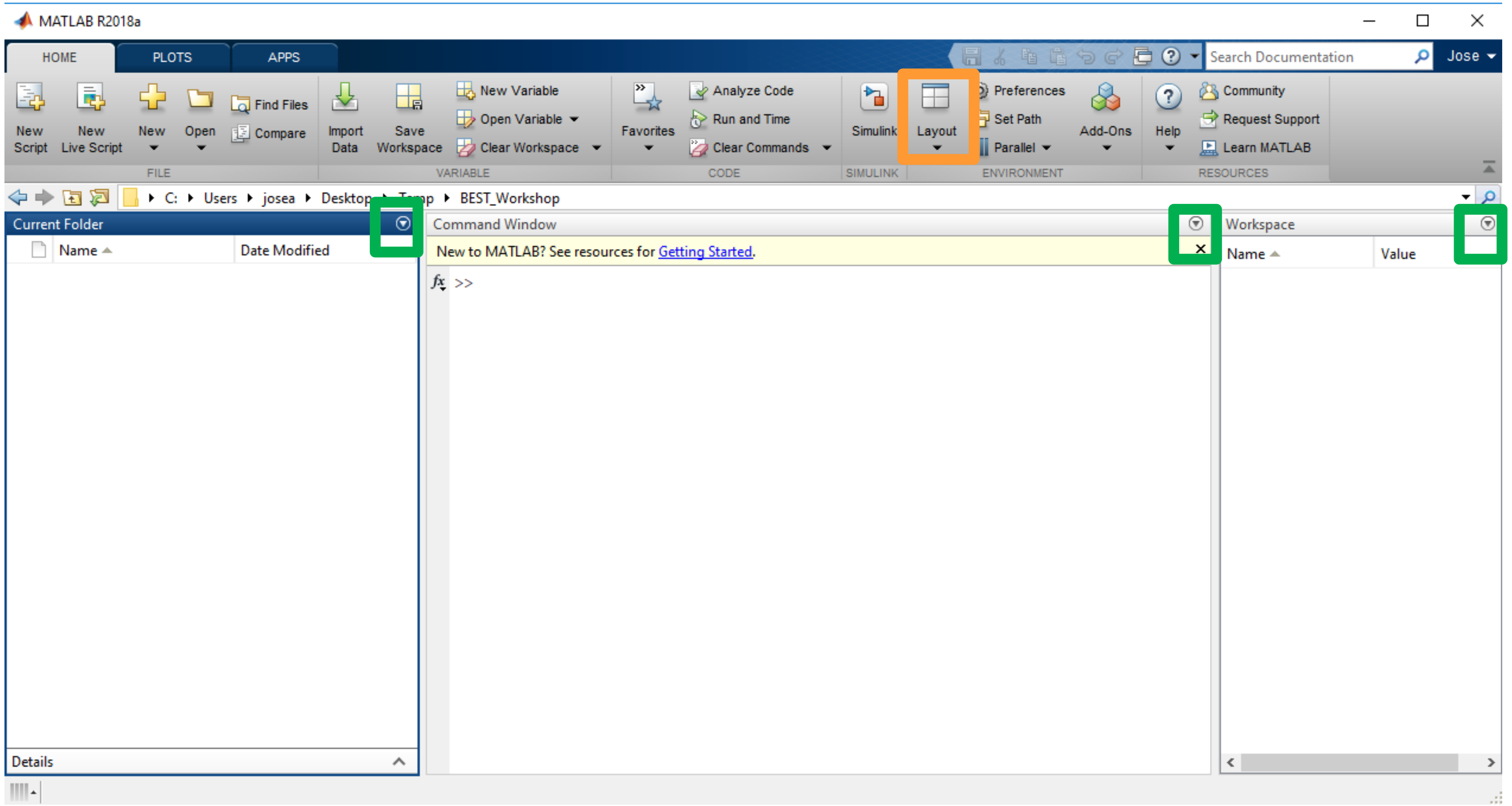
(Type your commands here)

Active workspace

(Variables used by your programs will show up here)

MATLAB Interface

- You can customize the way your interface looks by docking and undocking components, dragging windows or using default layouts. Use the docking arrows (in green below) or the layout button on the toolstrip (in red)



New to MATLAB? See resources for Getting Started.

```
fx >>
```

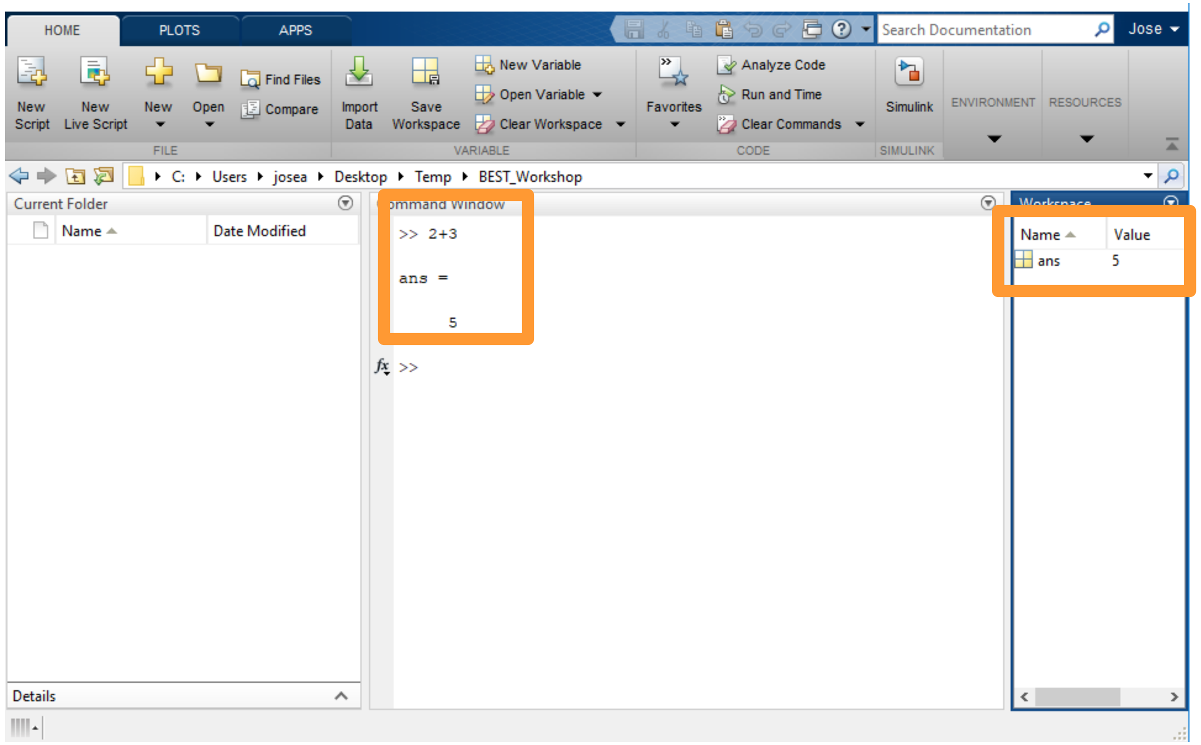
Running commands

- Type the command you want to execute in the command line and press Enter in the keyboard.

- Try adding 2+3

  >>2+3

- A variable is created to store the answer “ans” and the value is 5.



```
>> 2+3

ans =

     5

>>
```

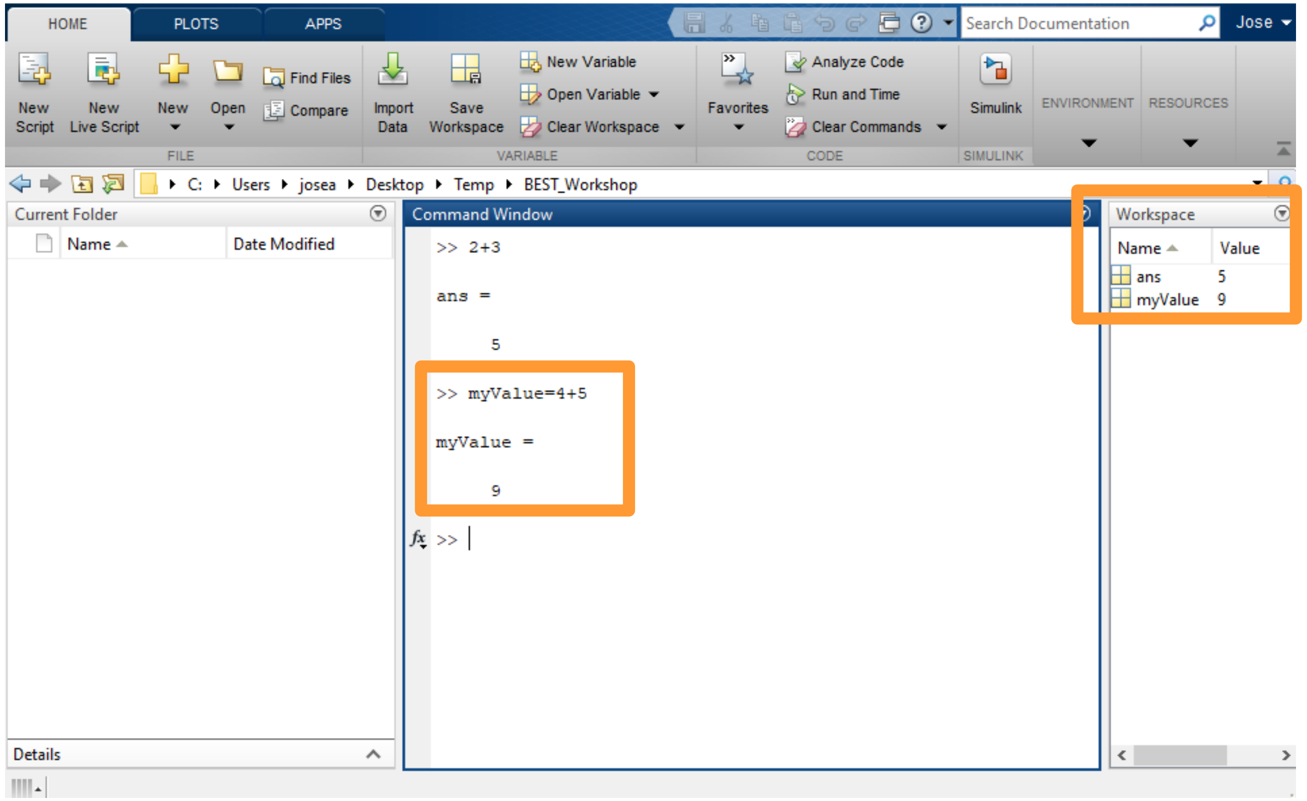
Name	Value
ans	5

Creating variables

- Assign the result of a math operation to a variable named “myValue”

- `>>myValue=4+5`

- The variable that has been assigned is no present in the workspace explorer window.



```
>> 2+3

ans =

     5

>> myValue=4+5

myValue =

     9

>> 
```

Name	Value
ans	5
myValue	9

Suppressing the output of a command

- The command window starts getting crowded with previous commands and answers.

- Place a semicolon “;” after each command to suppress its output.

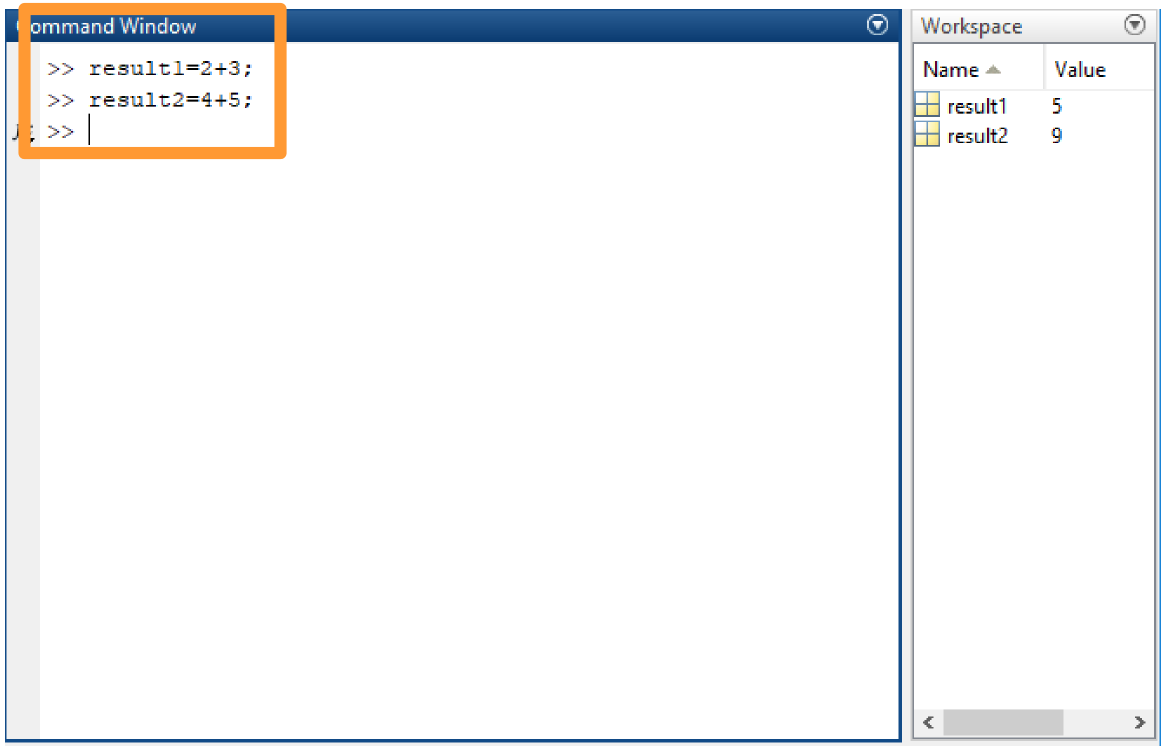
1. Clear the workspace (delete all variables in memory)

   >>clear

2. Then clean your command window

   >>clc

3. Perform some math calculations and assign the result to variables as shown in the picture.



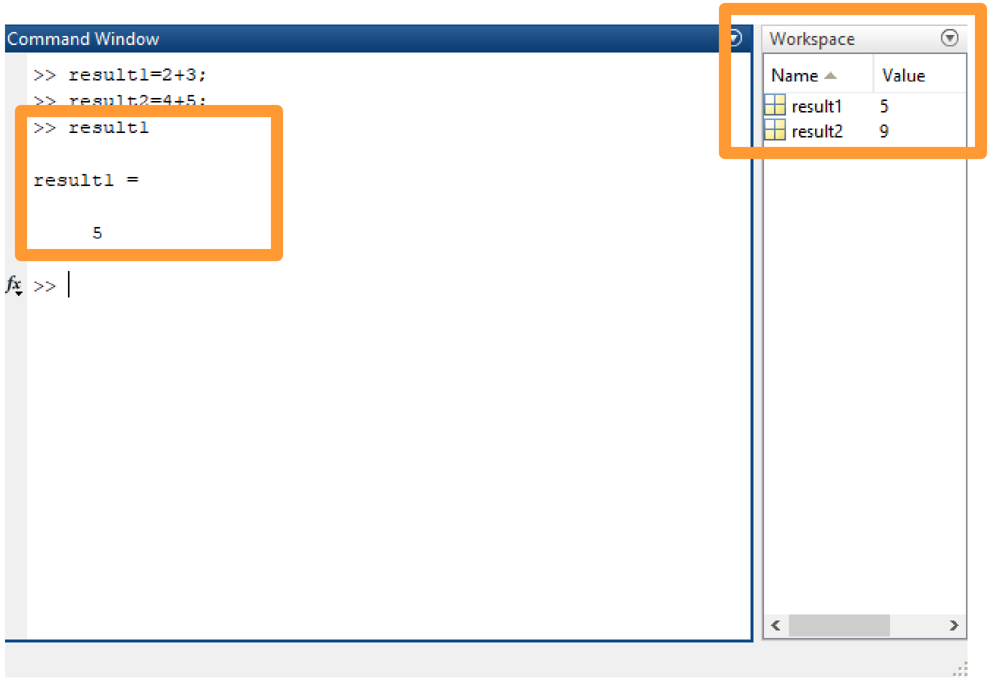
```
>> result1=2+3;
>> result2=4+5;
>> 
```

Name	Value
result1	5
result2	9

Suppressing the output of a command

- The output of commands is stored in the variables names, the values of variables can be checked using the workspace explorer window.

- To output the value of a variable, type the variable name in the command line without a semicolon.

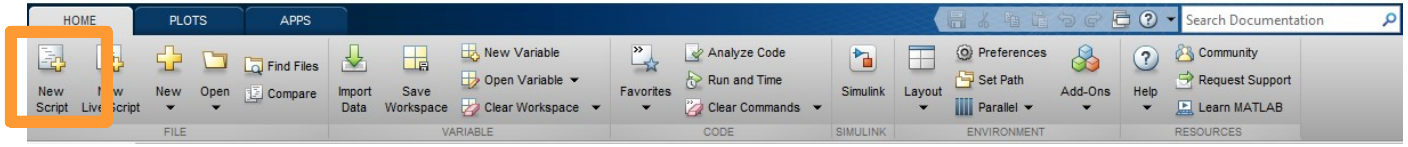


```
>> result1=2+3;
>> result2=4+5;
>> result1

result1 =

     5

>> |
```

Name	Value
result1	5
result2	9

Creating a MATLAB Script

- Scripts are MATLAB files that contain a program
- Scripts contain multiple commands and are saved with a “.m” extension
- Click the “New Script” button in the toolstrip to open the MATLAB Editor



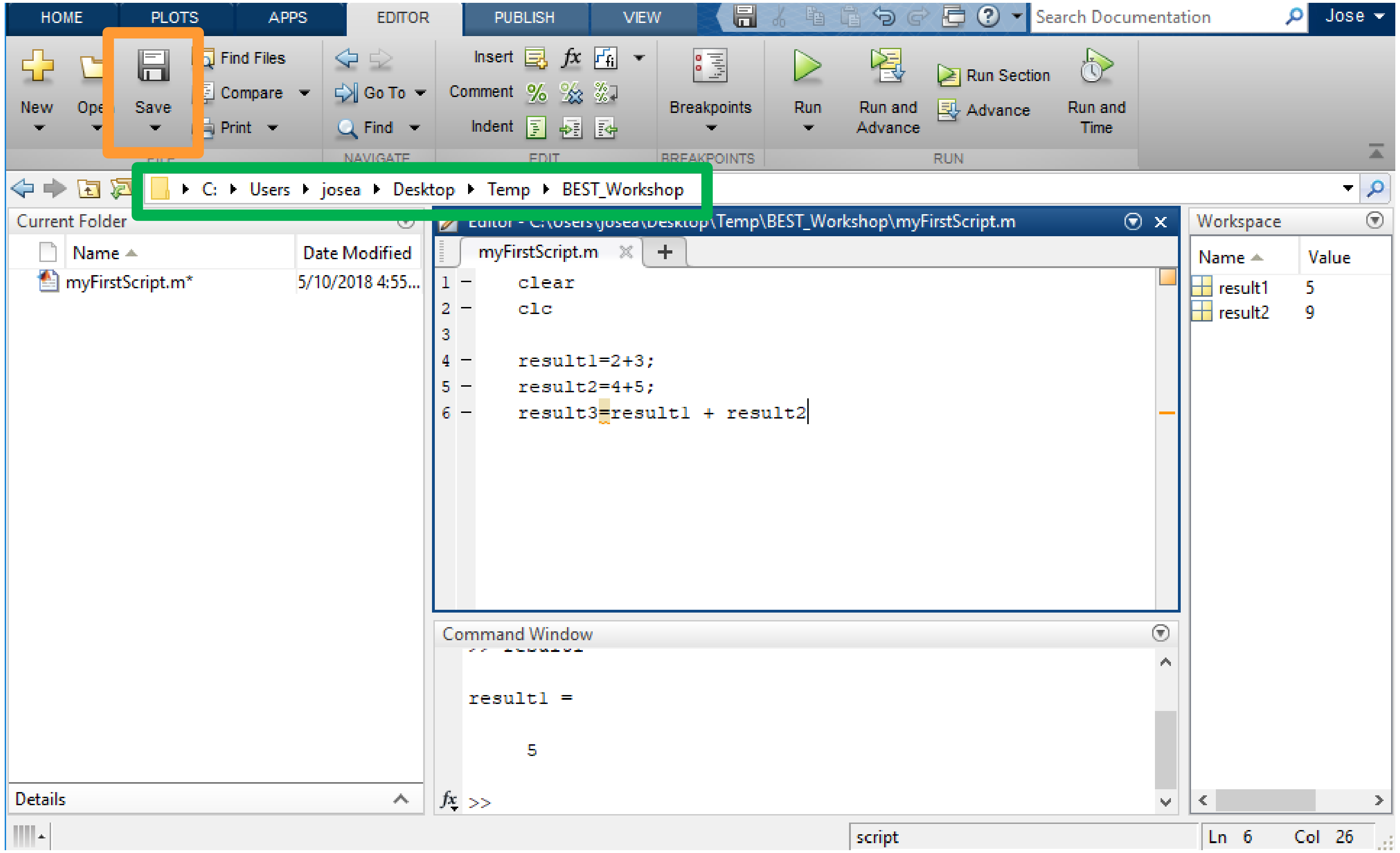
Saving a MATLAB Script

- Type commands in the order you want them to be executed.

1. Type the code below and then press the save button in the toolstrip.

```
clear
clc
result1=2+3;
result2=4+5;
result3=result1 + result2
```

2. Save the script in the same folder you are currently working in MATLAB



C: ▸ Users ▸ josea ▸ Desktop ▸ Temp ▸ BEST_Workshop

Editor - C:\Users\josea\Desktop\Temp\BEST_Workshop\myFirstScript.m

Name	Date Modified
myFirstScript.m*	5/10/2018 4:55...

myFirstScript.m

```
clear
clc

result1=2+3;
result2=4+5;
result3=result1 + result2
```

```
result1 =

     5

>>
```

Name	Value
result1	5
result2	9

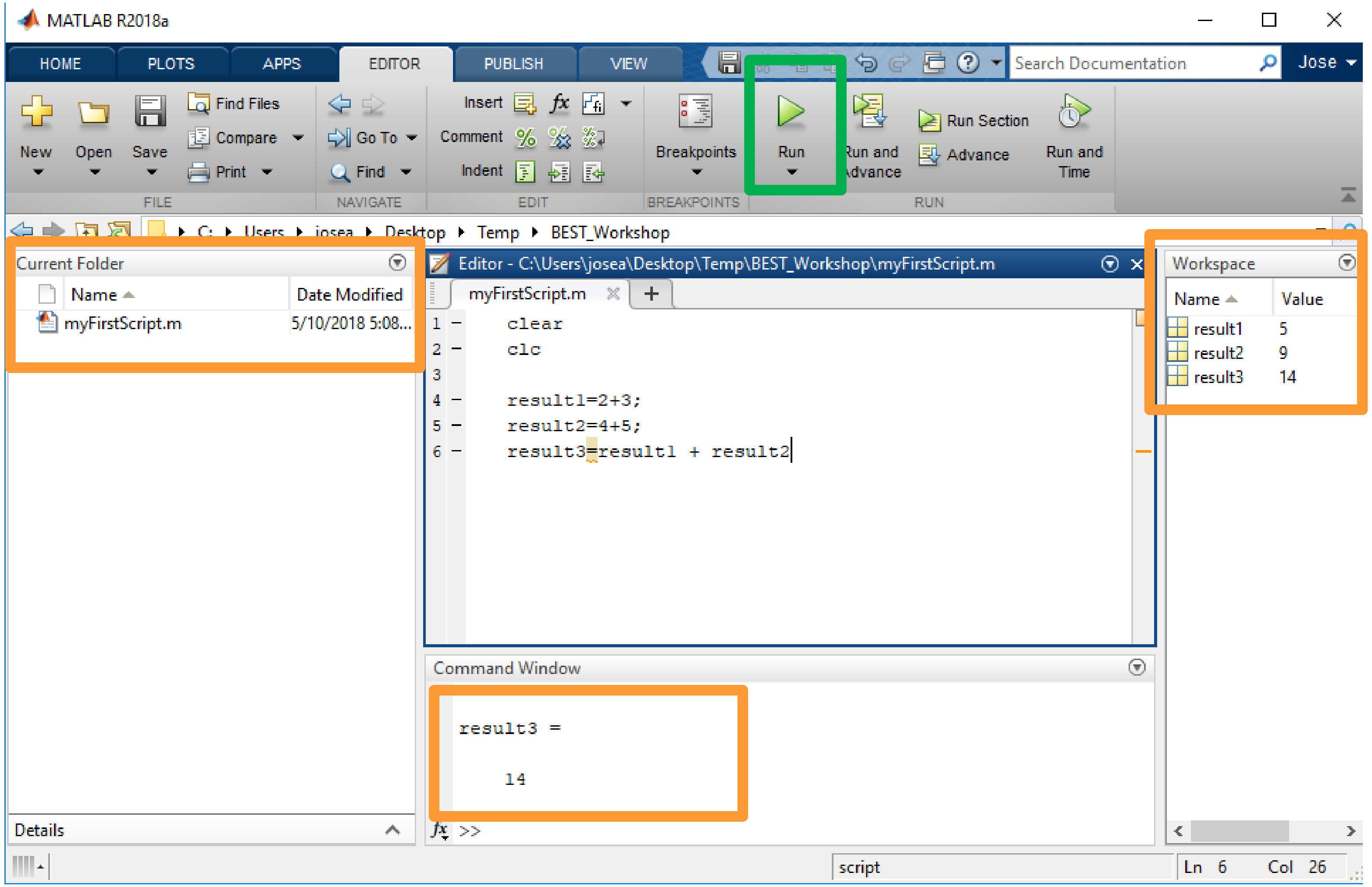
script   Ln 6   Col 26

Running a MATLAB Script

1. Make certain the script file should is in the working directory.
2. Click the “Play” button on the editor toolstrip to run MATLAB scripts.
3. Check the workspace for variables used

- Commands that don’t have suppressed output like “result3” will be shown in the command line

- Congrats ! You ran your first MATLAB script ☺



Name	Date Modified
myFirstScript.m	5/10/2018 5:08...

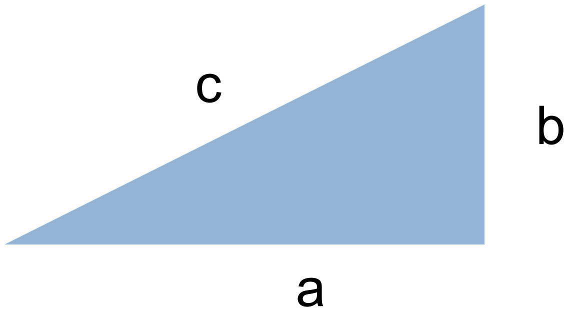
```
clear
clc

result1=2+3;
result2=4+5;
result3=result1 + result2
```

```
result3 =

    14
```

Name	Value
result1	5
result2	9
result3	14

Solving a Simple Problem

- Lets now try to solve a simple problem by writing a MATLAB script.
- Consider calculating the length of the hypotenuse of a right triangle using the equation below.



$$a^2 + b^2 = c^2$$

$$\downarrow$$

$$c = \sqrt{a^2 + b^2}$$

Solving a Simple Problem

- Write a script that calculates the value of “*c*” when a=12 and b=17

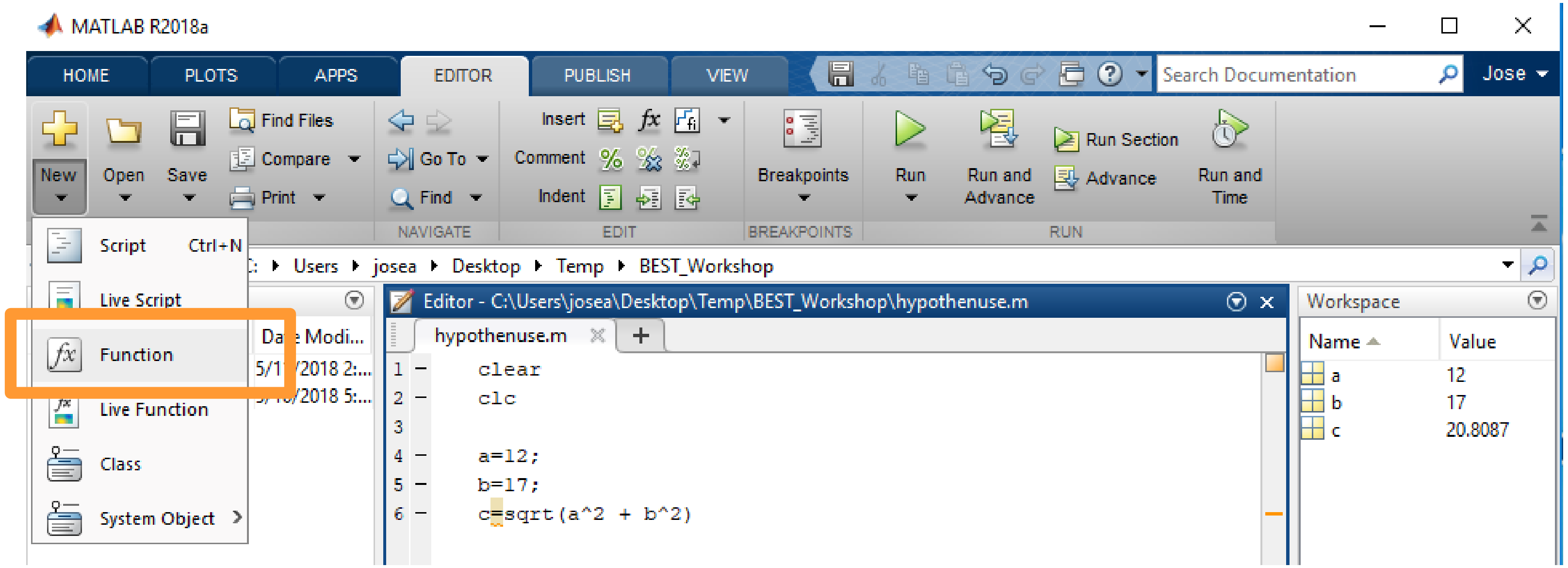
1. Place the following code in a MATLAB script

```
a=12;
b=17;
c=sqrt(a^2 + b^2)
```

2. Run the script
3. Check that the calculated value of c is 20.8087

Creating MATLAB Functions

- Functions help execute previously written with one command.
- The difference between MATLAB Functions and scripts, is that functions take inputs variables and return output variables to the program calling it.
- Press on the “New” button dropdown on the editor toolstrip and select “Function”



```
clear
clc

a=12;
b=17;
c=sqrt(a^2 + b^2)
```

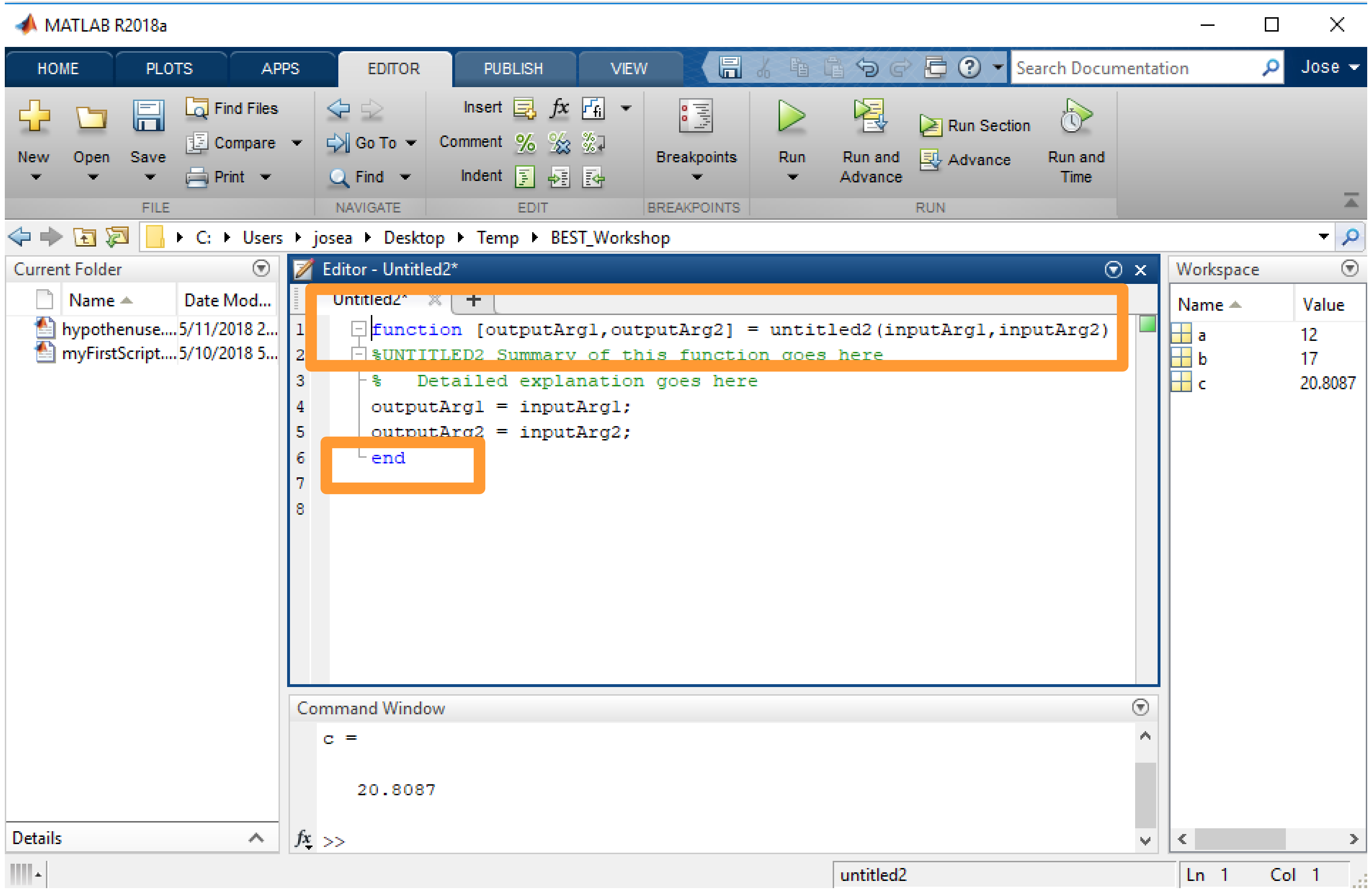
Name	Value
a	12
b	17
c	20.8087

Creating MATLAB Functions

- In the case of a default new function file the inputs and outputs are labeled “InputArg” or “OutputArg”

- Change these names to make them more descriptive for calculating the hypotenuse

- The ending of a function has to be specified with the word “end”.



Name	Date Mod...
hypothenuse....	5/11/2018 2...
myFirstScript....	5/10/2018 5...

```
function [outputArg1,outputArg2] = untitled2(inputArg1,inputArg2)
%UNTITLED2 Summary of this function goes here
%   Detailed explanation goes here
outputArg1 = inputArg1;
outputArg2 = inputArg2;
end
```

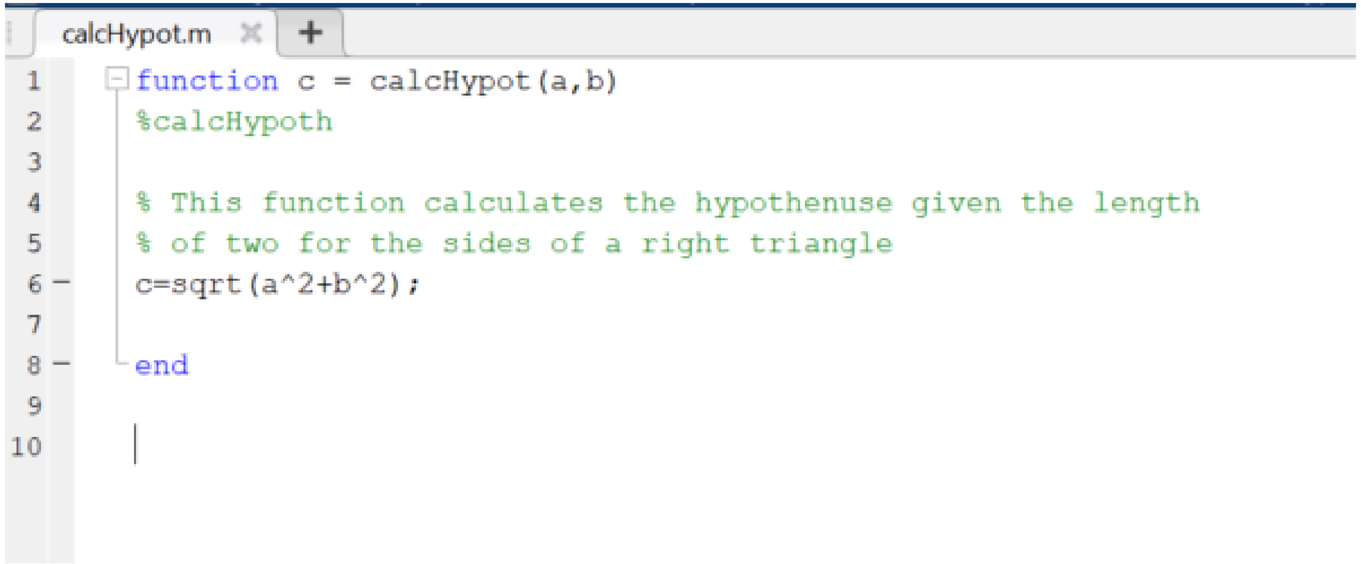
```
c =

   20.8087

>>
```

Name	Value
a	12
b	17
c	20.8087

Creating MATLAB Functions

- Create a MATLAB function that calculates the hypotenuse

1. Use a, b, and c as variable names and call your function “calcHypot”
2. Implement the same equation used on the previous exercise.
3. Save your file with the same name you gave your function.



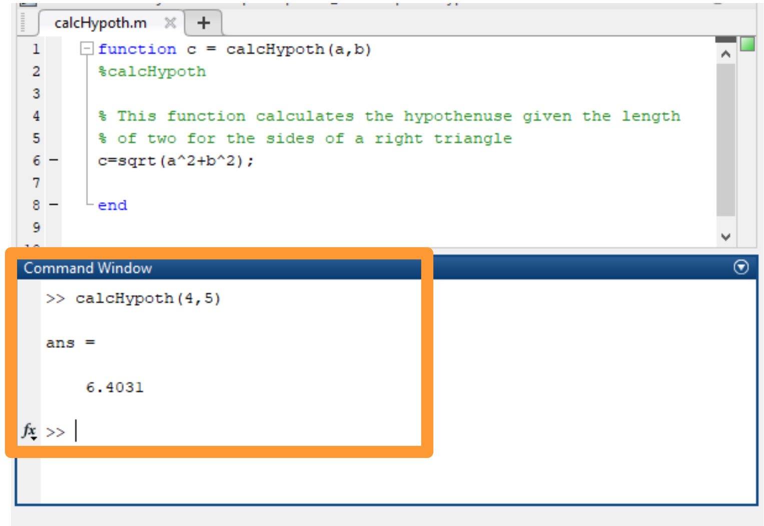
```
function c = calcHypot(a,b)
%calcHypoth

% This function calculates the hypothenuse given the length
% of two for the sides of a right triangle
c=sqrt(a^2+b^2);

end
```

Calling MATLAB Functions

- Use the MATLAB function created in MATLAB scripts or in the command line
- Execute the following in the command line:

```
>>calcHypoth(4,5)
```

- Congrats! You just created and ran your first MATLAB function ☺

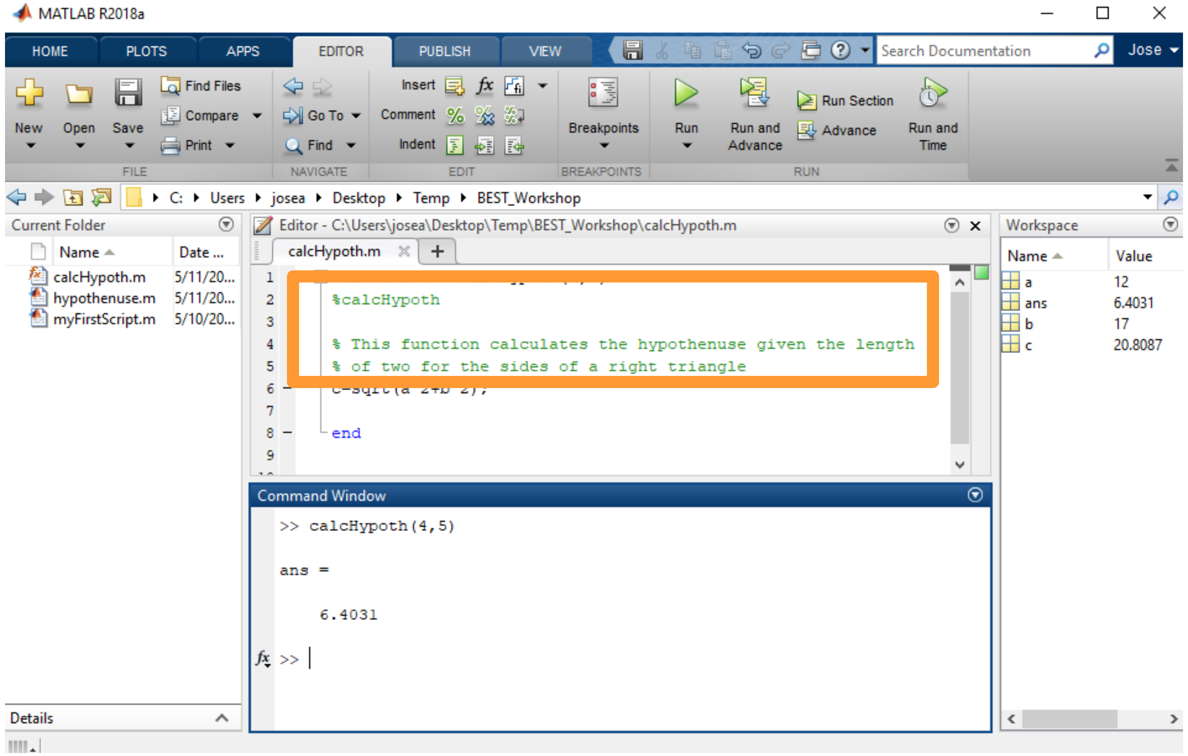


```
function c = calcHypoth(a,b)
%calcHypoth

% This function calculates the hypothenuse given the length
% of two for the sides of a right triangle
c=sqrt(a^2+b^2);

end
```

```
>> calcHypoth(4,5)

ans =

    6.4031

>> 
```

Commenting on your code

- Use the percent symbol “%” to add a comment. Any characters to the right of this symbol on a single line will not be executed when the script or function is run.



Name	Date ...
calcHypoth.m	5/11/20...
hypothenuse.m	5/11/20...
myFirstScript.m	5/10/20...

Editor - C:\Users\josea\Desktop\Temp\BEST_Workshop\calcHypoth.m

calcHypoth.m

```
%calcHypoth

% This function calculates the hypothenuse given the length
% of two for the sides of a right triangle
c=sqrt(a^2+b^2);

end
```

Command Window

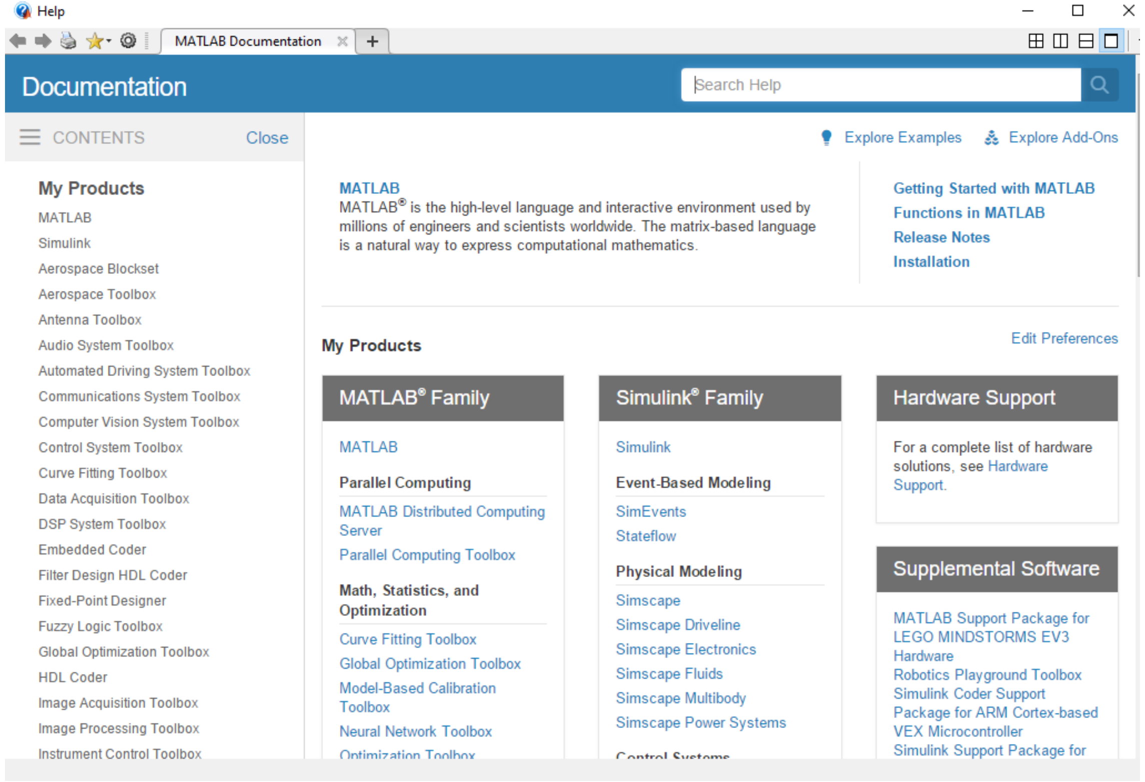
```
>> calcHypoth(4,5)

ans =

    6.4031

>> 
```

Name	Value
a	12
ans	6.4031
b	17
c	20.8087

Getting help with MATLAB - Documentation

- Documentation:
  - Open the MATLAB documentation and search for any functionality you would like to find functions and tools that will help you accomplish your tasks.

```
>> doc
```



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MATLAB

MATLAB® is the high-level language and interactive environment used by millions of engineers and scientists worldwide. The matrix-based language is a natural way to express computational mathematics.

Getting Started with MATLAB
Functions in MATLAB
Release Notes
Installation

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Optimization Toolbox

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SimEvents
Stateflow

Physical Modeling

Simscape
Simscape Driveline
Simscape Electronics
Simscape Fluids
Simscape Multibody
Simscape Power Systems

Control Systems

Hardware Support

For a complete list of hardware solutions, see Hardware Support.

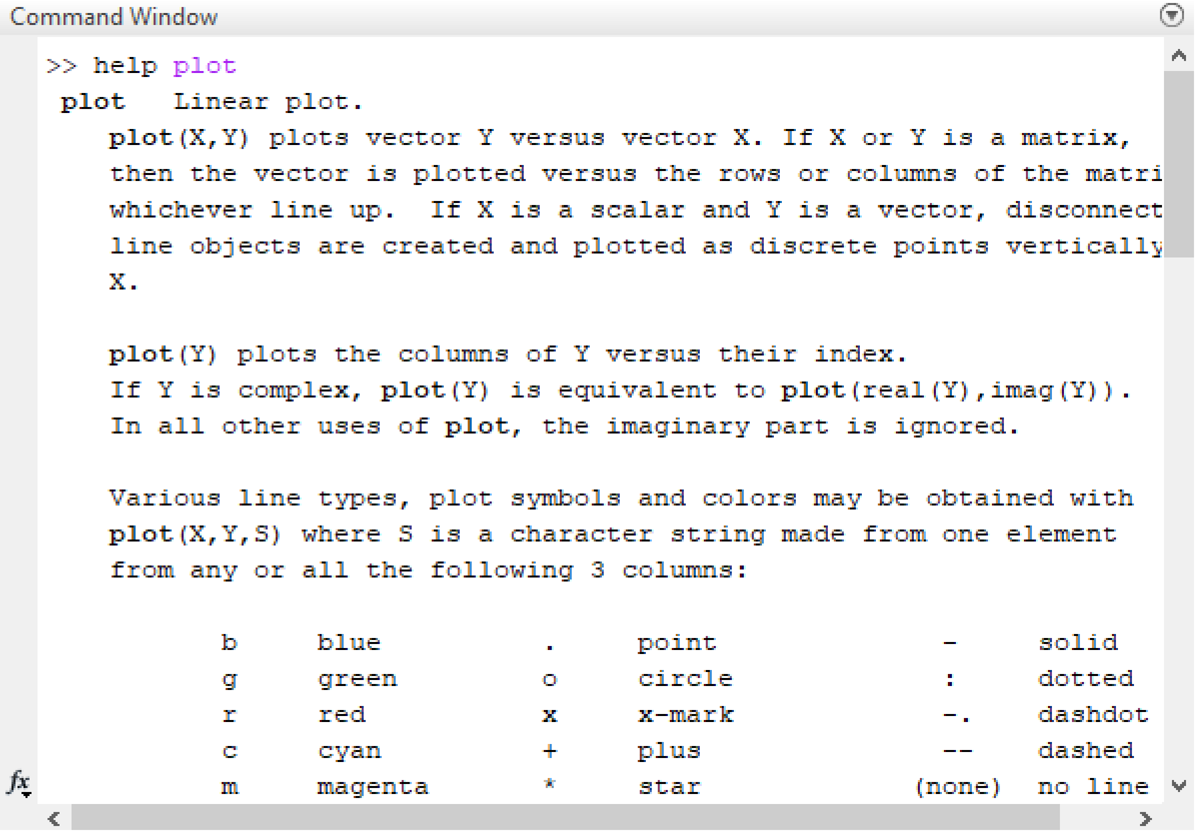
Supplemental Software

MATLAB Support Package for LEGO MINDSTORMS EV3 Hardware
Robotics Playground Toolbox
Simulink Coder Support Package for ARM Cortex-based VEX Microcontroller
Simulink Support Package for

Getting help with MATLAB – Function help

- For any function that you are intending to use or that might be throwing an error type the word “help” followed by the function name.
- For example:

  >>help plot



```
>> help plot
 plot   Linear plot.
    plot(X,Y) plots vector Y versus vector X. If X or Y is a matrix,
    then the vector is plotted versus the rows or columns of the matri
    whichever line up.  If X is a scalar and Y is a vector, disconnect
    line objects are created and plotted as discrete points vertically
    X.

    plot(Y) plots the columns of Y versus their index.
    If Y is complex, plot(Y) is equivalent to plot(real(Y),imag(Y)).
    In all other uses of plot, the imaginary part is ignored.

    Various line types, plot symbols and colors may be obtained with
    plot(X,Y,S) where S is a character string made from one element
    from any or all the following 3 columns:

           b     blue          .     point              -     solid
           g     green         o     circle             :     dotted
           r     red           x     x-mark             -.    dashdot
           c     cyan          +     plus               --    dashed
           m     magenta       *     star             (none)  no line
```

End of Unit 1: Intro to MATLAB

- Congrats !

- Now you have a good idea how to create MATLAB programs, now lets program some robots ☺