22-Functions Part 1

text: Chapter 7.1-7.5

ECEGR 101

Engineering Problem Solving with Matlab

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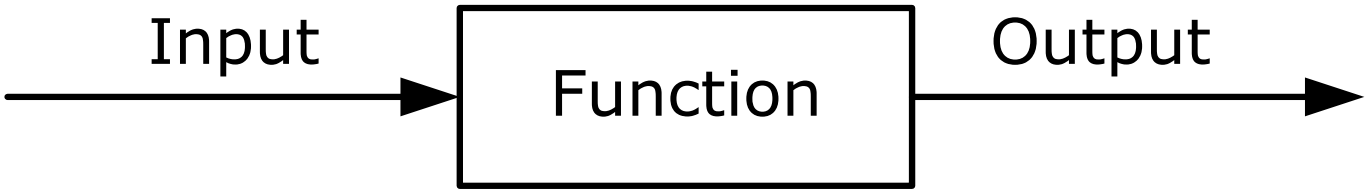
Overview

- Function Syntax
- Help Line
- Saving Functions
- Using Functions

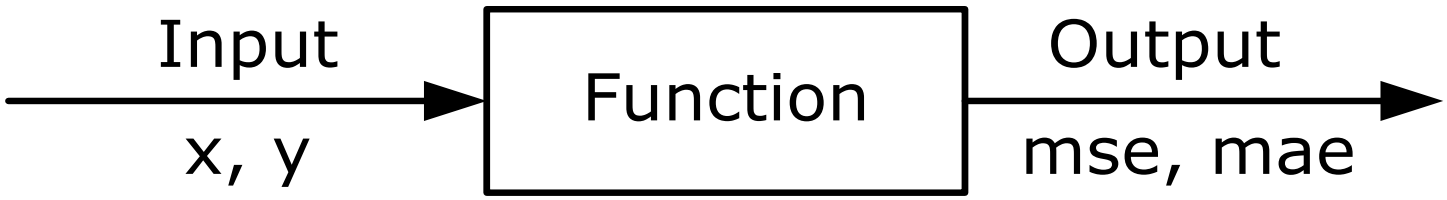
Functions

- Function
  - A special type of m-file that runs in its own independent workspace.
  - It receives input data through a input argument list and returns results to the caller through an output argument list.
- Compare to built-in MATLAB functions (sin(x), log(x), mean(x)).



Function Example

Calculate the mean squared error (MSE) and the maximum absolute error (MAE) between two input vectors.



Function Example (cont.)

MSE is defined as

$$MSE(x,y) = \frac{\sum_{k=1}^{N} (x_k - y_k)^2}{N}$$

where N is the length of the vectors (they have to be of the same length)

MAE is defined as

$$MAE(x,y) = \max_k \left| (x_k - y_k) \right|$$

Function Example (cont.)

- We can calculate the MSE and MAE of two given vectors on the command line

  or we can write a function that will calculate MSE and MAE for any two vectors…

```
Command Window

>>
>> x = [1 5 7 9 11 0 3 4 6 8];
>> y = [0 6 8 9 10 1 1 5 8 8];
>> mse = mean((x-y).^2)
mse =
   1.4000
>> mae = max(abs(x-y))
mae =
    2
>>
```

C:\Users\agnieszka\Documents\ECEGR 101\LECTURES\CHAPTER 6\calculate_MSE_MAE.m

File Edit Text Go Cell Tools Debug Desktop Window Help

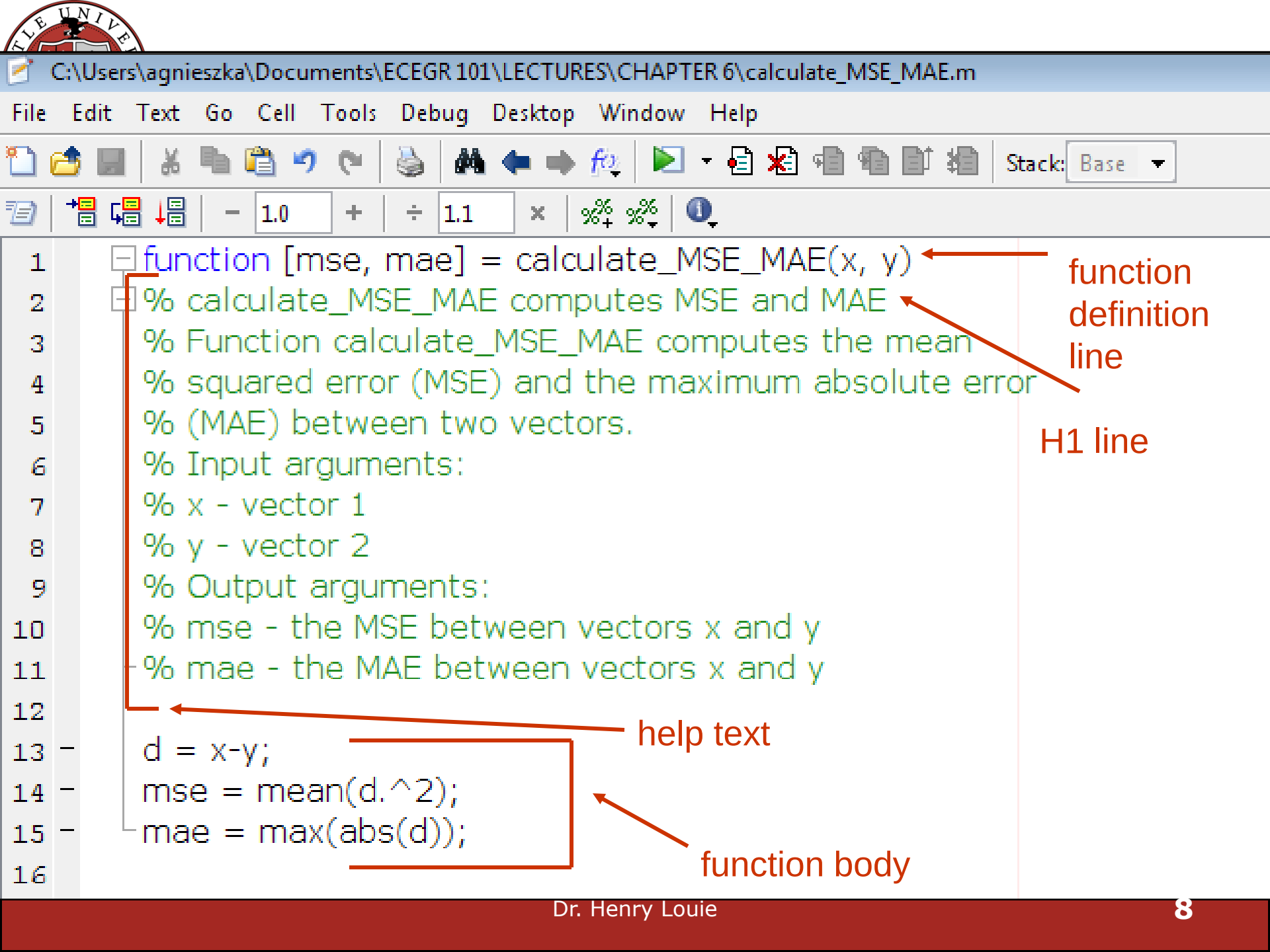
Stack: Base

1.0 1.1

```
1  function [mse, mae] = calculate_MSE_MAE(x, y)
2  % calculate_MSE_MAE computes MSE and MAE
3  % Function calculate_MSE_MAE computes the mean
4  % squared error (MSE) and the maximum absolute error
5  % (MAE) between two vectors.
6  % Input arguments:
7  % x - vector 1
8  % y - vector 2
9  % Output arguments:
10 % mse - the MSE between vectors x and y
11 % mae - the MAE between vectors x and y
12
13 d = x-y;
14 mse = mean(d.^2);
15 mae = max(abs(d));
16
```

$$MSE(x,y) = \frac{\sum_{k=1}^{N} (x_k - y_k)^2}{N}$$

$$MAE(x,y) = \max_k |(x_k - y_k)|$$


C:\Users\agnieszka\Documents\ECEGR 101\LECTURES\CHAPTER 6\calculate_MSE_MAE.m
File Edit Text Go Cell Tools Debug Desktop Window Help
Stack: Base
1.0
1.1
1 function [mse, mae] = calculate_MSE_MAE(x, y)
2 % calculate_MSE_MAE computes MSE and MAE
3 % Function calculate_MSE_MAE computes the mean
4 % squared error (MSE) and the maximum absolute error
5 % (MAE) between two vectors.
6 % Input arguments:
7 % x - vector 1
8 % y - vector 2
9 % Output arguments:
10 % mse - the MSE between vectors x and y
11 % mae - the MAE between vectors x and y
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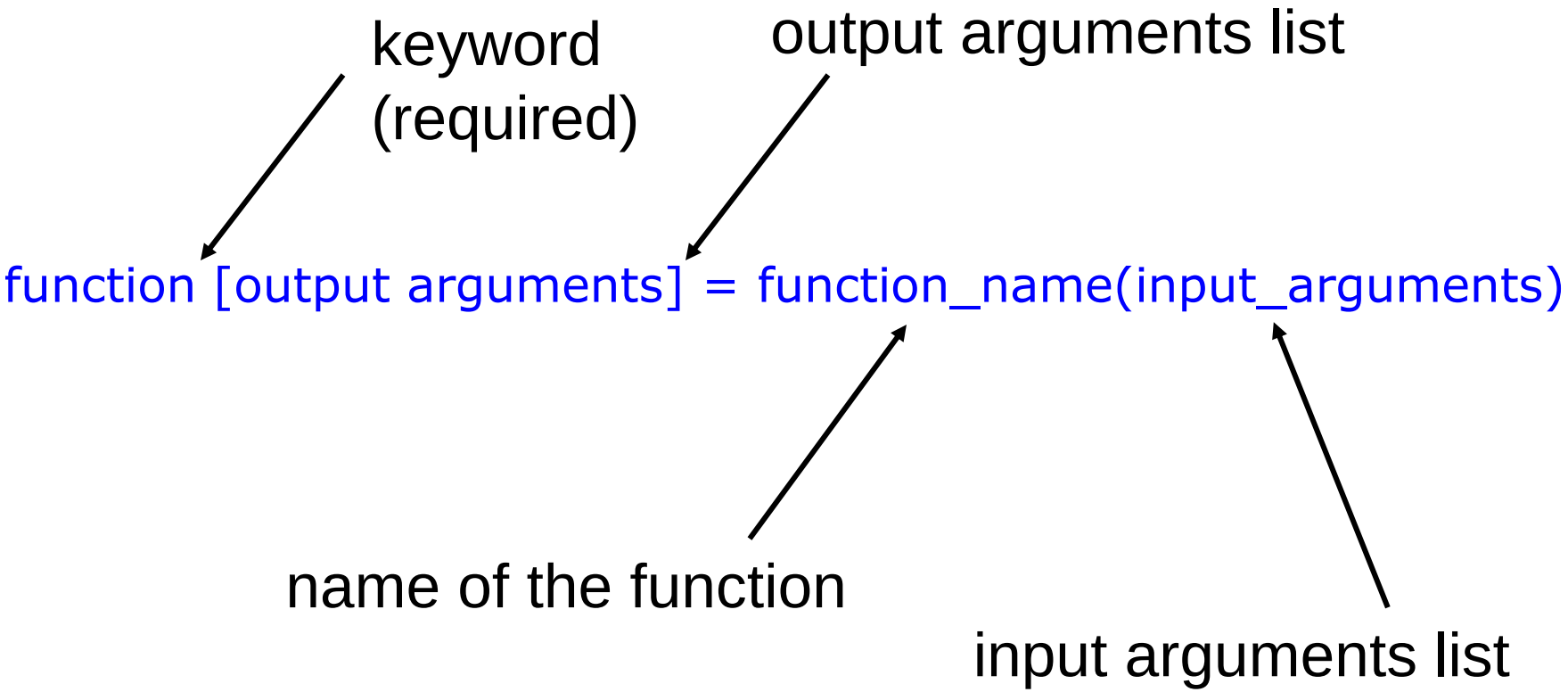
13 d = x-y;
14 mse = mean(d.^2);
15 mae = max(abs(d));
16
function definition line
H1 line
help text
function body

Function Definition Line



Exercise

Is this a correct function definition line?

Function [a] = area(w, h)

function [output arguments] = function_name(input_arguments)

Exercise

Is this a correct function definition line?

Function [a] = area(w, h)

Answer: no.

The keyword has to be typed in all small letters.

Exercise

Is this a correct function definition line?

function out = sqr_abs(x)

function [output arguments] = function_name(input_arguments)

Exercise

Is this a correct function definition line?

```
function out = sqr_abs(x)
```

Answer: yes.

If there is only one output variable, no square parenthesis are needed.

Exercise

Is this a correct function definition line?

function y = sumSquaredElements([1 2 3])

function [output arguments] = function_name(input_arguments)

Exercise

Is this a correct function definition line?

```
function y = sumSquaredElements([1 2 3])
```

Answer: no.

The list of input arguments must contain variables not values.

Exercise

Is this a correct function definition line?

function x = randomInt()

function [output arguments] = function_name(input_arguments)

Exercise

Is this a correct function definition line?

```
function x = randomInt()
```

Answer: yes.

Function may not have any input variables.

Exercise

Is this a correct function definition line?

function plotResults(x1, x2)

function [output arguments] = function_name(input_arguments)

Exercise

Is this a correct function definition line?

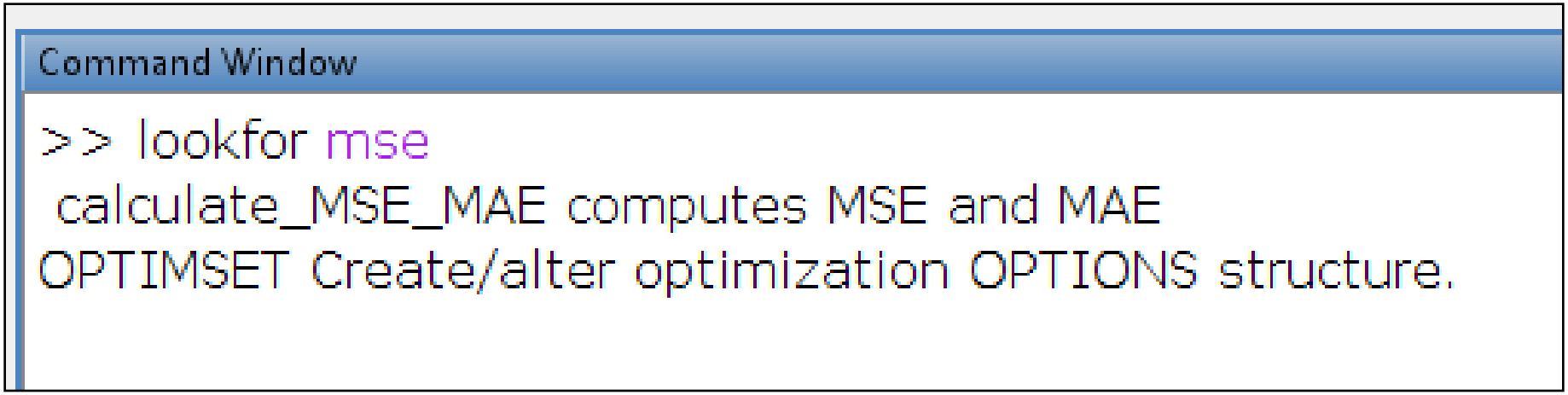
```
function plotResults(x1, x2)
```

Answer: yes.

Functions do not need to have any output variables.

The H1 Line

- First comment line
- Used by the lookfor command in MATLAB:



The Help Text

- Comment lines starting just after the H1 line and ending with an empty line.
- Explain the function and its input and output variables.
- Displayed when help function_name is typed.

Command Window

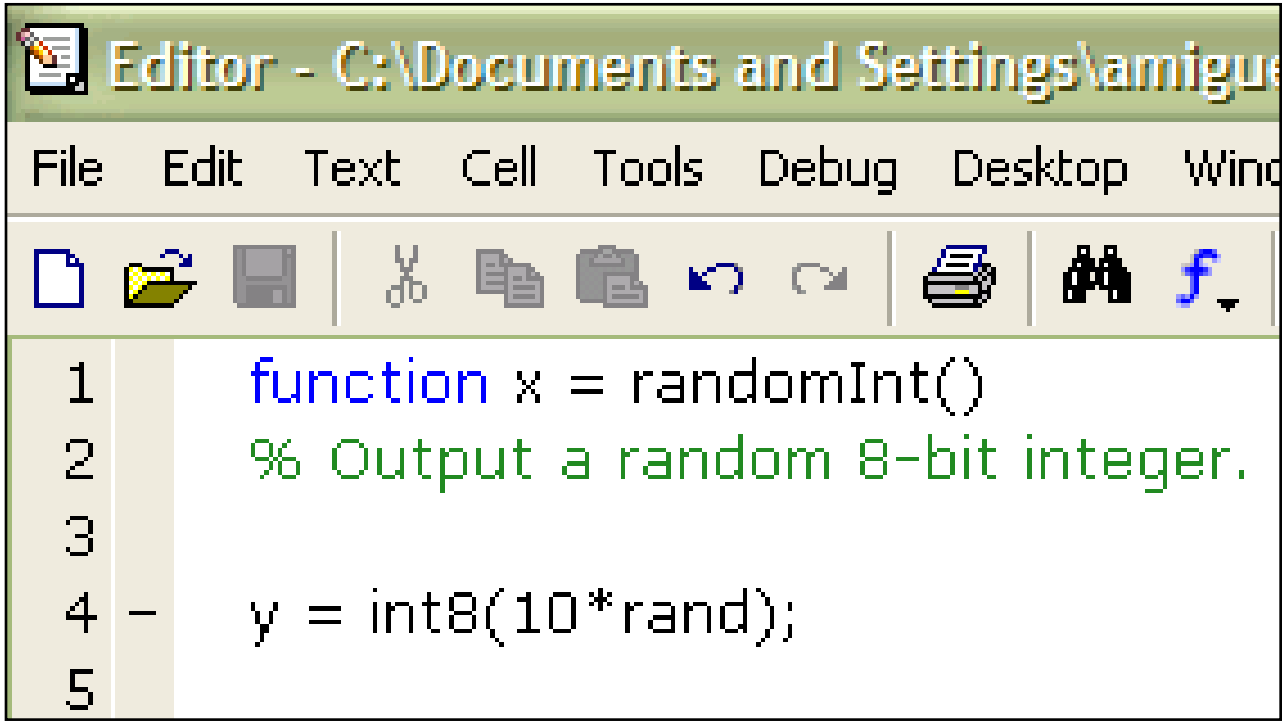
```
>> help calculate_MSE_MAE
  calculate_MSE_MAE computes MSE and MAE
  Function calculate_MSE_MAE computes the mean
  squared error (MSE) and the maximum absolute error
  (MAE) between two vectors.
  Input arguments:
  x - vector 1
  y - vector 2
  Output arguments:
  mse - the MSE between vectors x and y
  mae - the MAE between vectors x and y
```

Function Body

- Contains computer program (MATLAB commands) that performs the calculations (or plots something, saves values to a file, etc)
- The commands in the function body have to assign values to the output arguments
- New variables can be created within the function body

Exercise

What is wrong with the following function?



Exercise

What is wrong with the following function?

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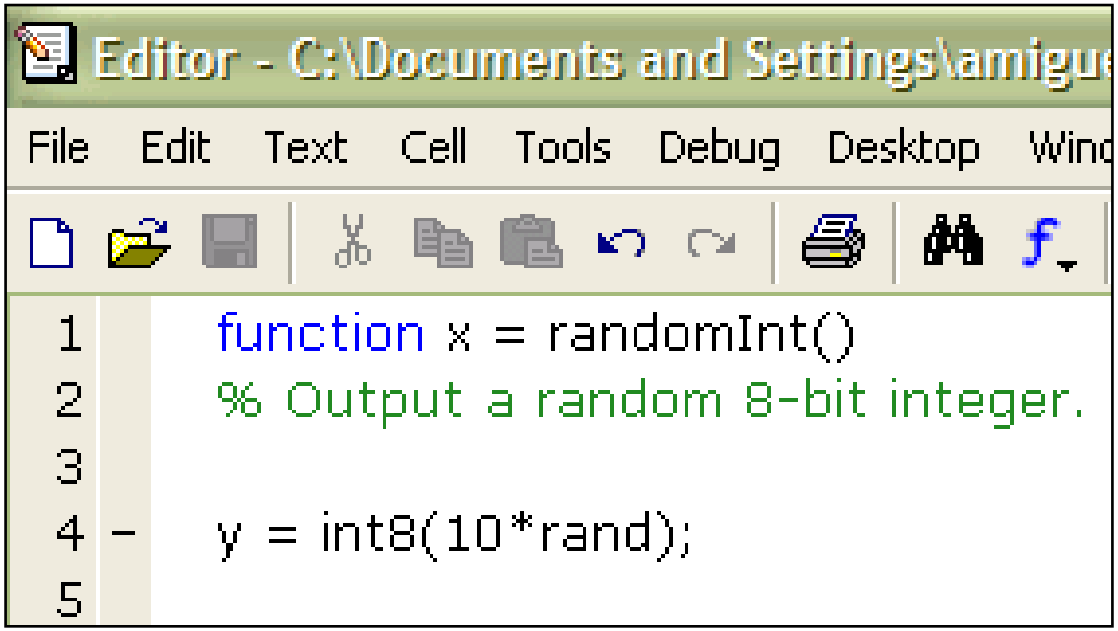
```
1     function x = randomInt()
2     % Output a random 8-bit integer.
3
4 -   y = int8(10*rand);
5
```

Answer: the function body never assigns a value to the output variable x.

Exercise

What is wrong with the following function?

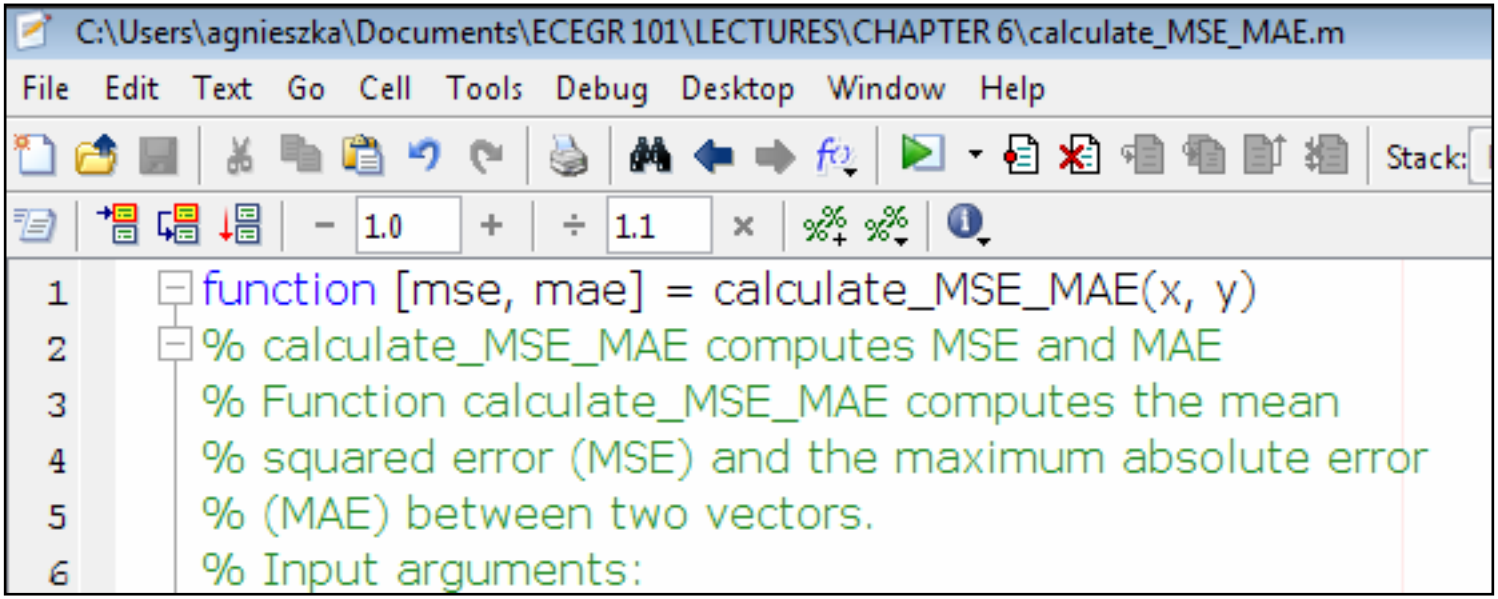


Command Window

```
>> z = randomInt
??? One or more output arguments not assigned during call to 'C:\Documents and Setting
```

Saving a Function File

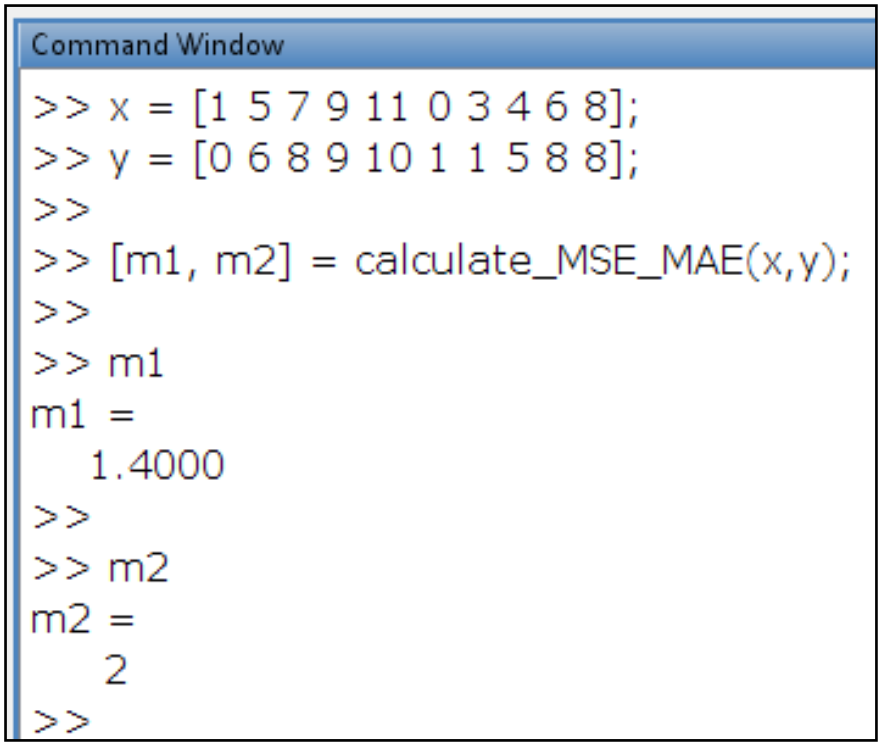
- Use the same file name as the function name.
- The file extension has to be ".m".



The above function has to be saved in a file calculate_MSE_MAE.m

Using a Function File

- Type the function name in the Command Window. Include input and output variables.
- Example:



Using a Function File

Command Window

```
>> [mse, mae] = calculate_MSE_MAE([1 2 3 4], [0 1 2 3]);
>>
>> mse
mse =
     1
>>
>> mae
mae =
     1
>>
```

Using a Function File