

# Introduction to *Matlab*

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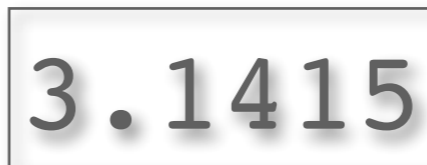
# What is *Matlab*?

- A **data-analysis program**:
  - compute, visualize, and analyze your data,
  - with simple command-line commands.
- A **programming language**:
  - high-performance technical computing
  - easier than low-level languages (C, Java, ...)
- A large array of **toolboxes**: add-on application-specific solutions:
  - signal processing, stats, neural networks, ...
  - *MIDItoolbox, MIRtoolbox, MoCap Toolbox.*

# Basic Data Structures

- Scalars:

$$s = 3.1415$$



- Vectors:

$$v = [1, 5, 7]$$



$$w = [1; 5]$$

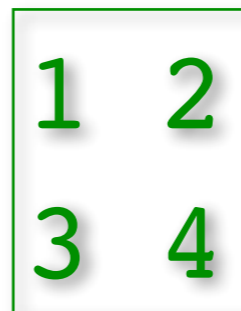


$$w'$$



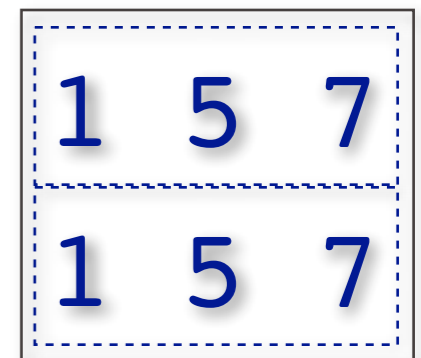
- Matrices:

$$m = [1, 2; 3, 4]$$

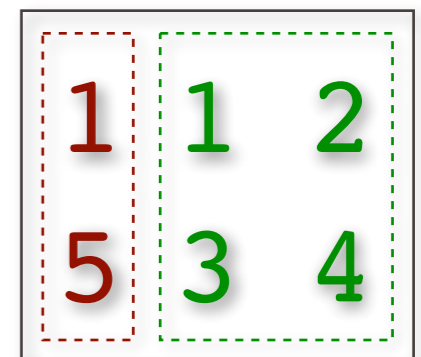


- Nothing: [ ]

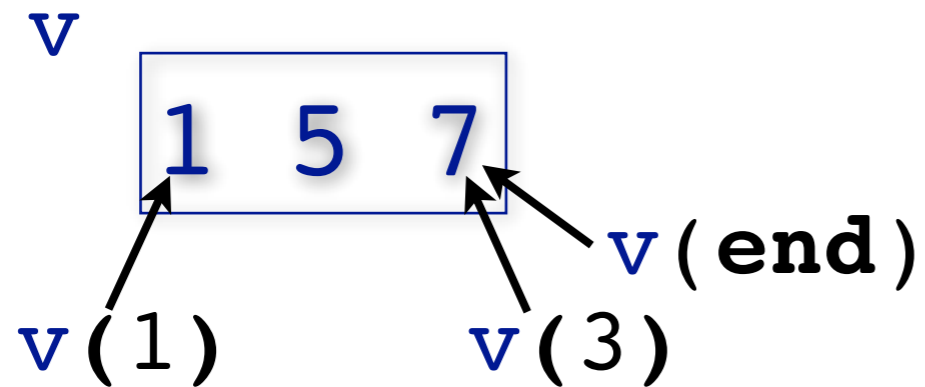
$$[v; v]$$



$$[w, m]$$

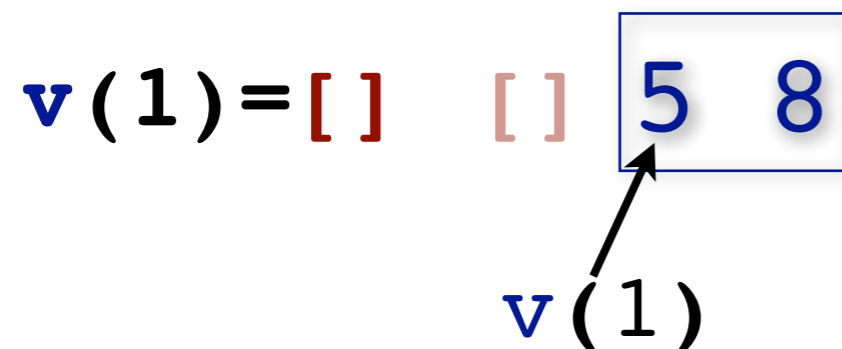


# Accessing elements

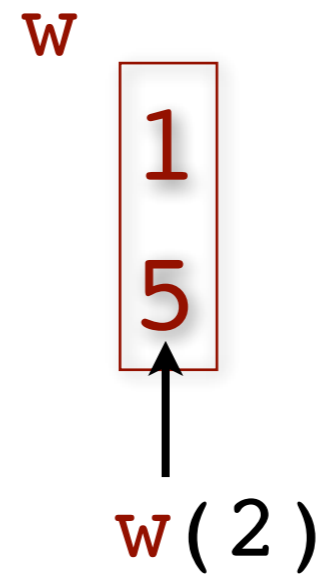


`length(v) = 3`

`size(v) = [1 3]`



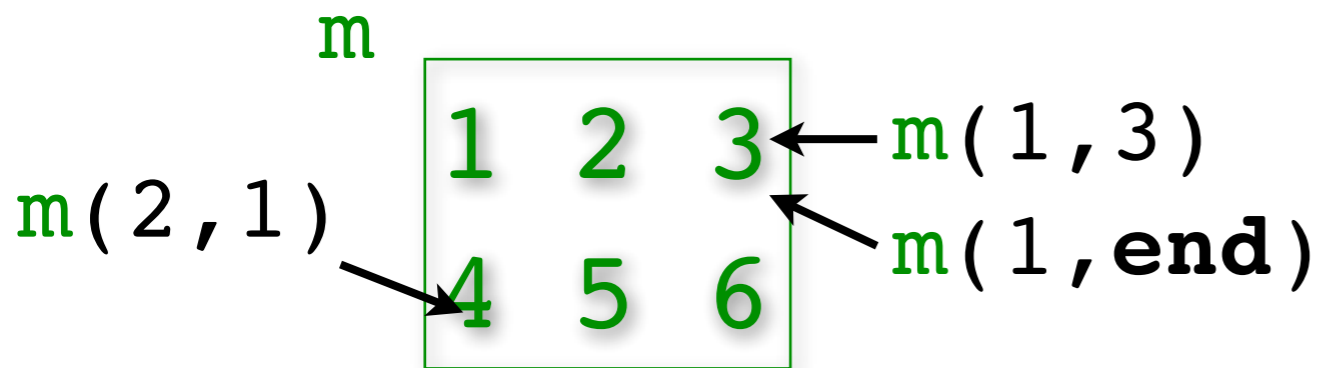
`size(v) = [1 2]`



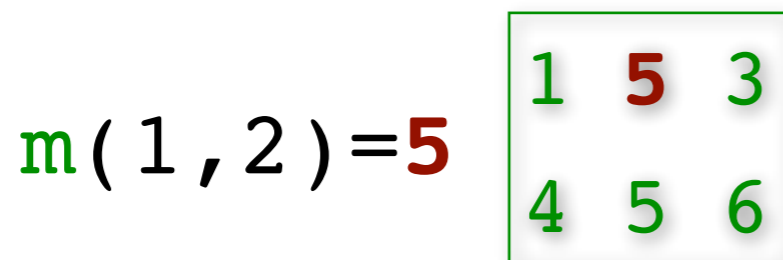
`length(w) = 2`

`size(w) = [2 1]`

# Accessing elements



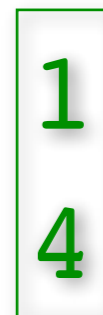
`size(m) = [2 3]`



$m(2, :)$



$m(:, 1)$

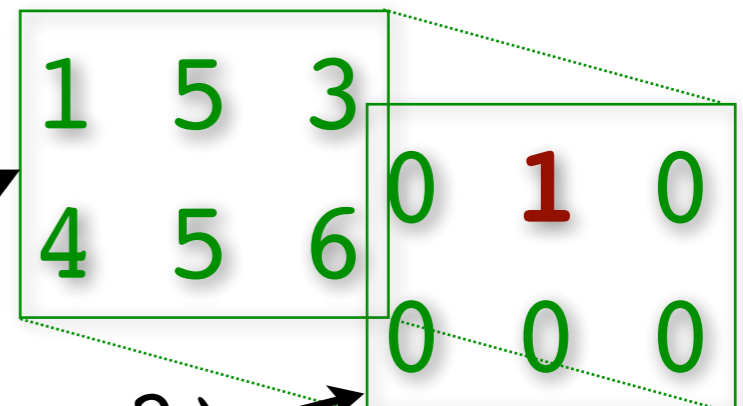


More dimensions!

`size(m) = [2 3 2]`

$m(1, 2, 2) = 1$

$m(:, :, 1)$



$m(:, :, 2)$

# Colon operator

`u = 1:5`

1	2	3	4	5
---	---	---	---	---

`v = 1:2:9`

1	3	5	7	9
---	---	---	---	---

`m = [v; v+1; v*2]`

1	3	5	7	9	1
2	4	6	8	10	2
2	6	10	14	18	3
1	2	3	4	5	

`m(2:3, 3:5)`

# Element-By-Element Operations

## vs. Matrix Operations

$$[1 \ 2 \ 3] - 4 \dots\dots\dots [-3 \ -2 \ -1]$$

$$[1 \ 2 \ 3] + [4 \ 5 \ 6] \dots\dots\dots [5 \ 7 \ 9]$$

$$[1 \ 2 \ 3] * 2 \dots\dots\dots [2 \ 4 \ 6]$$

$$[1 \ 2 \ 3] * [2; 3; 4] \dots\dots\dots \boxed{1 \ 2 \ 3} \ 20$$

$$[1 \ 2 \ 3] \cdot * [2 \ 3 \ 4] \dots\dots\dots [2 \ 6 \ 12]$$

$$[1 \ 2 \ 3] \cdot ^2 \dots\dots\dots [1 \ 4 \ 9]$$

$$[1 \ 2 \ 3] \cdot / [2 \ 3 \ 4] \dots\dots\dots [.5 \ .666 \ .75]$$

$$\sin([0 \ \text{pi}/2 \ \text{pi}]) \dots\dots\dots [0 \ 1 \ 0]$$

2  
3  
4

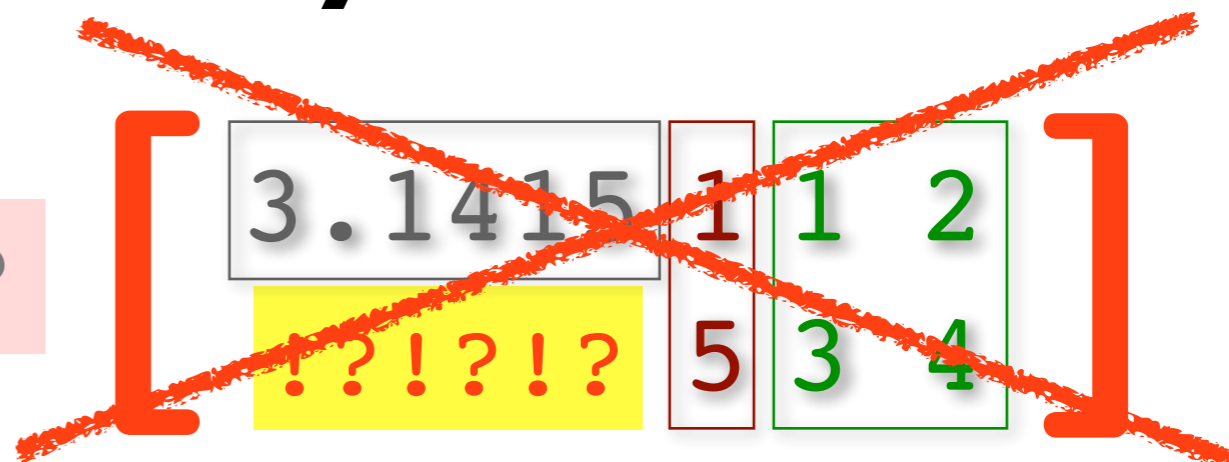
# Cell Arrays

s 3.1415

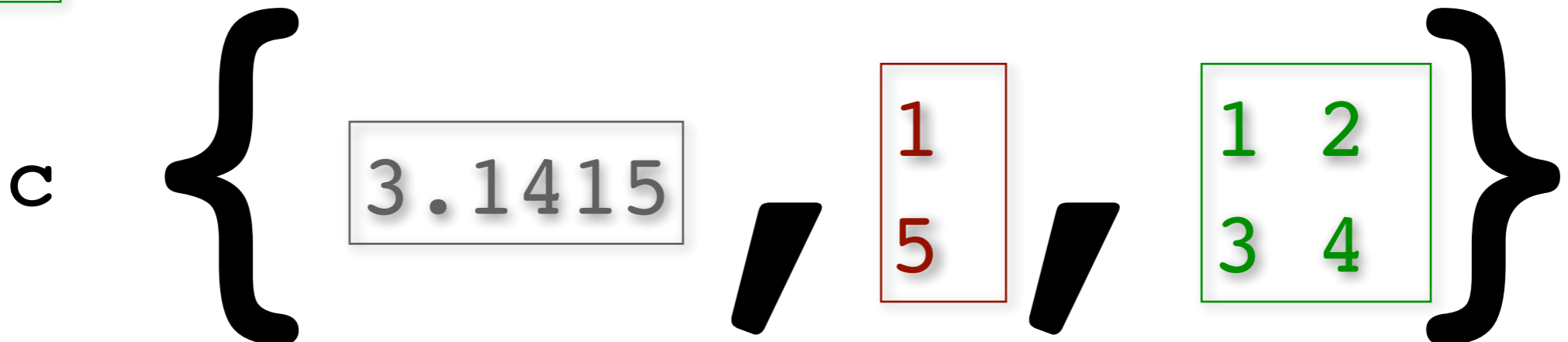
w 1  
5

m 1 2  
3 4

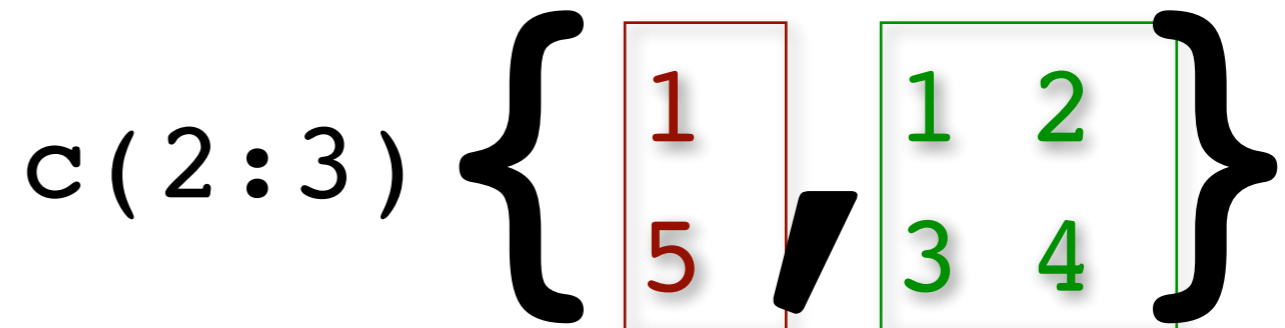
$c = [s, w, m] ?$



$c = \{s, w, m\} !$



c{1} 3.1415





# Text

h = 'hello'

w = 'world'

[h,w] 'helloworld'

p = [h, ' ', w] 'hello world'

{p; 'how are you?'}

{ 'hello world'  
'how are you?' }

# Structures

note1

```
note1.pitch = 'C'  
note1.duration = 'quaver'  
note1.register = 4
```

note2

```
note2.pitch = 'D'  
note2.duration = 'crochet'  
note2.register = 3
```

```
notes = [note1 note2]
```

notes.pitch

'C'

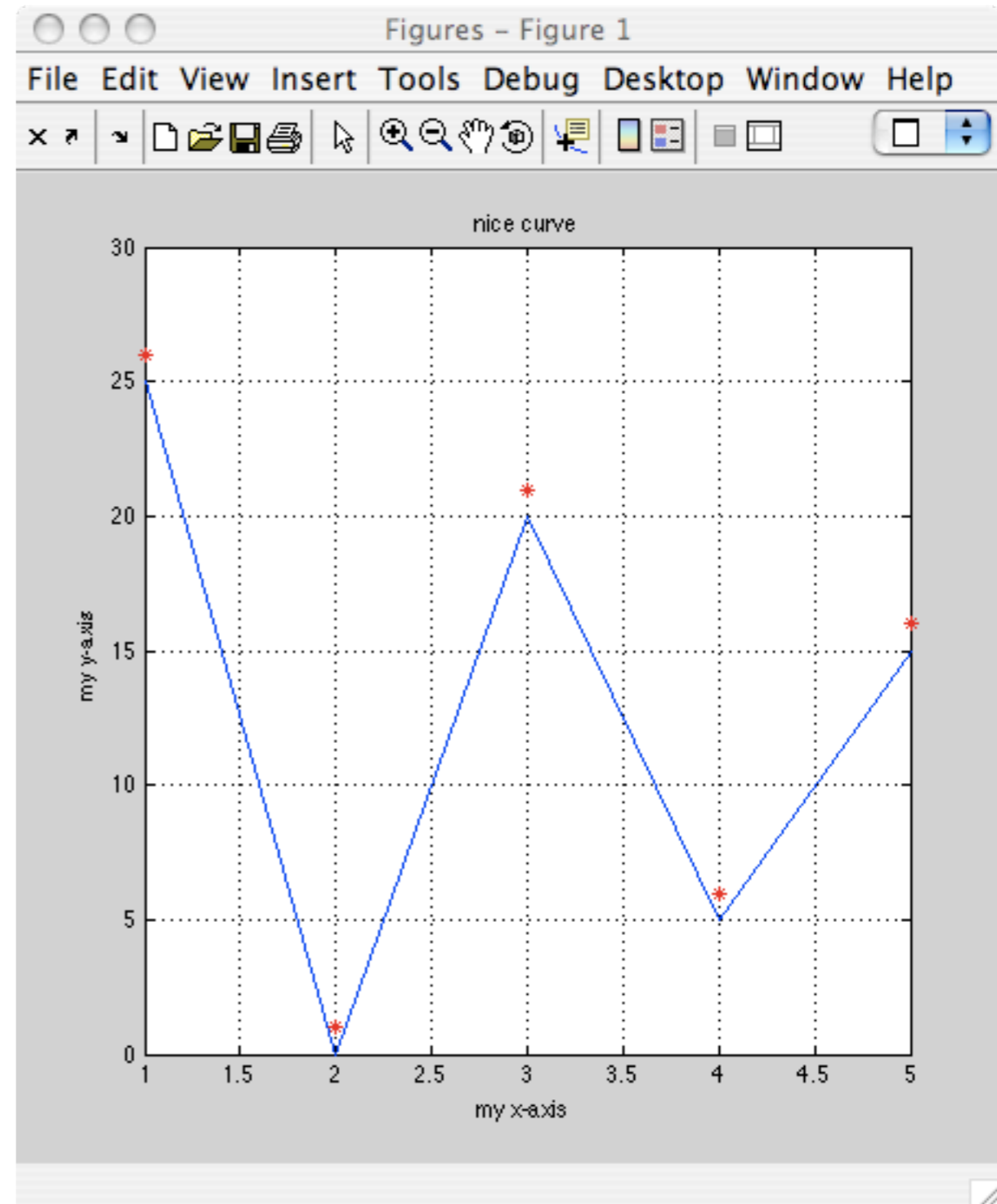
'D'

[notes.pitch]

'CD'

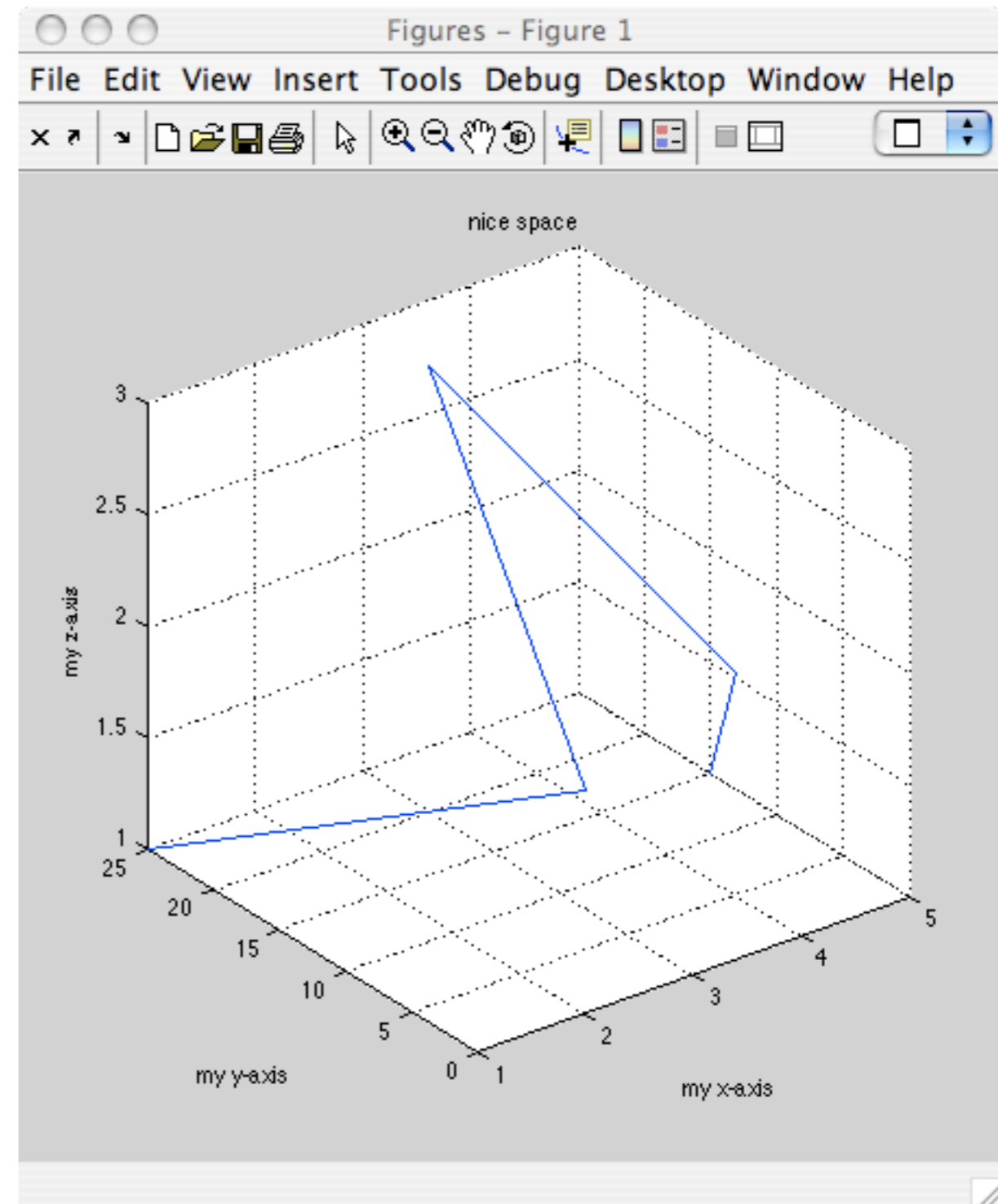
# Plots

```
x = 1:5;  
y = [25 0 20 5 15];  
plot(x, y);  
xlabel('my x-axis');  
ylabel('my y-axis');  
title('nice curve');  
grid on  
hold on  
plot(x, y+1, 'r*');
```



# 3D Plots

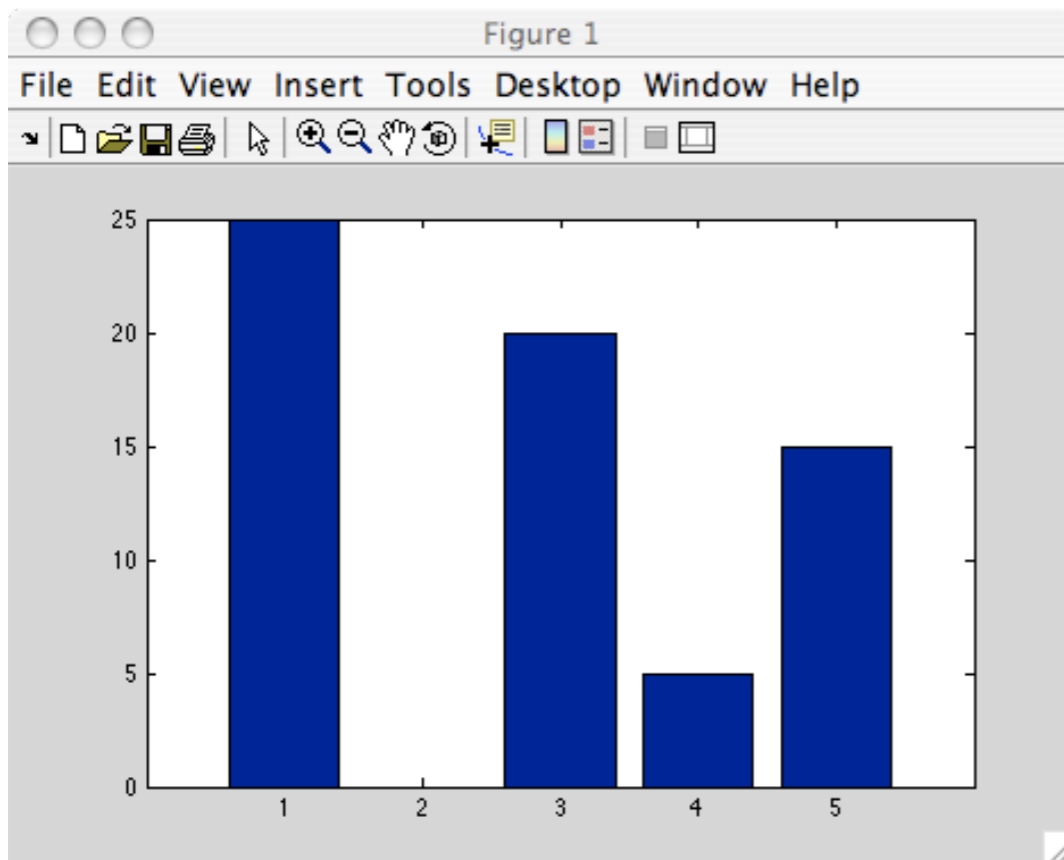
```
x = 1:5;  
y = [25 0 20 5 15];  
z = [1 2 3 2 1];  
plot3(x, y, z);  
xlabel('my x-axis');  
ylabel('my y-axis');  
zlabel('my z-axis');  
title('nice space');
```



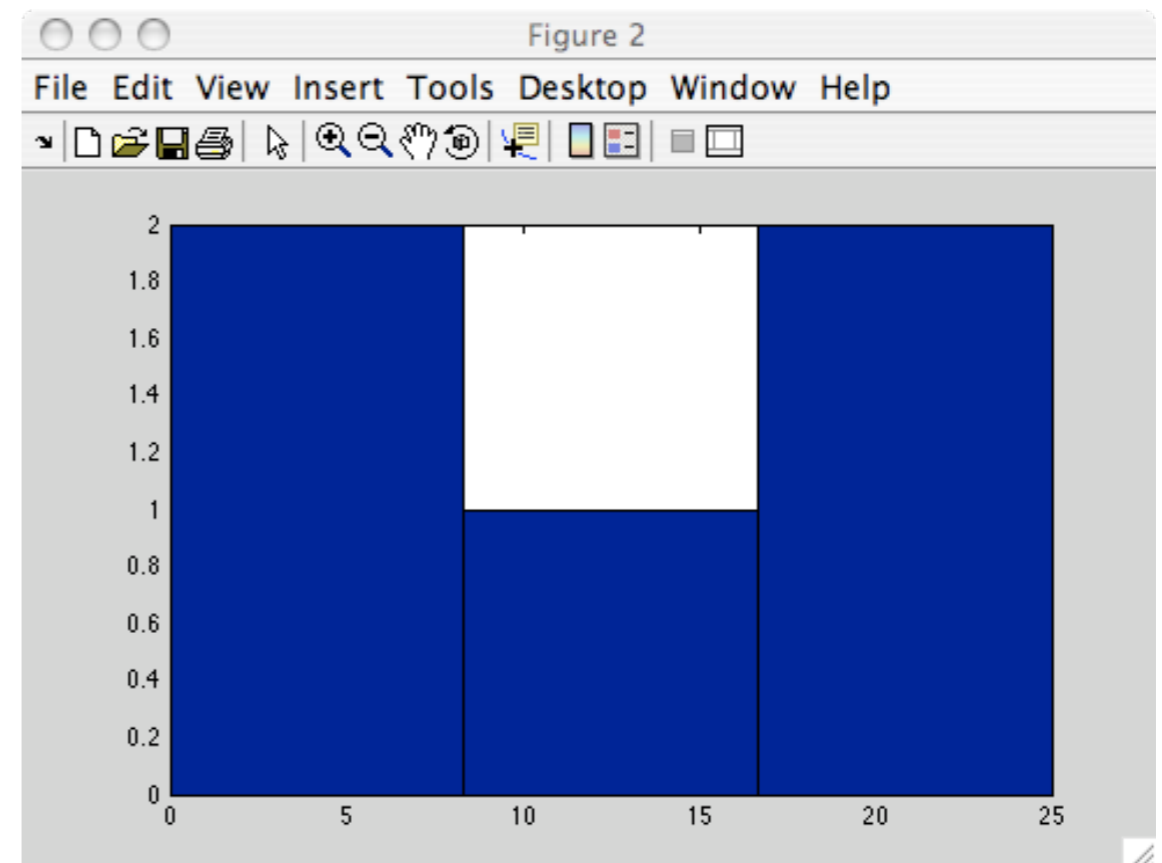
# Bars, Histograms

```
x = 1:5; y = [25 0 20 5 15];
```

```
figure, bar(x,y);
```

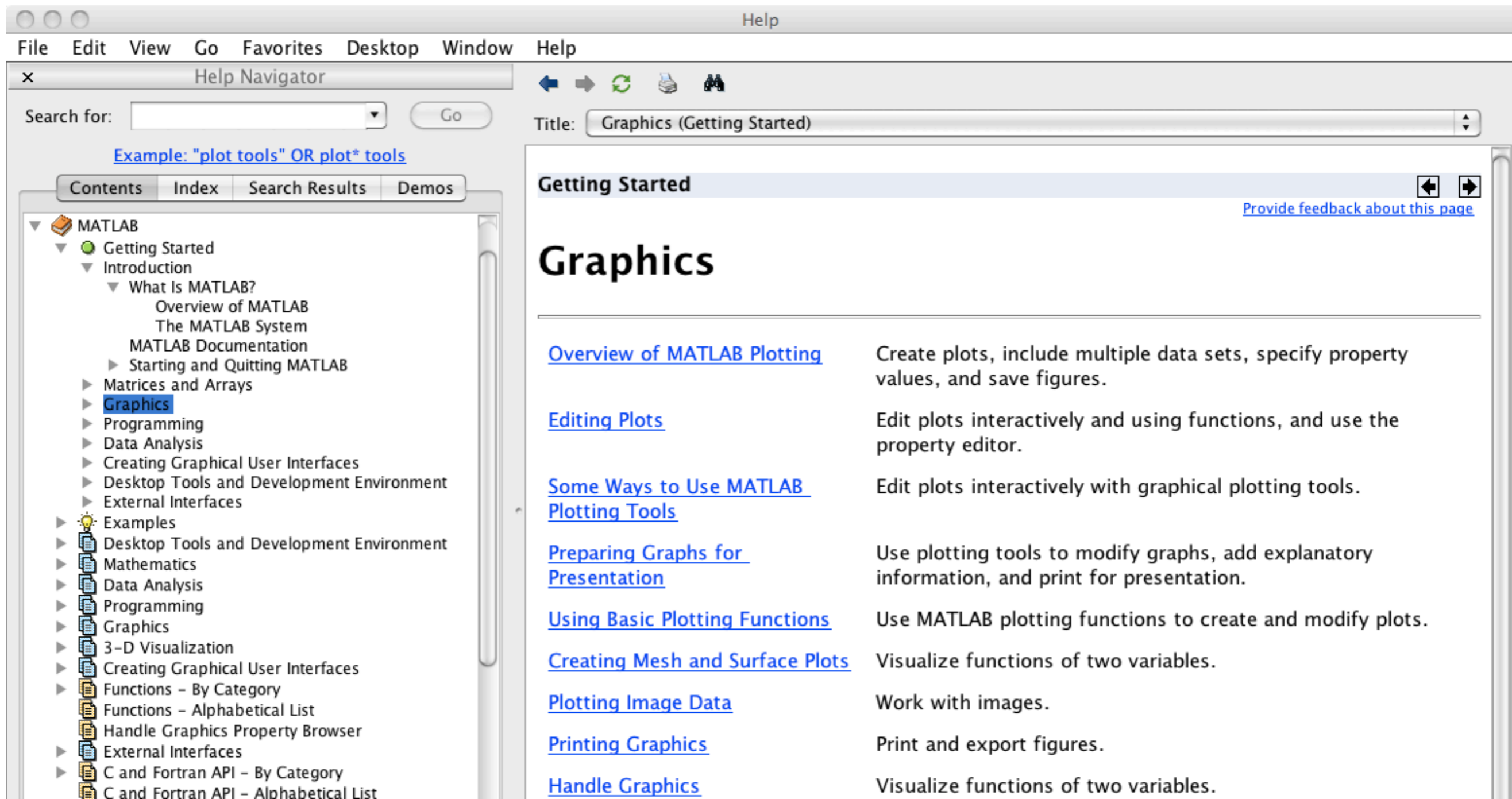


```
figure, hist(y,3);
```



# Advanced graphics?

- Check *Matlab* documentation (type 'doc')



The screenshot shows the MATLAB Help Navigator window. The title bar reads "Help". The menu bar includes "File", "Edit", "View", "Go", "Favorites", "Desktop", "Window", and "Help". The main window is titled "Help Navigator" and contains a search bar, navigation buttons, and a tree view of the MATLAB documentation. The "Graphics" section is selected in the tree view. The main content area displays the "Getting Started" page for "Graphics", which includes a list of links and their descriptions:

Link	Description
<a href="#">Overview of MATLAB Plotting</a>	Create plots, include multiple data sets, specify property values, and save figures.
<a href="#">Editing Plots</a>	Edit plots interactively and using functions, and use the property editor.
<a href="#">Some Ways to Use MATLAB Plotting Tools</a>	Edit plots interactively with graphical plotting tools.
<a href="#">Preparing Graphs for Presentation</a>	Use plotting tools to modify graphs, add explanatory information, and print for presentation.
<a href="#">Using Basic Plotting Functions</a>	Use MATLAB plotting functions to create and modify plots.
<a href="#">Creating Mesh and Surface Plots</a>	Visualize functions of two variables.
<a href="#">Plotting Image Data</a>	Work with images.
<a href="#">Printing Graphics</a>	Print and export figures.
<a href="#">Handle Graphics</a>	Visualize functions of two variables.

# Managing variables

```
>> a = 3;
```

```
>> b = 6;
```

```
>> who
```

```
Your variables are a b
```

```
>> save my_file
```

```
>> dir
```

```
. .. my_file.mat
```

```
>> clear
```

```
>> who
```

```
(No variable!)
```

```
>> load my_file
```

```
>> who
```

```
Your variables are a b
```

# Scripts

> New > Script

```
% Nice code!
```

```
a = 3;
```

```
b = 6
```

```
total = a+b
```

> Save `myscript.m`

```
>> myscript
```

```
b = 6
```

```
total = 9
```

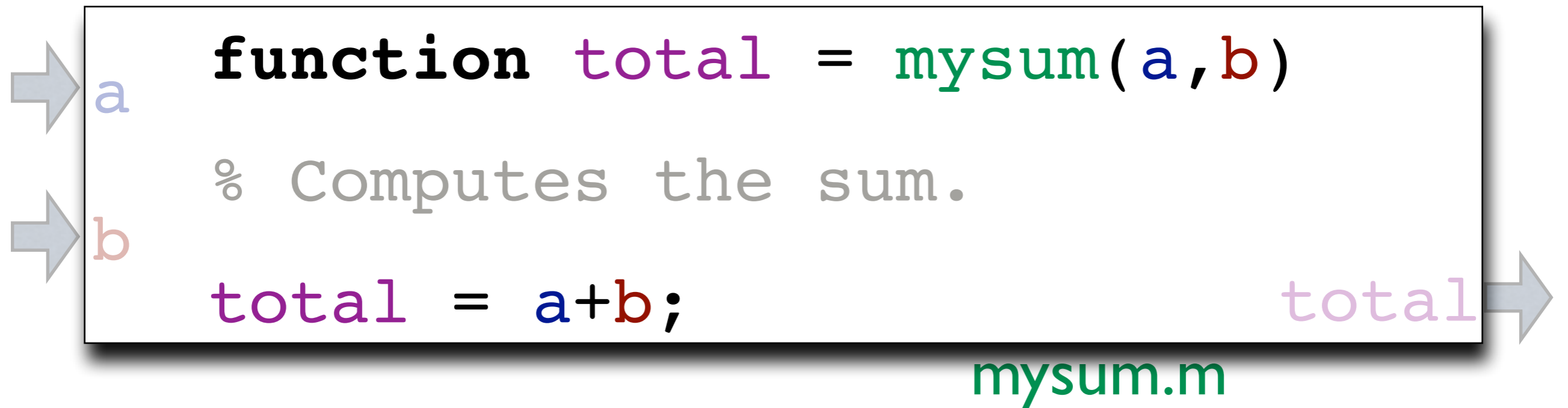
```
>> who
```

```
Your variables  
are a b total
```



# Functions

```
function total = mysum(a,b)
% Computes the sum.
total = a+b;
mysum.m
```

A diagram showing a function definition in MATLAB. The code is enclosed in a box. On the left side of the box, there are two arrows pointing to the variables 'a' and 'b'. On the right side of the box, there is an arrow pointing to the variable 'total'. Below the box, the filename 'mysum.m' is written in green.

```
>> mysum(3,3)
```

```
ans = 6
```

```
>> who
```

~~Your variables are a b total~~

*(internal variables a b are defined only inside the function)*

# Example of Matlab Commands

- ***sqrt***: square-root
- ***sin, cos, abs, max, min, ...***
- tests:  $a == 1$ ,  $a < 1$ , **&** (and), **|** (or), **~**(not)
- ***sum, prod, mean, std, ...***
- ***corrcoef***: correlation matrix
- ***rand***: random numbers
- Check *Matlab* documentation: 'doc rand', etc.

# Programming

```
for i=1:5  
    i*2  
end
```

```
ans = 2  
ans = 4  
ans = 6  
ans = 8  
ans = 10
```

```
for i=1:5  
    if i==3  
        disp('three')  
    else  
        disp('not three')  
    end  
end
```

```
not three  
not three  
three  
not three  
not three
```

# More about Matlab?

The image shows a screenshot of the MATLAB Help Navigator window. The window title is 'Help'. The menu bar includes 'File', 'Edit', 'View', 'Go', 'Favorites', 'Desktop', 'Window', and 'Help'. The main content area is titled 'Help Navigator' and contains a search bar with the text 'Search for:' and a 'Go' button. Below the search bar, there are tabs for 'Contents', 'Index', 'Search Results', and 'Demos'. The 'Contents' tab is active, showing a tree view of the MATLAB documentation. The 'Graphics' section is highlighted in blue. The main content area displays the 'Getting Started' page for 'Graphics', with a list of links including 'Overview of...', 'Editing P...', 'Some Ways to...', 'Plotting Tools', 'Preparing Graphs for Presentation', 'Using Basic Plotting Functions', 'Creating Mesh and Surface Plots', and 'Plotting Image Data'. A yellow sticky note is overlaid on the page with the text 'Check documentation (type 'doc')'.

# Exercises

# I. Random composer

## *ChordProgression*

12
11
7
4
0

*Chord*

16	14	12
15	13	11
11	9	7
8	6	4
4	2	0

4	2	0
---	---	---

*BassLine*

# 2. Simple synthesizer

