Introduction to MATLAB

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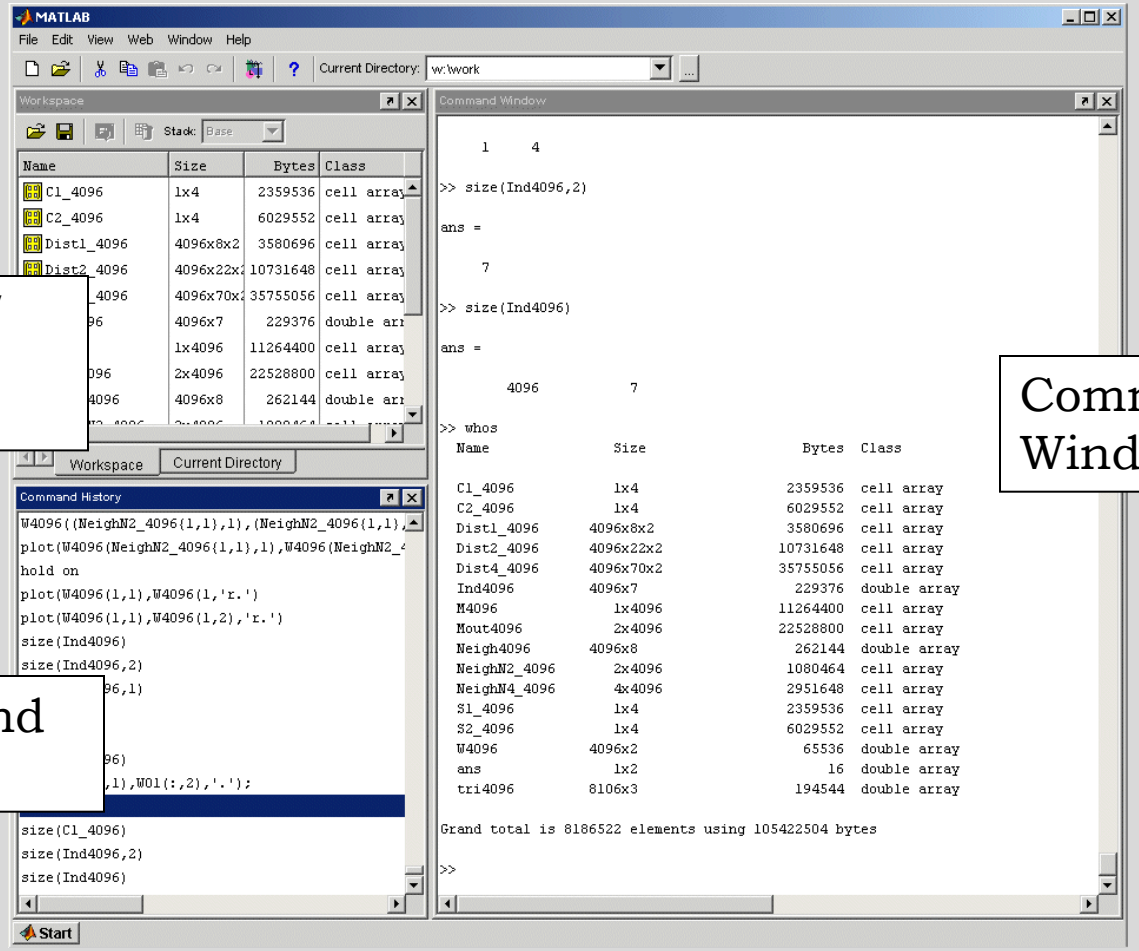
MATLAB

- Stands for **MAT**rix **LAB**oratory
- Very good tool for the manipulation of matrices
- Great visualisation capabilities
- Loads of built-in functions
- Easy to learn and simple to use

Desktop



Workspace / Current Directory

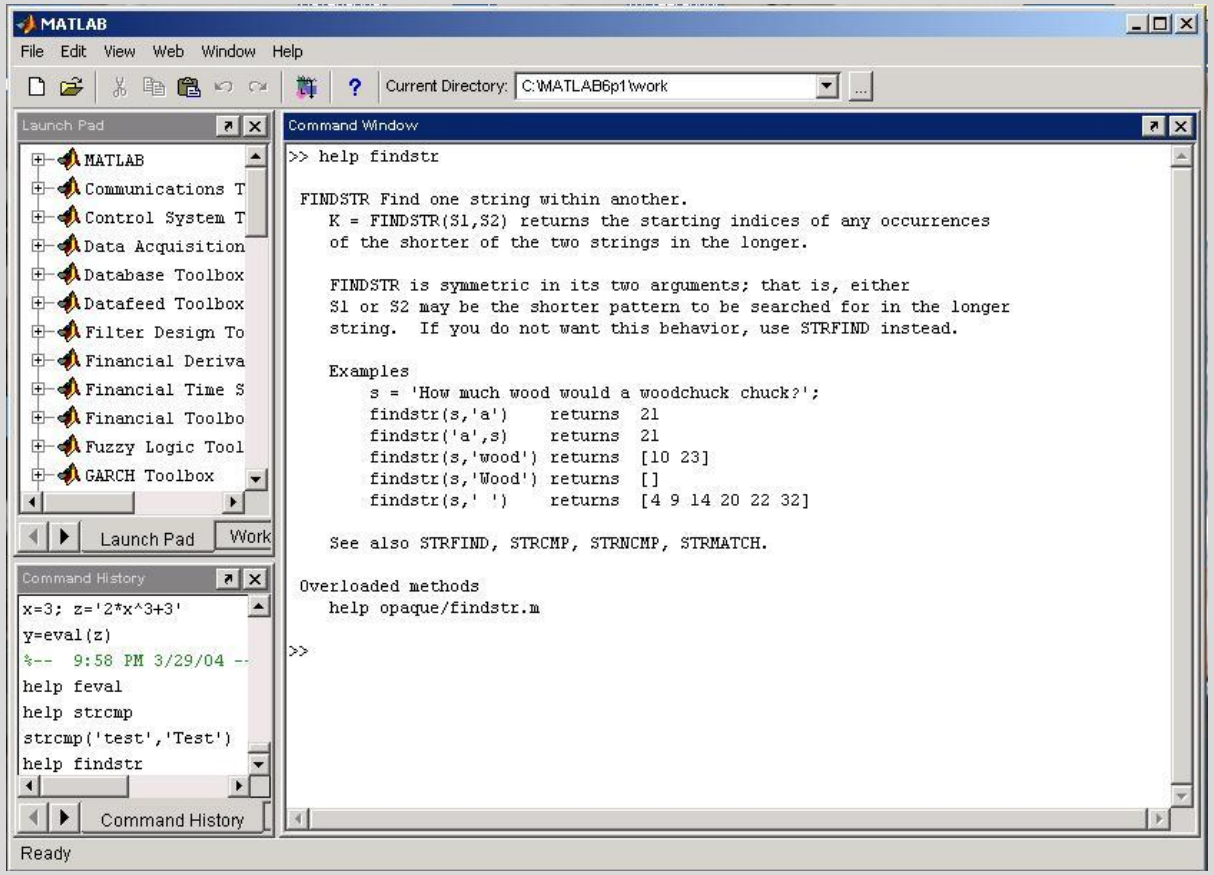
Command History

Command Window

🔎 Explore the MATLAB Desktop

Getting Help and Looking Up Functions

- To get help on a function type “help function_name”, e.g., “help plot”.
- To find a topic, type “lookfor topic”, e.g., “lookfor matrix”



Workspace

- **who**, **whos** – current workspace vars.
- **save** – save workspace vars to *.mat file.
- **load** – load variables from *.mat file.
- **clear all** – clear workspace vars.
- **close all** – close all figures
- **clc** – clear screen
- **clf** – clear figure

MATLAB symbols

>>	prompt
. . .	continue statement on next line
,	separate statements and data
%	start comment which ends at end of line
;	(1) suppress output
	(2) used as a row separator in a matrix

Matrices

- Do not need to initialise type, or dimensions

```
>>A = [3 2 1; 5 1 0; 2 1 7]
A =
     3     2     1
     5     1     0
     2     1     7
>>
```

square brackets to define matrices

semicolon for next row in matrix

Manipulating Matrices

- Access elements of a matrix

```
>>A(1,2)
ans=
2
```

indices of matrix element(s)

```
A =
     3     2     1
     5     1     0
     2     1     7
```

- Remember Matrix_name(row,column)
- Naming convention Matrix variables start with a capital letter while vectors or scalar variables start with a simple letter

The : operator

- VERY important operator in MATLAB
- Means '**to**'

```
>> 1:10
ans =
     1     2     3     4     5     6     7     8     9    10
>> 1:2:10
ans =
     1     3     5     7     9
```

Manipulating Matrices

```
>> A.'          % transpose
>> B * A        % matrix multiplication
>> B. * A       % element by element
                % multiplication
>> B / A        % matrix division
>> B. / A       % element by element
                % division
>> [B A]        % join matrices (horizontally)
>> [B; A]       % join matrices (vertically)
```

```
A =
     3     2     1
     5     1     0
     2     1     7

B =
     1     3     1
     4     9     5
     2     7     2
```

For loops

- x = 0;

```
for i = 1:2:5          % start at 1, increment by 2
    x = x + i;         % end with 5.
end
```

This computes $x = 0 + 1 + 3 + 5 = 9$

While loops

- x = 7;

  while (x >= 0)

  x = x - 2;

  end;

  This computes $x = 7 - 2 - 2 - 2 - 2 = -1$

If statements

```
if (x == 3)
    disp('The value of x is 3.');
elseif (x == 5)
    disp('The value of x is 5.');
else
    disp('The value of x is not 3 or 5.');
end;
```

Switch statement

- **switch dice_face**
  case *{1}*
    disp('Rolled a 1');
  case *{2}*
    disp('Rolled a 2');
      ....
  case *{5}*
    disp('Rolled a 5');
  otherwise
    disp('Rolled a 6');
  end

Break statements

- **break** – terminates execution of for and while loops. For nested loops, it exits the innermost loop only.

Vectorization

- MATLAB is an interpreted language, i.e., it is not compiled before execution, loops run slowly.
- *Vectorized code runs faster* in MATLAB.
- Example: x = [1 2 3];

```
for i = 1:3
    x(i) = x(i) + 5;
end;
```

VS.

Vectorized:

```
x = x + 5;
```

Example

- This code computes the *sine* of 1,001 values ranging from 0 to 10:

```
i = 0;
for t = 0:.01:10
    i = i + 1;
    y(i) = sin(t);
end
```

- This is a vectorized version of the same code:

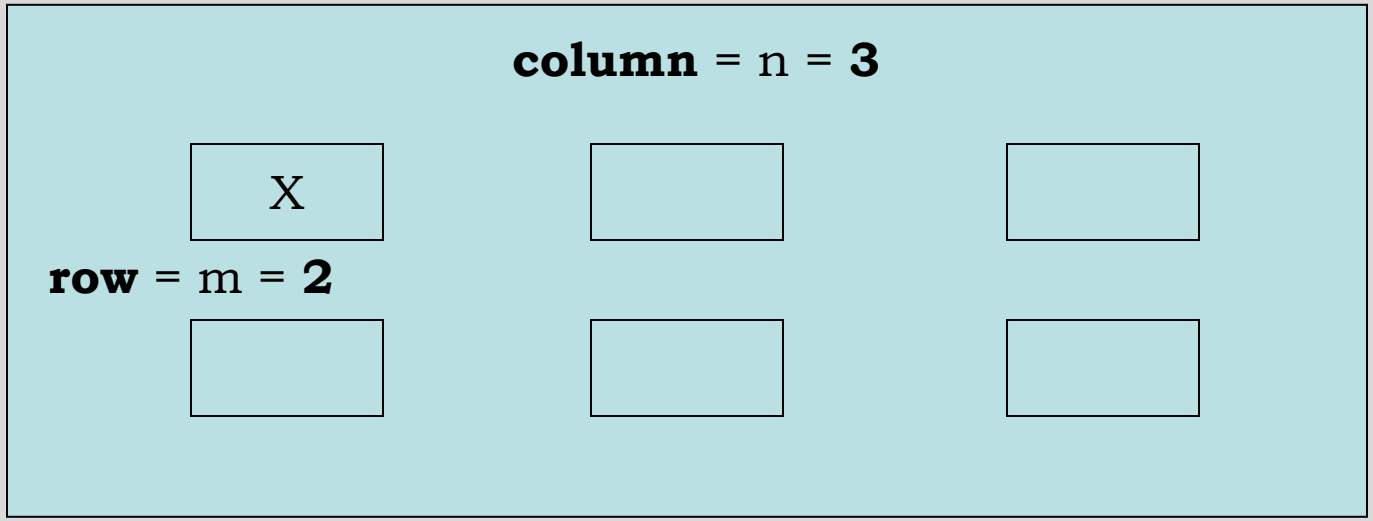
```
t = 0:.01:10;
y = sin(t);
```

Graphics

- **plot(x, y);** % plots y vs. x.
- **plot(x, y, ‘k-’);** % plots a black line of y vs. x.
- **hold on;** % put several plots in the same % figure window.
- **figure;** % open new figure window.

Graphics

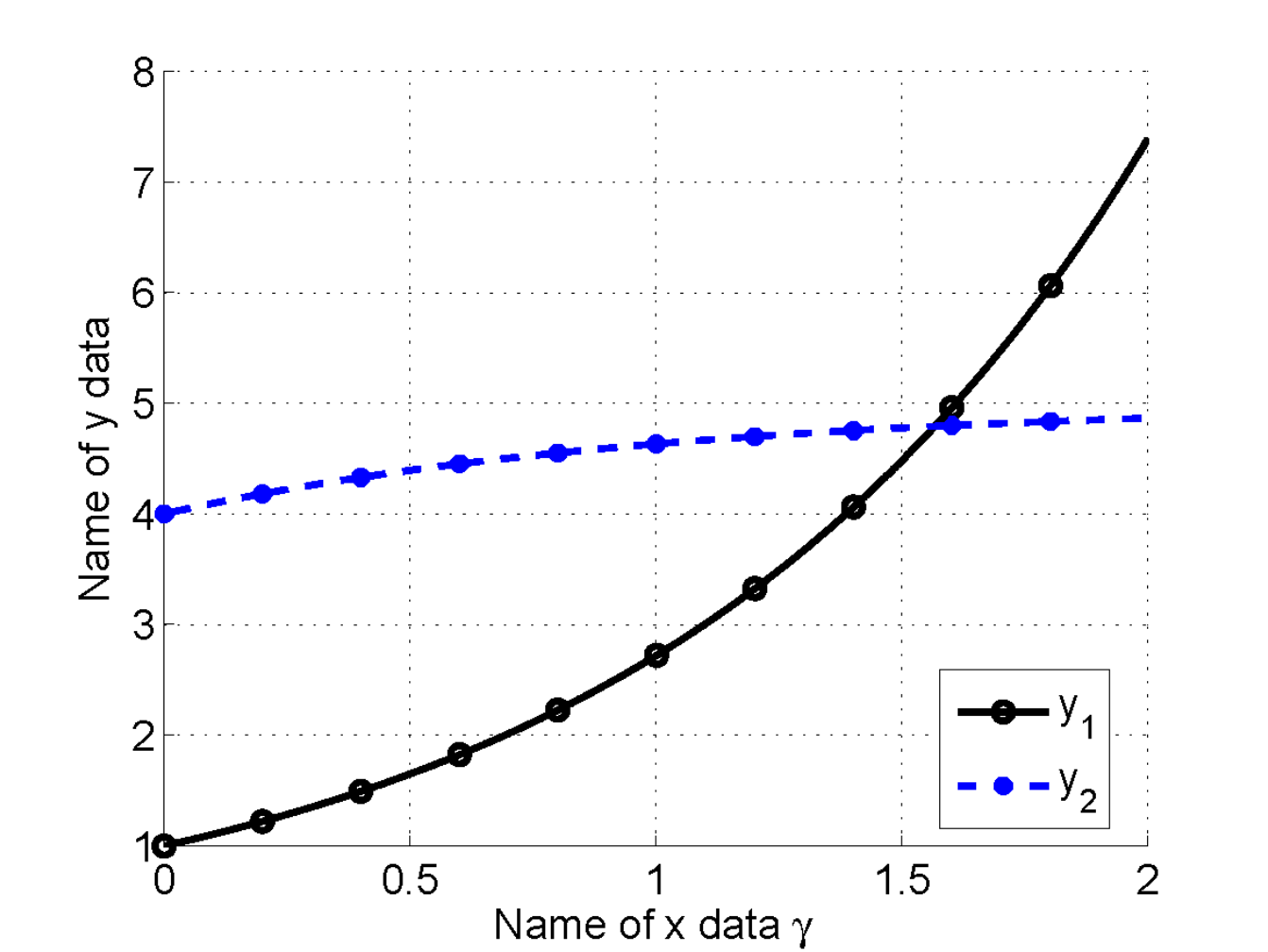
- **subplot(m, n, 1)** % Makes an **m x n** array
  % for plots. Will place plot in 1st
  % position.



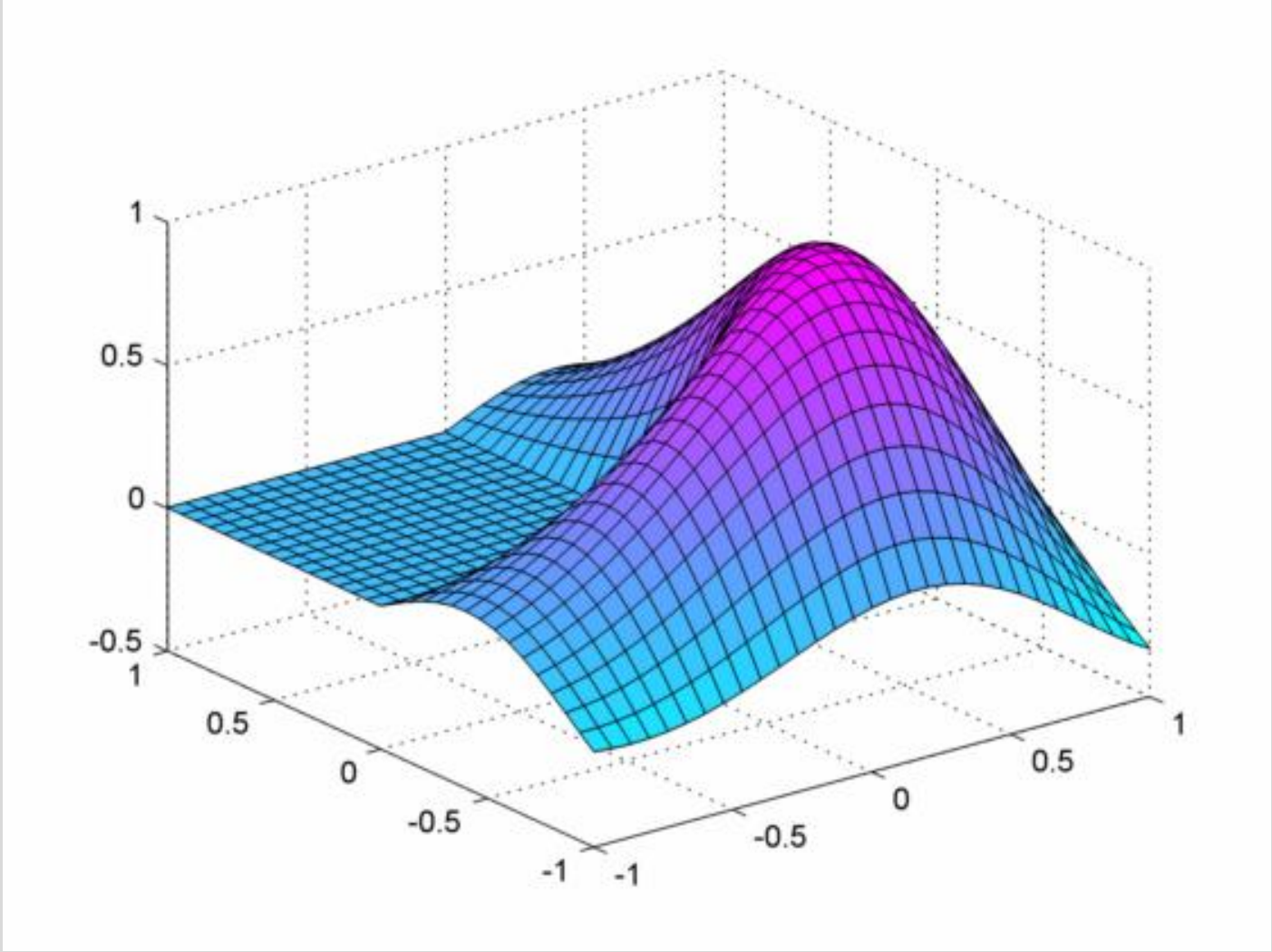
Graphics

- **plot3(***x, y, z***)** – plot 2D function.
- **mesh(***x, y, z***)** – surface plot.
- **contour(***z***)** – contour plot of z.
- **axis([***x_{min} x_{max} y_{min} y_{max}***])** – change axes
- **title(‘**My title**’)** – add title to figure;
- **xlabel(**‘y label’**), ylabel**(‘y label’) – label axes.
- **legend** – add key to figure.

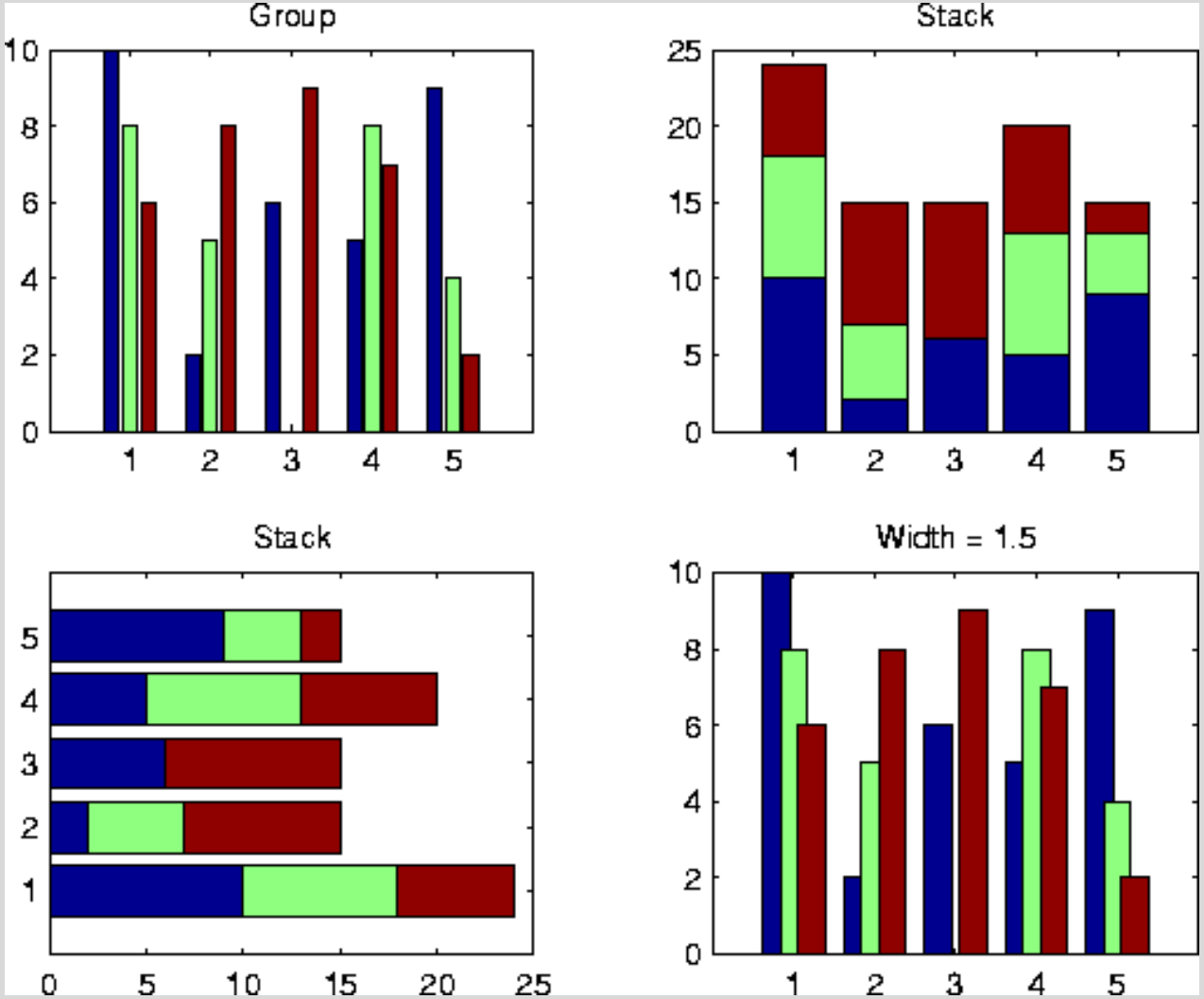
Examples of Plots – x vs y



Examples of Plots – *3D surface*



Examples of Plots – *Bar charts*



Scripts and Functions

- Two kinds of M-files:

  - **Scripts**, which do not accept input arguments or return output arguments. They operate on data in the workspace. *FIXED*

  - **Functions**, which can accept input arguments and return output arguments. Internal variables are local to the function. *VARIABLE*

Advantages

- May behave as a calculator or as a programming language
- Has powerful graphics generation/visualisation of data
- Relatively easy to learn
- Interpreted (not compiled), errors are easy to fix
- Optimized to be relatively fast when performing matrix operations

Disadvantages

- Not a general-purpose programming language such as C, C++, or FORTRAN
- Designed for scientific computing, and is not well suitable for other applications
- Interpreted language, slower than a compiled language such as C++
- MATLAB commands are specific for MATLAB usage. Most of them do not have a direct equivalent with other programming language commands

Let's look at some **code** now!