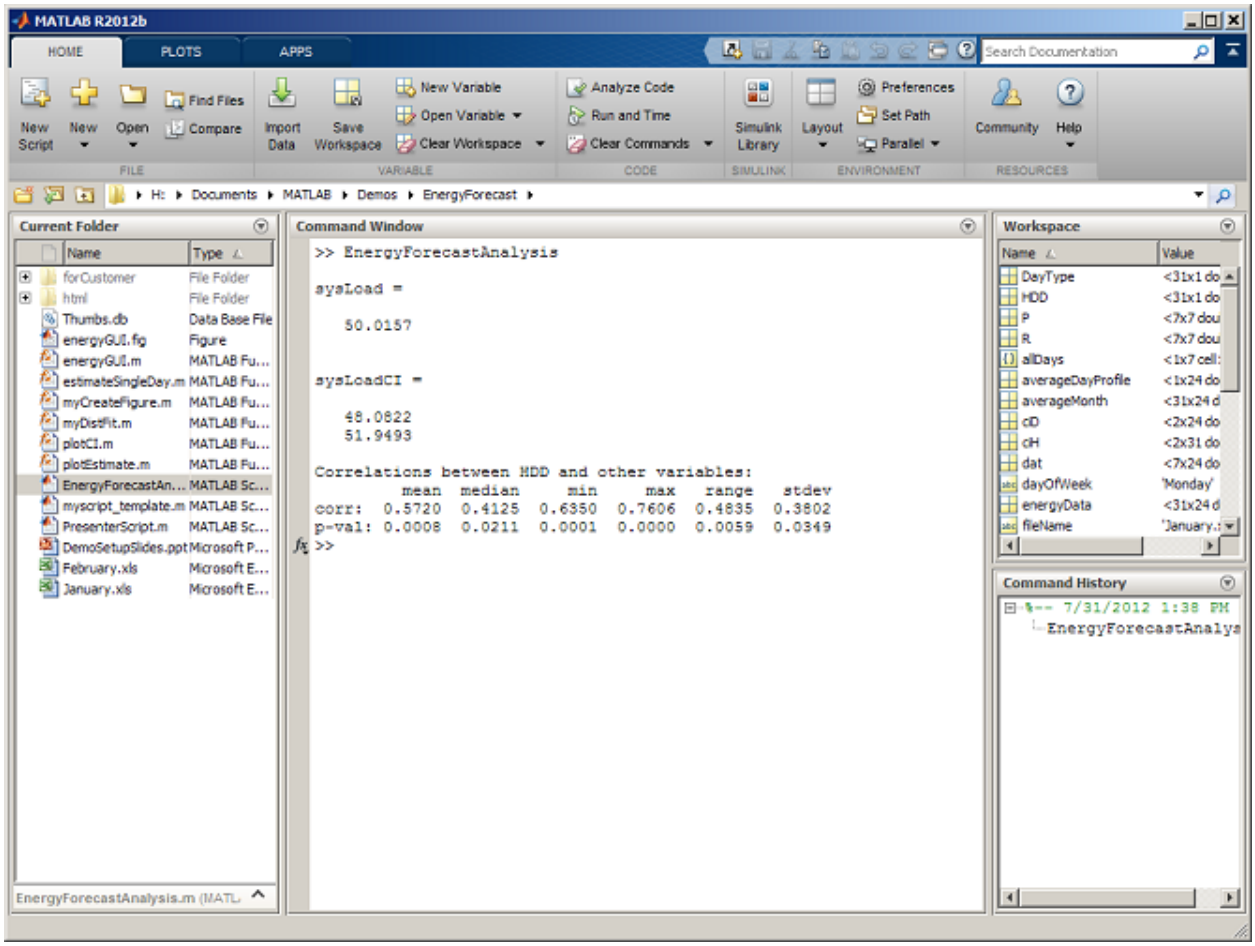
An Introduction to Matlab - Tasks

1 Identify features of the Matlab desktop

On this screenshot, label

1. The variables currently in working memory
2. The last but one command issued at the interactive prompt
3. The user prompt



2 Set the current working directory

Set the working directory to N:\My work\Matlab

3 Simple arithmetic at the command line

Find the value of:

1. The sum of four and three
2. Five cubed

3. Twenty two divided by seven
4. Compute $e^{i\pi}+1$
5. Compute cos π + 1 / sin π

3.1 Create and use a variable

Create i = sqrt(-1).

The log_I of a number is:

$$log_i(x) = \frac{2\ln(x)}{i\pi}$$

Using the variable you have just created, calculate $log_I(12)$.

4 Write a post in the Moodle forum explaining how Matlab views data

What is the fundamental data structure used in Matlab?

5 Creating matrices

1. Create this matrix.

$$\begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix}$$

2. What is the fewest number of keystrokes required to create this matrix at the Matlab command prompt?
3. Create this vector

$$(1\ 2\ 3\ 4\ 5\ 6\ 7\ 8\ 9)$$

4. What is the fewest number of keystrokes required to create this matrix at the Matlab command prompt?
5. Create this vector

$$\begin{pmatrix} 1 \\ 2 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \\ 7 \\ 8 \\ 9 \end{pmatrix}$$

6. What is the fewest number of keystrokes required to create this matrix at the Matlab command prompt?

5.1 Creating a matrix with *rand*

Create a 3 by 4 matrix of uniformly distributed random numbers.

6 Arithmetic with matrices

Create

```
A = [1 2; 3 4], B = [5 6; 7 8]
```

Compute

```
A + B

A - B

A * B

A .* B

A \ B

A .\ B

A / B

A ./ B

A ^ 2

A .^ 2

A ^ B

A .^ B
```

7 Manipulating matrices

7.1 Use sum, diag and flip functions

What are the results of:

```
sum(A)

sum(A')

sum(A,2)
```

What does sum() do?

```
diag(A)
```

```
diag(A,2)
```

What does diag() do?

```
fliplr(A)
```

```
flipud(A)
```

What do fliplr() and flipud() do?

7.2 Use of cat, vertcat, horzcat functions

What are the results of

```
cat(1,A,B)
```

```
cat(2,A,B)
```

```
cat(1,A',B')
```

```
cat(1,A,B')
```

```
vertcat(A,B)
```

```
horzcat(A,B)
```

Which of these are equivalent?

7.3 Use of rot90 and reshape functions

What are the results of

```
rot90(A)
```

```
rot90(A')
```

Create

```
A =

     1     4     7    10
     2     5     8    11
     3     6     9    12
```

Evaluate:

```
B = reshape(A,2,6)

B = reshape(A,4,3)
```

8 Comparing single element variables

Create the variables

```
x=1
y=1.0
z=[1]
a='1'
b=['1']
```

What are the results of

```
x==y
x==z
y==z
x==a
x==b
z==b
```

What do the results mean?

Evaluate

```
str2num(a)==x

int2str(x)==b
```

What does the functions *str2num* and *int2str* do? What do the results mean?

9 Comparing matrix elements and matrices

9.1 Comparing matrix elements to values and assigning a new value

Create the matrix

```
a=[1 2 3;3 2 1;1 2 4]
```

Evaluate the following expressions:

```
a>2

a==1

(a>1) & (a<3)
```

Evaluate:

```
a( a > 2 )
```

What is the result?

```
a(a > 2) = 5
```

What is the result?

10 Referencing matrix elements

Create the vector

```
a = linspace(1,100,20)
```

What element is in 6th position?

Create the matrix

$$b = \begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix}$$

Evaluate

```
x=b(2,2)
sub2ind(size(b),2,2)
[R C]=ind2sub([3,3],5)
```

What values are returned?

What do the functions *sub2ind* and *ind2sub* do?

11 Deleting matrix elements

a = [1,2,3,4,5]

a(3) = []

a = [2,3,1,5,4]

a(a == 3) = []

12 Solving a first order differential equation.

Find a numerical solution for

$$\begin{cases} t^2y' = y + 3t \\ y(1) = -2 \end{cases} \text{ over the interval } 1 \le t \le 4$$

Create an m file defining the function:

```
function f = yp( t,y )
%UNTITLED Summary of this function goes here
%   detailed explanation goes here

f=1/t^2*(y + 3)

end
```

and save this as yp.m

Use this in the following command at the Matlab prompt.

```
[t,y]=ode45('yp' ,[1,4],-2).
```

Display the contents of *t* and *y*.

13 Reading and saving data

13.1 Read a spreadsheet file

Note: for this to work you must have the file *results.xlsx* in the correct folder – n:\My Work\Matlab. Check this first.

Read the spreadsheet results.xlsx with the command

[numbers text all]=xlsread('n:\My Work\Matlab\results.xlsx')

What are the contents of the variables

- numbers
- text
- all?

13.2 Save to a mat file

Save the spreadsheet data to a Matlab data file *results.mat*.

Clear Matlab memory.

Read the mat file just created. What data structures exist?

14 Creating and editing a 2d plot

For the following matrices:

x = [1:10]

y = [x.^2]

Create a simple x,y plot using the graphics window

Create a simple x,y plot using the command line

Edit the plot by:

- Adding a title
- Changing the line colour to blue and line style to dashed
- Add labels to x and y axes

15 Creating an overlay plot

For the following matrices:

x = [1:10]

y = [x.^2]

z = [x.^3]

Create a simple x,y plot of x and y

Overlay a simple x,y plot of x and z

16 Creating subplots

Create a 2x2 subplot, containing the following:

- Plot x,y where y = [x.^2]
- Plot x,z where z = [x.^3]
- Plot x,a where a = [x.^4]
- Plot x,b where b = [x.^5]

Where x = [1:10]

For further guidance see:

http://www.mathworks.co.uk/help/matlab/creating_plots/create-graph-with-subplots.html

17 Creating a plot from an equation

A dampened sine plot is a sinusoidal where amplitude approaches zero over time.

Plot

$$y(t) = e^{-t} \cdot \cos 2\pi t$$

Given time as

t = linspace (-10,10,100)

and calculating *y(t)* as

y = (exp(1).^-t).*(cos(2*pi*t))

Plot y against time.

What does each line of Matlab do?

18 Extension: 2D Plots

Visit: http://www.mathworks.co.uk/discovery/gallery.html

Explore the different examples of 2D plots, select one or more plot types of interest.

For each plot type:

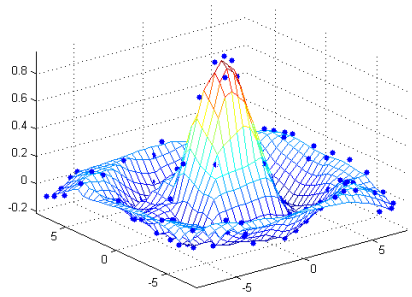
- Copy the *.mat* file containing the data to your workspace.
- Open the .m file and enter the lines from the script sequentially at the Matlab prompt.
- Between each line examine the figure window in the light of the comments in the file.

Investigate: http://www.mathworks.co.uk/help/matlab/examples/index.html

19 Creating a 3D plot

Visit: http://www.mathworks.co.uk/help/matlab/visualize/representing-a-matrix-as-a-surface.html

Work through: **Example – Displaying Nonuniform Data on a Surface** and generate the plot:



20 Arithmetic in a script

Write a script that calculates and displays

3+4

[1 2 3]*[4 5 6]'

[1 2 3].*[1 2 3 4 5 6 7 8 9 10]

3+4 * 1/π

21 A script using:

21.1 If or switch?

Create and run the following script:

```
prompt='Please enter u for undergraduate, p for postgraduate or s for staff
\n';

regStat = input(prompt,'s');

if regStat == 'p'
    fprintf('Postgraduates may take all courses free. \n')
elseif regStat == 'u'
    fprintf('Undergraduates may take some courses free. \n')
elseif regStat == 's'
    fprintf('Staff must pay for some courses. \n')
else
    fprintf('I''m sorry, I don''understand. \n')
end
```

Comment this script appropriately.

Create and fun the following script:

```
prompt='Please enter u for undergraduate, p for postgraduate or s for staff
\n';

regStat = input(prompt,'s');

switch regStat
    case 'p',
        fprintf('Postgraduates may take all courses free. \n')
    case 'u',
        fprintf('Undergraduates may take some courses free. \n')
    case 's'
        fprintf('Staff must pay for some courses. \n')
    otherwise
        fprintf('I''m sorry, I don''t understand. \n')
end
```

Comment this script appropriately.

21.2 While

Create and run the following script:

```
prompt=['******************Status Menu************************\n' ...
    '1                  Undergraduate \n' ...
        '2                  Postgraduate \n' ...
        '3                  Staff \n' ...
        '4                  Quit \n' ...
    '*****************************************************\n'];
regStat = 0;
while regStat ~= 4
regStat = input(prompt);
switch regStat
    case 2,
        fprintf('Postgraduates may take all courses free. \n')
    case 1,
        fprintf('Undergraduates may take some courses free. \n')
    case 3,
        fprintf('Staff must pay for some courses. \n')
    case 4,
        break;
    otherwise
        fprintf('I''m sorry, I don''t understand. \n')
end
end
```

Comment this script appropriately.

21.3 for

```
first = [1 2 3]
next = [1 2 3 4 5 6 7 8 9 10]

for i = first
    for j = next
        combi=i*j;
        fprintf('%d \n',combi);
    end
end
```

Comment this script appropriately.

22 Creating a simple function

Create a function file

```
function [mean] = avg(x)
[rows cols]=size(x)
mean = sum(x)/cols
end
```

Comment this function appropriately.

23 Calling a function from a function

Create a function file

```
function [ variance ] = myvar( x )
%UNTITLED2 Summary of this function goes here
%   Detailed explanation goes here

[rows cols]=size(x)

xbar = avg(x)

resids = (x-xbar).^2

variance = sum(resids)/cols

end
```

and then create a further function file

```
function [ stdev ] = mysd( x )
%UNTITLED3 Summary of this function goes here
%   Detailed explanation goes here

stdev = sqrt(myvar(x))

end
```

Comment this function appropriately.

24 Creating a multi-function solution

Create a Matlab program to do some simple statistics. Be sure to comment your code.

First the user is asked if they want to analyse one data series or two or allow them to quit.

If they choose one data series, they are prompted to enter a vector of numbers and the program returns a report containing

- Central tendency: mean, median, and mode
- Diffusion : variance and standard deviation
- Shape: skew and kurtosis
- Normality: the result of Kolmogorov-Smirnov test
- Quartiles

Or allow them to quit to the main menu.

If they choose two data series they are prompted for two data vectors and the program then reports including

- A scatter plot of the first against the second series with a best fit line
- Pearson's R. the F statistic, the regression coefficients slope and intercept and results from a t-test for the coefficients. You should investigate the help for *regstat*.

Or allow them to quit to the main menu.

If you have time, improve the usability of your program by using the functions at

http://www.mathworks.co.uk/help/matlab/ref/inputdlg.html

25 Reading data for a Matlab program

Write a program similar to Task 24, to perform the analysis on two data series but reading the data series from columns in a spreadsheet created in Excel.

Create a spreadsheet to test your program.

26 Creating a cell

Create the *cell* array cnames as follows:

```
cnames = {'jim', 'joe', 'jane', 'janet'};

% notice the use of the curly brackets {}
```

How does this differ from the array created by:

```
names = ['jim', 'joe', 'jane', 'janet' ]
```

Create

```
mixed_values = {'jim', 89, [5 2 1] };
```

What is the value returned by

```
mixed_values{3}(1)
```

Can you explain what this Matlab command does?

Create

```
mixed_values = ['jim', 89, [5 2 1] ];
```

What is the result?

27 Creating and using a struct

Create the following script

```
jim=struct('fName','jim','sName','Tyson','age',21)
kim=struct('fName','kim','sName','Dyson','age',12)

myclass=[kim, jim]

myclass(1)

myclass(1).fName

[rows cols]=size(myclass)
ages = []
fprintf('Forname  Surname Age\n')
for student = myclass
    fprintf('%s %s is %d \n',student.fName, student.sName, student.age)
    ages =[ages student.age];
end

avclassage = avg(ages);

fprintf('The average age of a student is %f \n', avclassage)
```

Write a new function that takes as its input a *structure* like myclass and returns the average age of students in myclass.

28 Extension Task - GUIs

Visit: http://www.mathworks.co.uk/help/matlab/examples/index.html

Watch the video tutorial:

Creating a GUI with GUIDE (10 min, 28 sec)

Work through: Displaying Matrix Data in a GUI
(http://www.mathworks.co.uk/help/matlab/examples/displaying-matrix-data-in-a-gui.html)

Using the Matlab documentation available:
http://www.mathworks.co.uk/help/matlab/index.html#gui-development

create a GUI of your own design.

Explore any examples of interest to you and the user community: Matlab Central.