Maths Skills (MTCS) G5071

Introduction

Kingsley Sage
Room 5C16, Pevensey III
khs20@sussex.ac.uk

Lecture 1

- What is this course going to cover?
  - Basic minimum maths skills that you will need to study computer science / cognitive computer science effectively
  - Challenge the assumption that maths is “hard”
  - MATLAB programming language
- Course assessment and support
  - 2 coursework assignments programming in MATLAB
  - Lab classes
  - Course web site at http://www.informatics.sussex.ac.uk/users/khs20/mtcs/mtcsmain.html

MATLAB

- MATLAB is an interactive system and programming language for general scientific computation
- MATLAB is widely used and available in computer labs on the campus
- Mathematics is the common language of science
- In MATLAB you can create your own re-usable tools – functions and programs (M-files)
- These tools can be grouped creating a *Toolbox* for working on particular classes of problem e.g. *Signals and Systems Toolbox* and *Symbolic Maths Toolbox*

MATLAB

- MATLAB is an *interpreted* language (unlike say C/C++ that are *compiled* languages)
- MATLAB is a *high level* language meaning that it deals in maths at a usefully abstract level without the user having to be concerned with what is happening at the machine / processor level
- (For advanced users): MATLAB can be integrated with compiled language functions when speed performance is more critical

Basic calculations

- Like a basic calculator MATLAB does simple maths multiplication, addition and subtraction
- It also handles complex numbers, square roots, powers, trig functions
- You can store and retrieve data; create, execute and save command sequences and lots of other interesting stuff we shall see …

```
>> 4+6+2

ans = 12
```

Operation	Symbol	Example
addition, a+b	+	5+3
subtraction, a-b	-	23-12
multiplication, a×b	*	3.14*0.85
division, a÷b	/ or \	56/8 = 8\56
power, a^b	^	5^2

Saving and retrieving data

- You can store information in MATLAB variables:

```
>> apples = 4;
>> bananas = 6;
>> melons = 2;
>> fruit=apples+bananas+melons % sum of current values

fruit=12
```

- The semicolon at the end of the line suppresses results
- The % introduces a comments – comments are for your benefit and are ignored by MATLAB

Saving and retrieving data

- You can edit this information using the cursor keys to change the values and fix any mistakes – you can check your variables

```
>> who

Your variables are:

ans apples bananas fruit melons
```

  - If you change the value of a variable apples = 6; then the value of fruit remains unchanged until explicitly re-evaluated (MATLAB variables have persistence)
  - The **File** menu has a **Save Workspace As** … item and MATLAB has commands **save** and **load**

More about variables

- MATLAB has rules about variable names which must be a single word without spaces:
  - Variables are case sensitive (`fruit`, `Fruit`, `FrUiT` and `FRUIT` are all different MATLAB variables)
  - Variables can contain up to 19 characters (any beyond the 19th are ignored)
  - Variables must start with a letter, followed by any number of letters, digits or underscores (Punctuation characters are not allowed since many have special meaning to MATLAB)

More about variables

- In addition, MATLAB has several special variables:

Variable	Value
`ans`	Default variable name used for results
`pi`	Ratio of the circumference of a circle to its diameter
`eps`	Smallest number such that when added to 1 creates a floating point number greater than 1 on the computer
`inf`	Infinity e.g. 1/0
`NaN`	Not-a-Number e.g. 0/0 (quick call a philiosopher)
`i and j`	i = j = square root = -1
`realmin`	The smallest usable positive real number
`realmax`	The largest usable positive real number

Common mathematical functions …

Variable	Value
`abs(x)`	Absolute value or magnitude of a complex number
`sqrt(x)`	Square root
`sin(x)`	Sine
`cos(x)`	Cosine
`ceil(x)`	Rounds a number upwards to the nearest integer
`floor(x)`	Rounds a number downwards to the nearest integer
`round(x)`	Rounds a number to the nearest integer
`real(x)`	The real part of a complex number
`imag(x)`	The imaginary part of a complex number
`log(x)`	Natural logarithm

Solving expressions

- Consider the quadratic equation $ax^2 + bx + c = 0$
- The roots (values of x where the equation is true) are given by: $x1,x2 = -b \pm \sqrt{(b2 - 4ac)} / 2a$
- If $a=1$, $b=5$, $c=6$, the solution is found by MATLAB as:

```
>> a=1;b=5;c=6;
>> x1=(-b+sqrt(b^2-4*a*c))/(2*a)
x1 = -2
>> x2=(-b-sqrt(b^2-4*a*c))/(2*a)
x2 = -3
>> a*x1^2+b*x1+c % substitute x1 to check …
ans =0
>> a*x2^2+b*x2+c % substitute x2 to check …
ans = 0
```

Solving expressions

- The last part of the calculation just checks the answers which are real
- MATLAB can also deal with complex numbers which have both a real and imaginary part without any special handling
- Try …

```
>> a=2;b=5;c=6;
>> x1=(-b+sqrt(b^2-4*a*c))/(2*a)
x1 =
  -1.2500 + 1.1990i

>> x2=(-b-sqrt(b^2-4*a*c))/(2*a)
x2 =
  -1.2500 - 1.1990i
```

Simple plots

- MATLAB has extensive graphics capabilities but for now just look at some simple plots of functions
- For example, plot the sine function over one cycle I.e. y=sin(x) for $0 \le x \le 2\pi$
- First create 30 points in our range using the MATLAB function `linspace` and find the sine of these points:

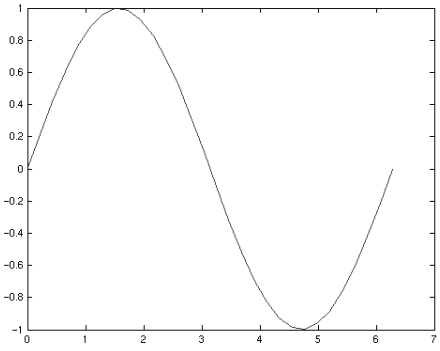
```
>> x=linspace(0,2*pi,30);
>> y=sin(x);

% the plot command generates a plot

>> plot(x,y)
```

Simple plots

- The MATLAB `plot` command is very powerful in choosing axis limits, marking data points, and drawing straight lines between them …



Online help

- You probably realise that MATLAB has many more commands than you could ever remember so extensive online help is available
- Three main forms: MATLAB command `help`, MATLAB command `lookfor`, and interactively using help from the menu bar
- If you know the topic, then `help <topic>` is simplest e.g.:

```
>> help(sqrt)
SQRT Square roor
SQRT(X) is the square root of the elements of X.
Complex results are produced is X is not positive.
See also SQRTM.
```

Online help

- There is a whole hierarchy of topics that you can search starting with the command `help` which lists all the main topics.
- Menu-drive help is available from the menu bar rather than the command line window so you can just click on the various options.
- The command `lookfor` searches all first lines to find your keyword.

```
>> lookfor complex
CONJ Complex conjugate
IMAG Complex imaginary part
REAL Complex real part
```

Next time …

- All about MATLAB files and programs
  - Functions and scripts
  - Control structures