ENME202 Matlab

INTRODUCTION

MATLAB INTERFACE

Current Folder: Displays Matlab files ("m-files" or scripts) in the current directory.

Editor: Built-in editor for writing m-files. You can copy & paste from a plain text file.

Command Window: Use to directly enter any Matlab command. You can run an m-file from this window by entering the file name, provided the file directory is part of your path.

Workspace: Shows all currently active variables

RUNNING MATLAB THROUGH UMD VIRTUAL LAB

Installing a native version of Matlab is recommended! However, if you are unable to install Matlab on your computer for any reason, Matlab can run without being installed by using the Virtual Computer Lab: http://virtlab.eng.umd.edu

When using Virtual Lab, always save your files to the U: volume to ensure that your code will remain available after closing the current Citrix session

HELP COMMANDS:

- help --> local help file
- lookfor --> search local help files for keyword
- doc --> online help file
- docsearch --> search online docs for keyword

Help topics are organized by classes of operators and functions.In addition to the core language elements under the "matlab" topic, specific help is also available for different packages (simulink, control, curvefit, etc.) available in Matlab.

```
% help            % view all available topics (now deprecated...)
% help lang       % view a summary of built-in programming language constructs
% help if         % view details on "if" statement usage
% help helptools  % view all available help tools
```

"doc" will display the HTML document page for a given topic, often with more discussion and examples than the help page. When available, the document page can also be accessed from a link to the "Reference page" at the bottom of the help page:

```
% doc if    % bring up document page for the "if" conditional statement
```

"lookfor" / "docsearch" will display a list of local / online help files containing the desired term:

```
lookfor dot
```

```
dot                          - Vector dot product.
dot                          - Vector dot product for tall arrays.
dotParenReference            - Dot-parens subscripted reference for a table
subsasgnDot                  - Subscripted assignment to a table.
```

```
subsrefDot                      - Subscripted reference for a table.
dotAssign                       - Subscripted assignment to a table using dot
dotReference                    - SUBSREFDOT Subscripted reference for a table
```

BASIC ARITHMETIC AND COMPUTATIONAL ERROR

Typing a mathematical expression in the command window will yield a result, similar to the functionality of a calculator:

Basic arithmetic (+, -)

```
2+2
```

```
ans = 4
```

```
2-2
```

```
ans = 0
```

Multiplication (*)

```
2*3
```

```
ans = 6
```

Exponentiation (^) (caret)

```
2^3
```

```
ans = 8
```

Fractional powers

```
2^0.5
```

```
ans = 1.4142
```

Increase number of significant digits displayed

```
format long
2^0.5
```

```
ans =
   1.414213562373095
```

Go back to default number of sig digits

```
format short
sqrt(2)
```

```
ans = 1.4142
```

There is a finite precision with which numbers can be represented, leading to rounding errors:

```
sqrt(2)^2 - 2   % Should be zero, but...
```

```
ans = 4.4409e-16
```

eps (epsilon) is the smallest significand (decimal part) difference that Matlab can represent

```
format long
eps         % ans = 2.220446049250313e-016
```

```
ans =
     2.220446049250313e-16
```

Matlab uses the international standard IEEE 754 for "high" precision representation of decimal numbers. This standard uses 52 bits to represent the significand. There are thus "gaps" between the numbers of length:

```
1 / 2^52    % ans = 2.220446049250313e-016
```

```
ans =
     2.220446049250313e-16
```

(this result is exactly the value of eps)

Two numbers whose significand differs by less than eps (after rounding) are identical to the computer. For example, (1+eps/2) is rounded down to nearest representable number, 1:

```
(1+eps/2) - 1
```

```
ans =
     0
```

Here, (1+2*eps/3) is rounded up to nearest representable number, 1+eps:

```
(1+2*eps/3) - 1
```

```
ans =
     2.220446049250313e-16
```

Let's try

```
(1-1)+eps/2   % same as (1+eps/2) - 1, but with the parentheses moved
```

```
ans =
     1.110223024625157e-16
```

Note: (1+eps/2)-1 produces 0 but (1-1)+eps/2 produces eps/2!

This shows that the round-off error should be thought of in a "relative" sense (relative to the numbers involved in the calculation).

Just to confirm this, try

```
1e-30 - 1e-31
```

```
ans =
     9.000000000000001e-31
```

Clearly Matlab can take differences (and multiplication, etc.) of numbers smaller than eps, so we need to think of the round-off error as "relative".

Note that successive calculations can *each* incur round-off error on the order of eps, so large expressions or repeated calculations can build up significant error if you are not careful!

CORE FUNCTIONS

sqrt() is one of the many built-in (core) functions in Matlab.

Each function does a mathematical calculation on the argument (input) being passed to the function.

exp() is Euler's number (e): e^x = exp(x)

```
format short
exp(1)    % e^1 = e, so ans = 2.7183
```

```
ans = 2.7183
```

log() is log base e (equivalent to natural log; ln)

```
log(exp(1))    % log base e, so log(e) = 1
```

```
ans = 1
```

```
exp(log(8))
```

```
ans = 8.0000
```

Just for fun, what is exp(log(8))-8?

```
exp(log(8)) - 8     % ans = -1.7764e-15 = 8*eps
```

```
ans = -1.7764e-15
```

log10() is log base 10

```
log10(8)
```

```
ans = 0.9031
```

```
10^(log10(8))
```

```
ans = 8.0000
```

Absolute value

```
abs(-2)
```

```
ans = 2
```

Trigonometric functions (arguments in radians)

```
sin(30 * pi/180)
```

```
ans = 0.5000
```

Append a "d" to the function name to work in degrees

```
sind(30)
```

```
ans = 0.5000
```

Note that pi is pre-defined

```
pi    % ans = 3.1416
```

```
ans = 3.1416
```

List all elementary math functions

```
help elfun
```

```
  Elementary math functions.

  Trigonometric.
    sin         - Sine.
    sind        - Sine of argument in degrees.
    sinh        - Hyperbolic sine.
    asin        - Inverse sine.
    asind       - Inverse sine, result in degrees.
    asinh       - Inverse hyperbolic sine.
    cos         - Cosine.
    cosd        - Cosine of argument in degrees.
    cosh        - Hyperbolic cosine.
    acos        - Inverse cosine.
    acosd       - Inverse cosine, result in degrees.
    acosh       - Inverse hyperbolic cosine.
```