

Introduction to MATLAB

ChEn 1703

<http://www.che.utah.edu/~sutherland/wiki>

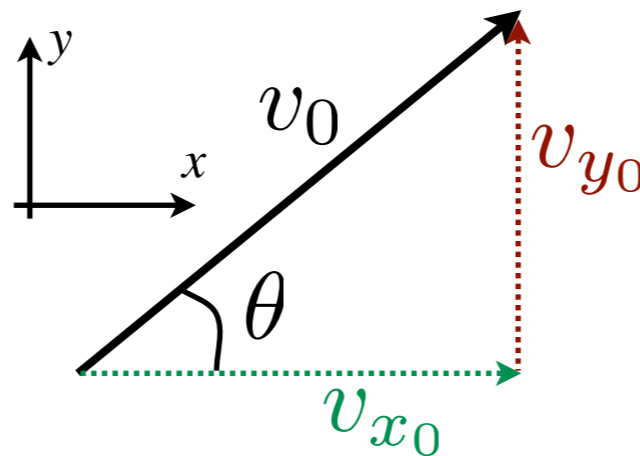
Example: Projectile Motion

Given an initial velocity of 20 m/s at an angle of 39° , calculate the position and velocity of the projectile at 5, 10, and 20 seconds.

Fundamental principle:
conservation of momentum.

Assumptions:

- Gravity acts in the (-y) direction
- No air resistance



$$v_x = v \cos(\theta)$$

$$v_y = v \sin(\theta)$$

$$v = \sqrt{v_x^2 + v_y^2}$$

Define: $x_0 = 0 \frac{\text{m}}{\text{s}}$

$$y_0 = 0 \frac{\text{m}}{\text{s}}$$

$$a = -9.8 \frac{\text{m}}{\text{s}^2}$$

Position $x = x_0 + v_x t$

$$y = y_0 + v_{y0} t + \frac{1}{2} a t^2$$

Velocity $v_x = \text{constant}$

$$v_y = v_{y0} + a t$$

Algorithm:

1. Calculate v_x, v_y from v_0 and θ .
2. Calculate x and y at the desired time.
3. Calculate v_x and v_y at the desired time.
4. Calculate v .

MATLAB Environment

- MATLAB = Matrix Laboratory
- Collection of computational tools
 - Allows us to perform complicated calculations easily.
 - Many tools built-in to help you.

- Command Window
 - Use as a “super calculator”
 - “help”

- MATLAB Editor
 - Use to create “scripts” - collection of commands (more soon...)
 - Can be used in debug mode - step through each command to see what is happening.
 - Anything valid in the command window is valid here...
 - Use ‘%’ to generate a comment - anything after ‘%’ is ignored until a new line.
 - ▶ Use this to make your code readable - document it for yourself and others!

Command	Description
<code>who</code>	List variables currently defined in Matlab.
<code>whos</code>	List all information about variables currently defined in Matlab.
<code>what</code>	List Matlab files in the current directory.
<code>clear</code>	Remove all defined variables from memory. Can clear a single variable by <code>clear a;</code>
<code>cls</code>	clear the command window
<code>close all</code>	close all figures

Working Directory

first place MATLAB looks for scripts and to load/save files.
Suggestion: set this to the directory that you want to work in.

The screenshot displays the MATLAB 7.4.0 (R2007a) environment. The File Editor window on the left shows a script with the following code:

```
1 %*****
2 %
3 %           | AUTHOR: James Sutherland |
4 %           |           CHFEN 1703   |
5 %           |_____
6 % This routine creates a table of temperature conversions from
7 % Celsius to Fahrenheit
8 %
9 %*****
10
11 - clear; % Clear all variables from MATLAB's memory
12 - clc;   % Clear the display
13
14
15 %----- Perform the calculations -----
16 - T_f = [32 : 10 : 212]'; % Define a column vector containing the
17 %           % temperatures in oF that we want
18 %           % to convert to oC
19
20 - T_c = 5/9 * (T_f-32); % Calculate the temperature in oC
21
22
23 %----- Print out the results -----
24 - disp('Here is a list of temperature conversions:')
25 - disp('T(oF)      T(oC)') % Print the column headings
26
27 - disp([T_f, T_c]); % This creates a matrix with two columns:
28 %           % the first column is the temp in oF and the
29 %           % second column is the temp in oC
30
31
```

The Command Window on the right shows the prompt `>> |` and a message: "This is a Classroom License for instructional use only. Research and commercial use is prohibited."

File Editor

MATLAB's built-in text editor to help you create & edit M-files (MATLAB scripts)

Command Window
interactively issue commands to MATLAB

MATLAB Basics

Defining Variables

- Variables may have any name, but no spaces in variable names
- Case-sensitive
 - ▶ `myVariable`, `myvariable`, `MyVariable`, `MYVARIABLE`, are all *different*.
- Variables may be defined as constant, or result of an expression.
 - ▶ `a=5; b=pi; c=a*b; (c=5*pi)`
- Use a semicolon ';' to terminate a Matlab statement.
 - ▶ Omitting ';' will result in the statement's result being printed to the screen.

Expressions

- May use variables and/or constants.

Arrays (Matrices & Vectors)

 Scalar - a single number

- `a=5; b=2.3; d=1.403e-8; c=a*b;`

 Vector - a collection of scalar values

- `f = [7.6, pi, a, 5.3e-2, b+c*d]; % a vector`
- `f = [1 2 3]; f=[1; 2; 3]; % row vectors`
- `f = [1; 2; 3]; f=[1 2 3]'; % column vectors`

$$f = [7.6 \quad 3.1415 \quad 0.053 \quad 2.3]$$

$$f = [1 \quad 2 \quad 3]$$

$$f = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$$

 Matrix - a collection of vectors

- `A = [1 2 3; 4 5 6;];`
- `arow1 = [1 2 3]; arow2 = [4 5 6]; A=[arow1; arow2];`

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix}$$

 All are treated the same in Matlab

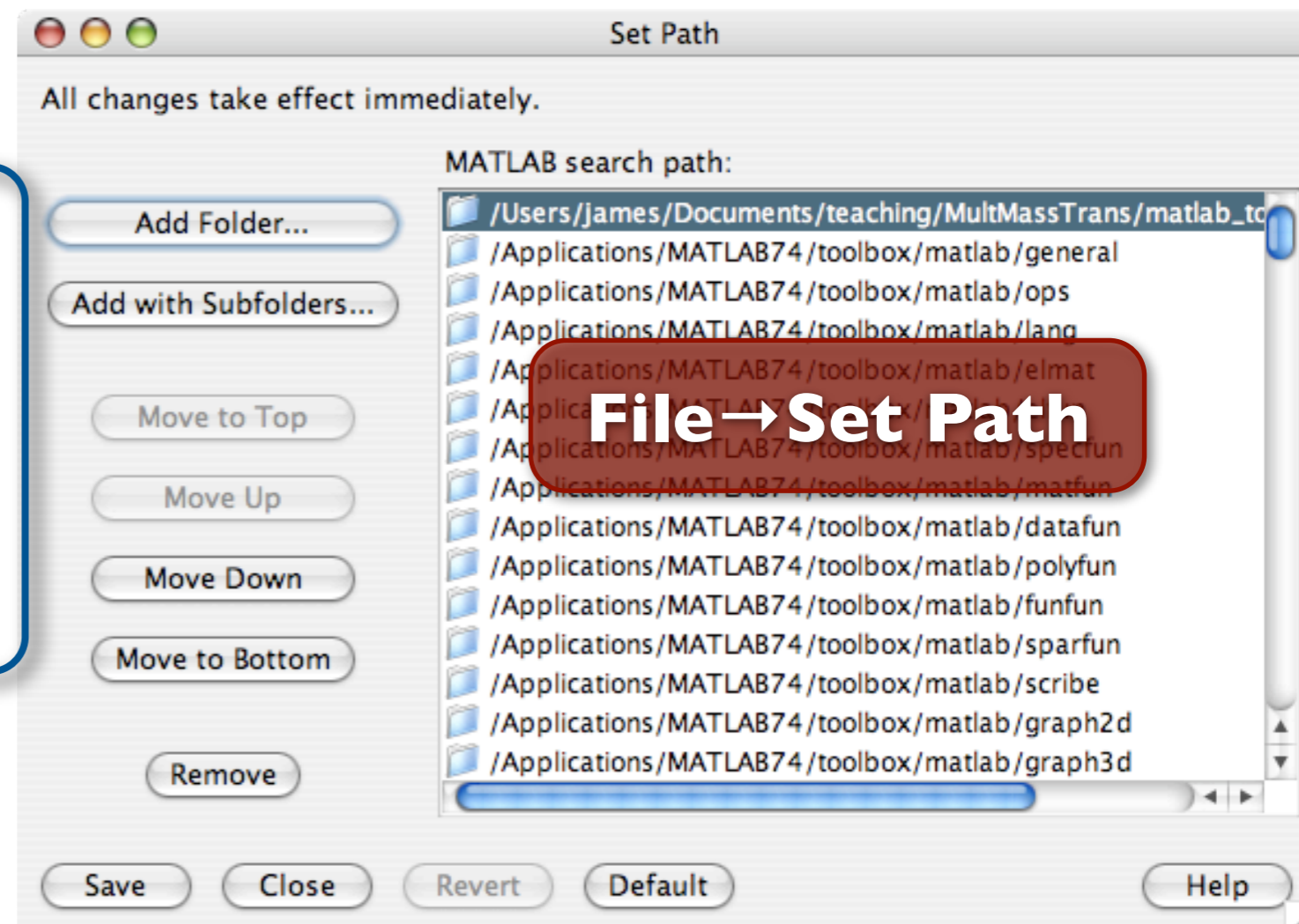
- More soon.

MATLAB's Path

- Path - set of directories where MATLAB should look for information.
- Save files anywhere you want. Make them accessible to MATLAB by adding the directory to the path.
 - Allows you to organize files better...

When you type something in MATLAB:

- If it is a variable, its value is displayed.
- If it is a “built-in” command, it is executed.
- The current directory is searched for an m-file with that name.
- The path is searched (in order) for an m-file with that name.



Some Useful Functions

Misc. Functions	
exp(x)	e^x
sqrt(x)	\sqrt{x}
log(x)	$\ln(x)$
log10(x)	$\log(x), \log_{10}(x)$

For help on any function, use
Matlab's "help" function
Example: **help cos**

Trigonometric Functions see table 3.1-2	
sin(x)	asin(x)
cos(x)	acos(x)
tan(x)	atan(x)
sec(x) - secant	asec(x)
csc(c) - cosecant	acsc(x)
cot(x) - cotangent	acot(x)
sinh(x) - hyperbolic sine	
cosh(x) - hyperbolic cosine	
tanh(x) - hyperbolic tangent	

Many other functions...