Week 7 Tutorial 3

The purpose of this tutorial is to demonstrate plotting with multiple plots in a single figure window. This is referred to as sublplots.

Note: One nice feature of live scripts is it allows you to use the "Run section" button or "Ctrl+r" or "Cmd+r" to will run each section (differentiated by the blue line) and you can see the plot change as we add more lines of code to give more detail to the plot. If you use the "Run section" button or shortcut, be sure to run each section, you cannot skip to a particular section without first running the prevoius sections as the setup variables won't exist.

```
% Always clear workspace variables before a new tutorial or program.
clear
clc
close all  % closes all figure windows
```

Edit the code below and update the variable named **`name`** with your name for this tutorial in the code below.

```
name="";
fprintf("Output for Tutorial_07_3 run by %s.\n\n", name)
```

Input

```
% Define GRAVITY in m/s^2
GRAVITY=9.81;

% Ask for the launch speed and direction of the projectile
vi=input('Enter the launch speed in m/s: ');
theta=input('Enter the launch angle in degrees above horizontal: ');
```

Manipulation

```
% Compute total time of flight and time to peak in seconds
tFlight=(2*vi*sind(theta))/GRAVITY;
tPeak=tFlight/2;

% Compute values at the peak
xPeak=vi*cosd(theta)*tPeak; % horizontal position in m
yPeak=vi*sind(theta)*tPeak - ((GRAVITY*tPeak^2)/2); % vertical position in m
vxPeak=vi*cosd(theta); % horizontal velocity in m/s (it is constant during the flight)
vyPeak=vi*sind(theta) - GRAVITY*tPeak; % vertical velocity in m/s
vPeak=sqrt(vxPeak^2 + vyPeak^2); % magnitde of velocity in m/s

% Create vectors for velocities and time
t=linspace(0,tFlight,30); % create 30 linearly spaced time values
vx=linspace(vxPeak, vxPeak, 30); % velocity x component in m/s
vy=vi*sind(theta) - GRAVITY.*t; % velocity y component in m/s
v=sqrt(vxPeak^2 + vy.^2);  % magnitude of velocity in m/s

% Create vectors for positions along the 30 points
```

```
x=vx.*t; % position x component
y=vi*sind(theta)*t - ((GRAVITY*t.^2)/2); % position y component
```

Plot 1 - Projectile Trajectory

In plot 1, we'll plot the trajectory of the projectile but, we will also plot the peak trajectory, we do this by providing a second dataset but we'll just use one point. We will also identify that point by adding some formatting to the point, otherwise it would show up as a blue dot that would not be easily identifiable on the plot.

The subplot command

In addition, you'll notice we use the `subplot()` function, this creates a figure window with numerous plots within that figure window. The format is much like we've seen when declaring vectors and is as follows `subplot(numRows, numCols, activeGraph)` where activeGraph is the plot you want to apply the following code to. Much like `figure(1)` tells MATLAB which figure window to apply configurations to. The order is as you would read a book, starting at the top left, move left to right and top to bottom.

```
% The subplot(rows, columns, active graph) function breaks the figure
% window into the desired number of graphs and selects the active graph to
% create.
subplot(2,2,1) % splits the figure window into 2 row and 2 columns of graphs
               % which is 4 graphs total.  The 1 represents the first graph
               % which is the graph in row 1 and column 1 of the window.

% The following plot command creates a line graph of the x and y vectors
% and also plots the point (xPeak,yPeak) with a red asterisk
plot(x,y,xPeak,yPeak,'r*')
% axis sets [xmin, xmax,ymin,ymax] for the axes
axis([0,2*xPeak,0,yPeak])
grid on  % adds gridlines to the graph
% The following add a title, axis labels, and a legend
title('Trajectory of a Projectile')
xlabel('Horizontal Position (m)')
ylabel('Vertical Velocity (m)')
legend('Trajectory','Peak') % you may move the legend box with the mouse in
                            % the figure window
```

Plot 2 - Magnitude of Velocity

The following will plot the magnitude of the velocity in the second subplot (upper right).

```
subplot(2,2,2) % graph number 2 is now active (1st row, 2nd column)

% The following plot command creates a line graph of the t and v vectors
% and also plots the point (tPeak,vPeak) with a red asterisk
plot(t,v,tPeak,vPeak,'r*')
axis([0,tFlight,vPeak,vi])
grid on
title('Velocity of a Projectile')
xlabel('Time (s)')
```

```
ylabel('Magnitude of Velocity (m/s)')
legend('Velocity','Peak Velocity')
```

Plot 3 - Velocity in the X Direction

The following will plot the velocity x component in the third subplot (lower left).

```
subplot(2,2,3) % graph number 3 is now active (2nd row, 1st column)

% The following plot command creates a line graph of the t and vx vectors
% and also plots the point (tPeak,vxPeak) with a red asterisk
plot(t,vx,tPeak,vxPeak,'r*')
axis([0,tFlight,0,vi])
grid on
title('Horizontal Velocity of a Projectile')
xlabel('Time (s)')
ylabel('Horizontal Velocity (m/s)')
legend('Vx','VxPeak')
```

Plot 4 - Velocity in the X Direction

The following will plot the velocity y component in the third subplot (lower right).

```
subplot(2,2,4) % graph number 4 is now active (2nd row, 2nd column)

% The following plot command creates a line graph of the t and vy vectors
% and also plots the point (tPeak,vyPeak) with a red asterisk
plot(t,vy,tPeak,vyPeak,'r*')
axis([0,tFlight,-vi,vi])
grid on
title('Vertical Velocity of a Projectile')
xlabel('Time (s)')
ylabel('Vertical Velocity (m/s)')
legend('Vy','VyPeak')
```

Example Output:

Run this tutorial from the **Command Window** and ensure your output matches the following. Your numbers don't have to match, for reference, I entered a launch speed of 90m/s and launch angle of 55 degrees.

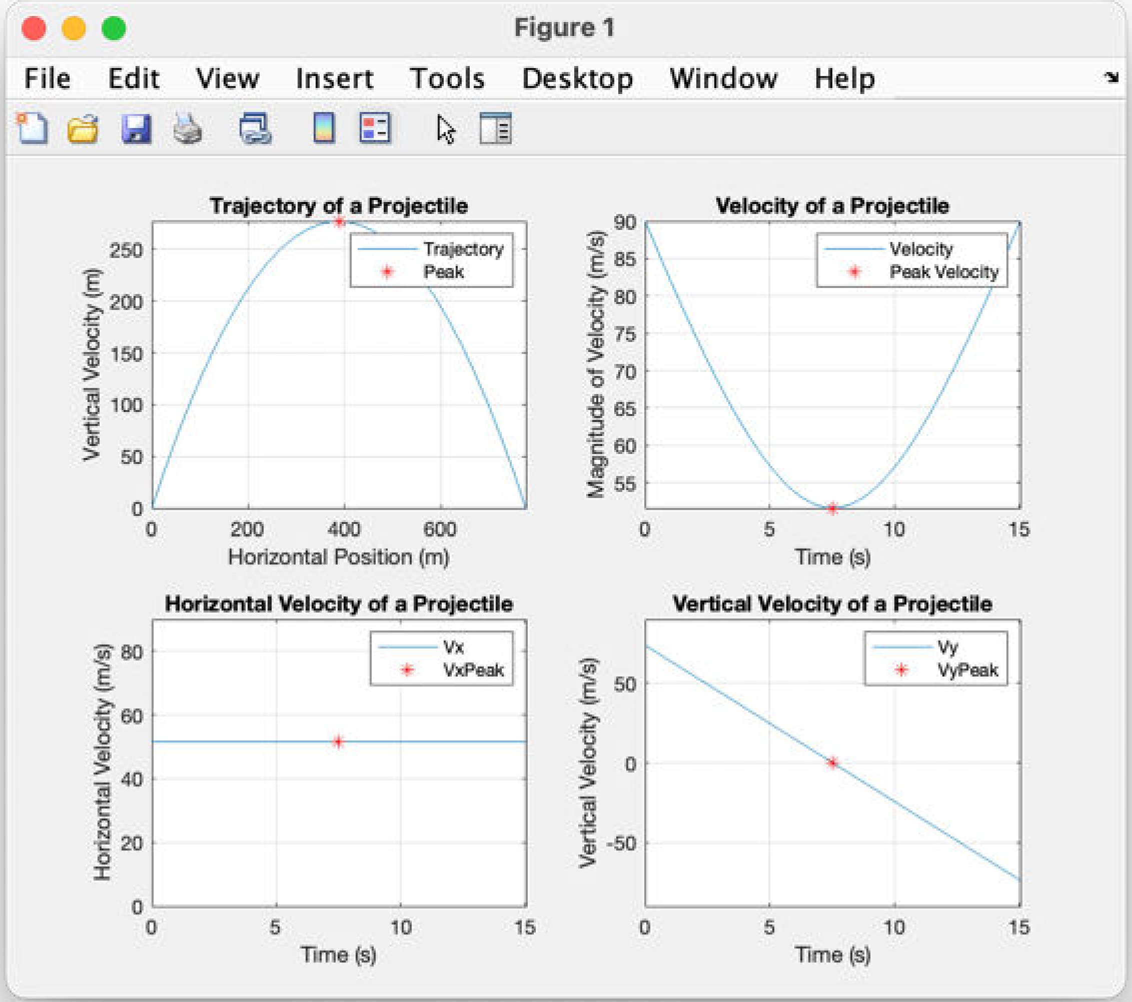
Figure 1
File
Edit
View
Insert
Tools
Desktop
Window
Help
Trajectory of a Projectile
Trajectory
Peak
Vertical Velocity (m)
Horizontal Position (m)
0
50
100
150
200
250
0
200
400
600
Velocity of a Projectile
Velocity
Peak Velocity
Magnitude of Velocity (m/s)
Time (s)
55
60
65
70
75
80
85
90
0
5
10
15
Horizontal Velocity of a Projectile
Vx
VxPeak
Horizontal Velocity (m/s)
Time (s)
0
20
40
60
80
0
5
10
15
Vertical Velocity of a Projectile
Vy
VyPeak
Vertical Velocity (m/s)
Time (s)
-50
0
50
0
5
10
15