# Discrete Structures: CMPSC 102

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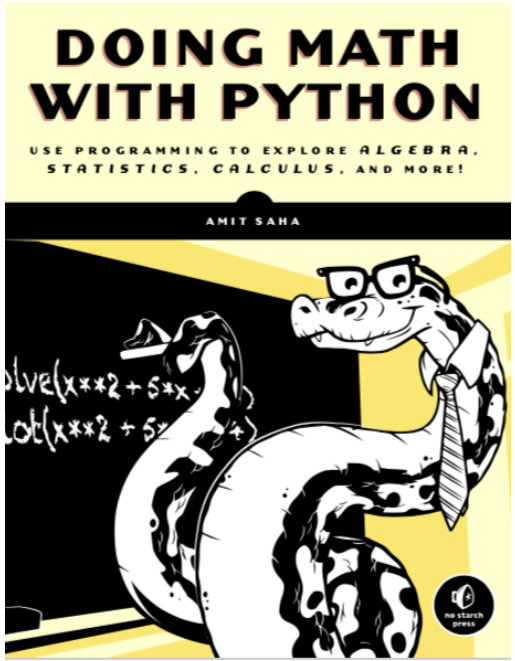
Fall 2018
Week 11

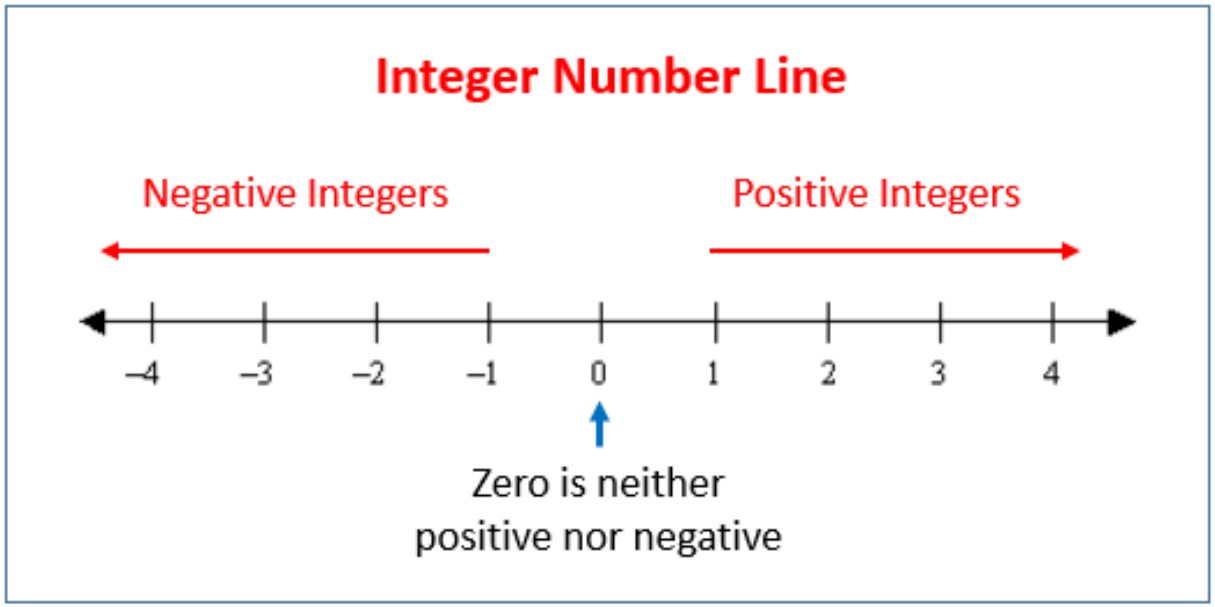



## Saha, Chapter 2: Visualizing Data with graphs

- How to present data with graphics
- Plotting basic numbers
- Plotting results from equations
- Plotting all kinds of things!

# A Number Line: $x$

## Denoted $R$

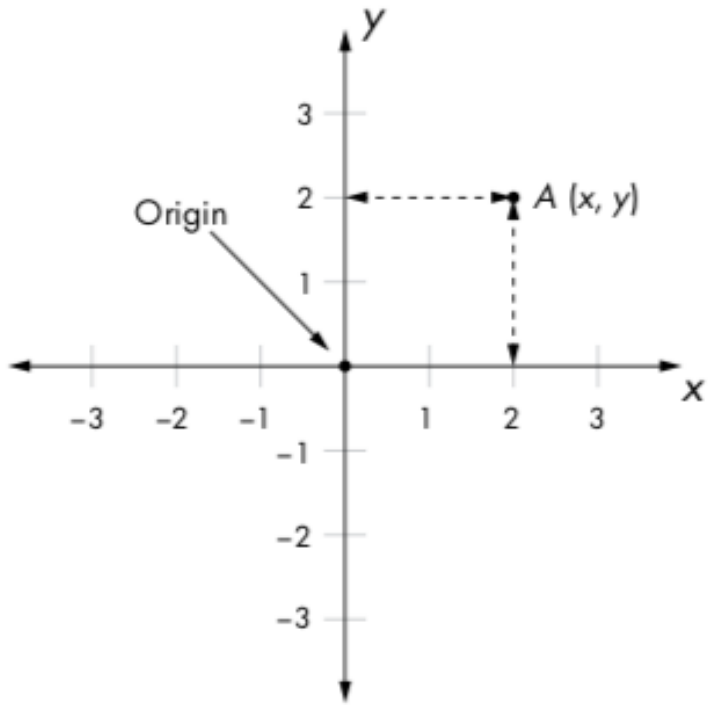



- The $x$-axis runs horizontally left to right
- The middle of the number line is where $x = 0$
- Left of 0: negative numbers (all kinds of numbers!)
- Right of 0: positive numbers (all kinds of numbers, too!)

# Cartesian system, 2-D Coordinates: $x$ and $y$

## Denoted $R^2$

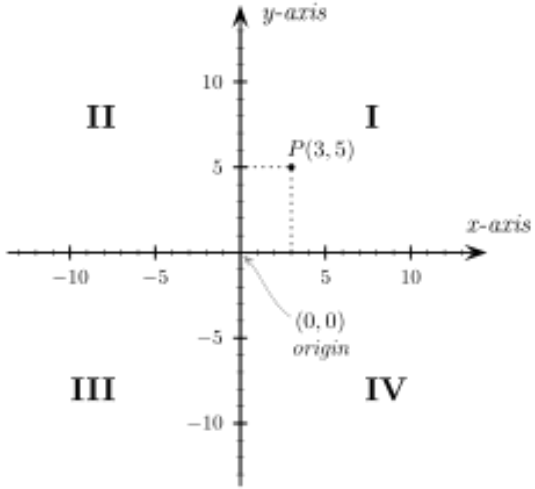





- The $x$-axis runs along the bottom (horizontally left to right)
- The $y$-axis runs along the side (vertically bottom to top)
- Typically, the $(0, 0)$ point (the origin) is shown where $x = 0$ and $y = 0$

# 2-D Coordinates: $x$ and $y$

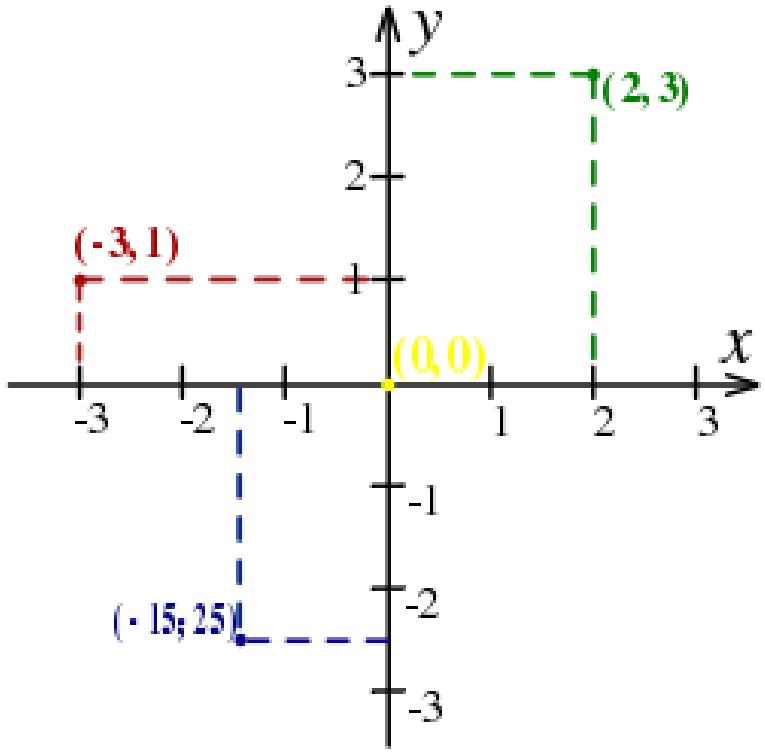
## Denoted $R^2$




- The two number lines are called the $x$-axis and the $y$-axis and are called the *coordinate axes*
- The intersection of the values of $x$ and $y$ creates the 2-D point (called the ordered pair) on the canvas.
- There are four quadrants defined by:
  1. Quadrant I: $(x, y)$
  2. Quadrant II: $(-x, y)$
  3. Quadrant III: $(-x, -y)$
  4. Quadrant IV: $(x, -y)$

# Example Coordinates: $x$ and $y$

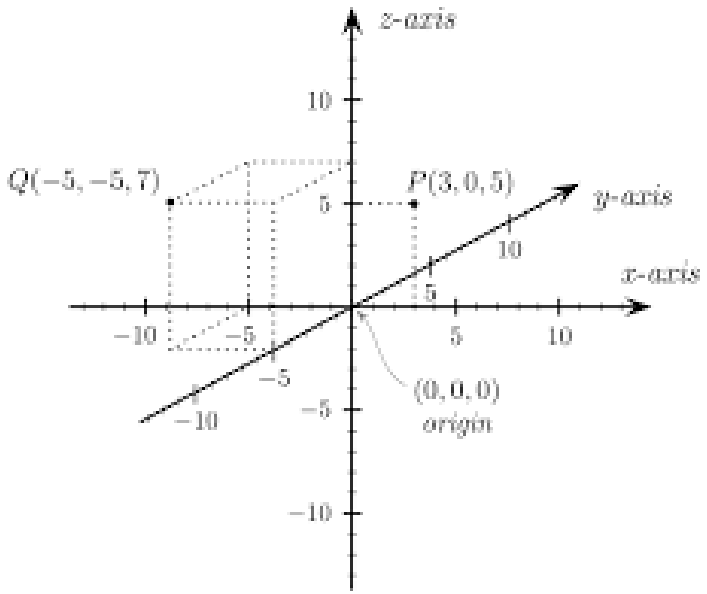
## Example plot




- Origin: $(0, 0)$
- Green: $(2, 3)$
- Red: $(-3, 1)$
- Blue: $(-1.5, -2.5)$

# 3-D Coordinates: $x$, $y$, and $z$

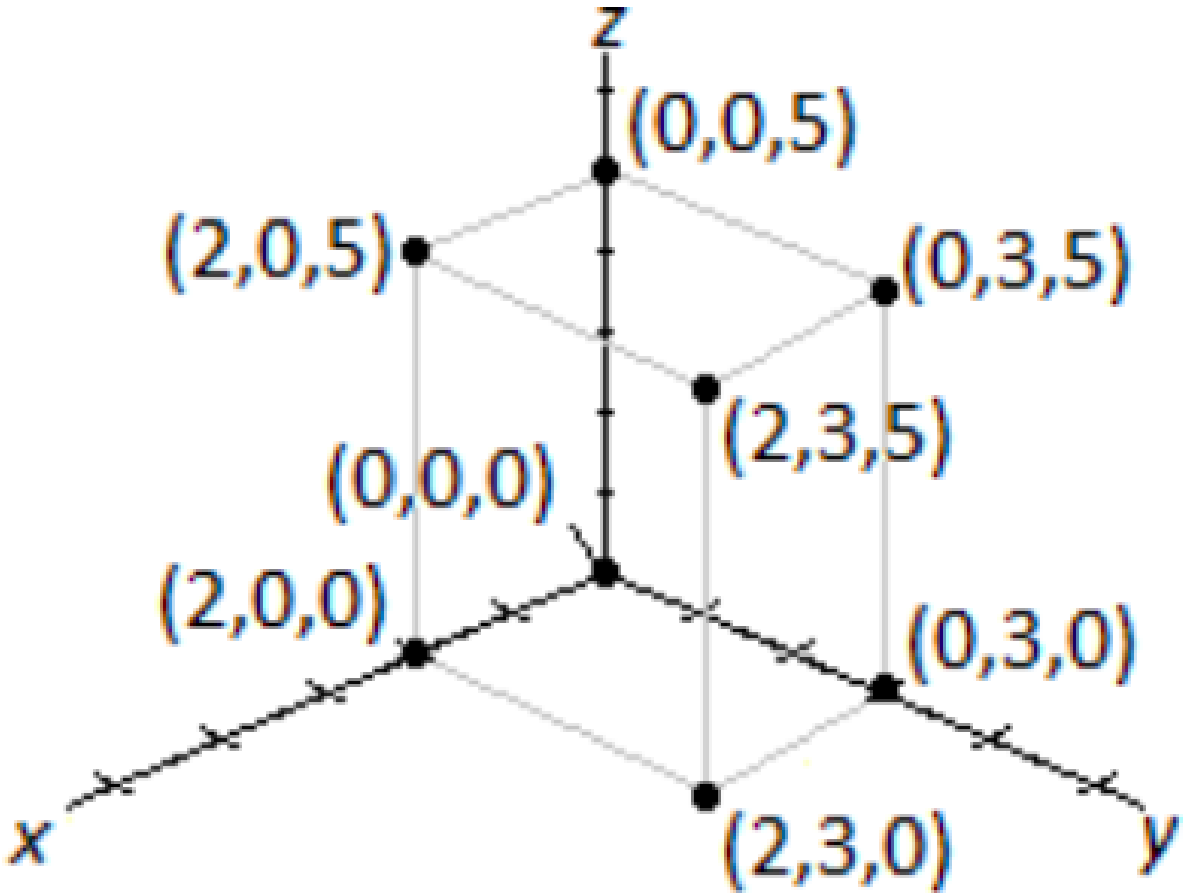
## Denoted $R^3$




- The three number lines are called the $x$-axis, the $y$-axis, and the $z$-axis and are called the *coordinate axes*
- The intersection of the values of $x$, $y$ and $z$ creates the point defined by the ordered triple on the canvas.
- The $z$-axis:

# 3-D Coordinates: $x$, $y$, and $z$

## Example plot



# Creating Plots with Matplotlib




- We first need to know that the library is installed on your machine.

python3

```
from pylab import plot, show
```

- https://matplotlib.org/index.html
- https://matplotlib.org/3.0.0/users/installing.html

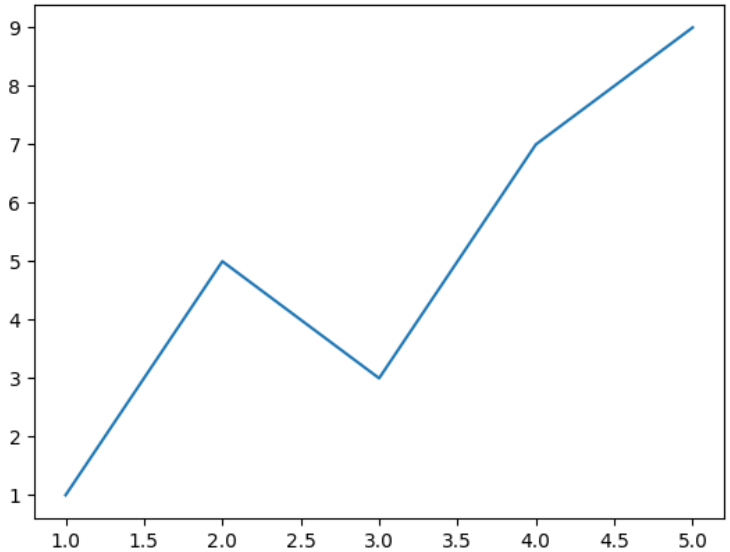
# Your First Plot

## Plot some simple points



### Place in python3 or in a python3 program file

```
from pylab import plot, show #get the library
x_num = [1,2,3,4,5] #def of x
y_num = [1,5,3,7,9] # def of y
plot(x_num, y_num)  # gives mem addr of obj
show() # draw the plot on canvas
```



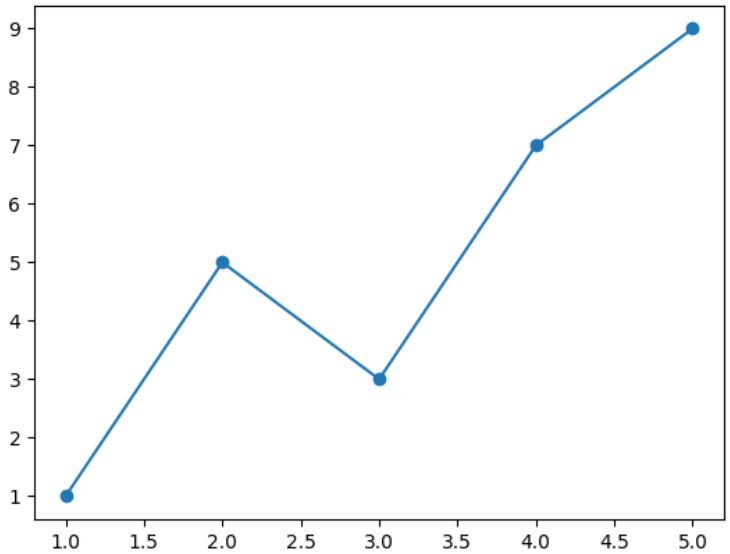
# Gimme Points, Not Lines

## Plot some basic numbers using points



### Place in python3 or in a python3 program file

```
from pylab import plot, show #get the library
x_num = [1,2,3,4,5] #def of x
y_num = [1,5,3,7,9] # def of y
plot(x_num, y_num, marker ='o')
# also including 'o', '*', 'x', and '+' as points
show() # draw the plot on canvas
```



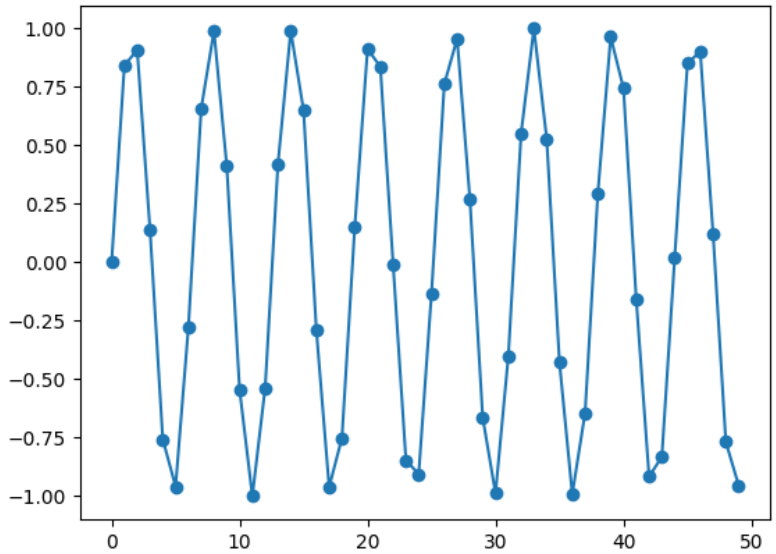
# Another Amazing Example!

## Plot the sin wave



### Place in python3 or in a python3 program file

```
from pylab import plot, show #get the library
import math
x_num = [i for i in range(50)]
y_num = [math.sin(i) for i in x_num]
plot(x_num, y_num, marker ='o')
# also including 'o', '*', 'x', and '+' as points
show() # draw the plot on canvas
```

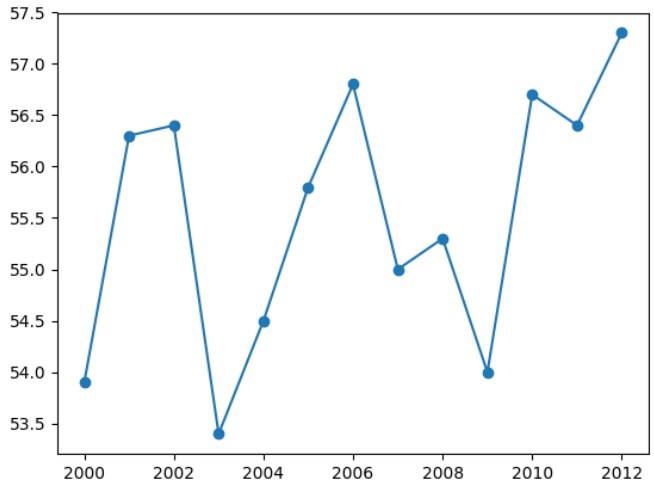


# Yet, **Another** Amazing Example!

## Plot the temperature in NYC and save the file too!

### Place in python3 or in a python3 program file

```
from pylab import plot, show, savefig #note savefig
nyc_temp = [53.9, 56.3, 56.4, 53.4, 54.5, 55.8,
56.8, 55.0, 55.3, 54.0, 56.7, 56.4, 57.3]
years = range(2000, 2013)
plot(years, nyc_temp, marker='o')
# also including 'o', '*', 'x', and '+' as points
savefig('mygraph.png') #save in root directory
show() # draw the plot on canvas
```



# Three Plots Together! Amazing!

## Plot the temperature in NYC aggregated by time



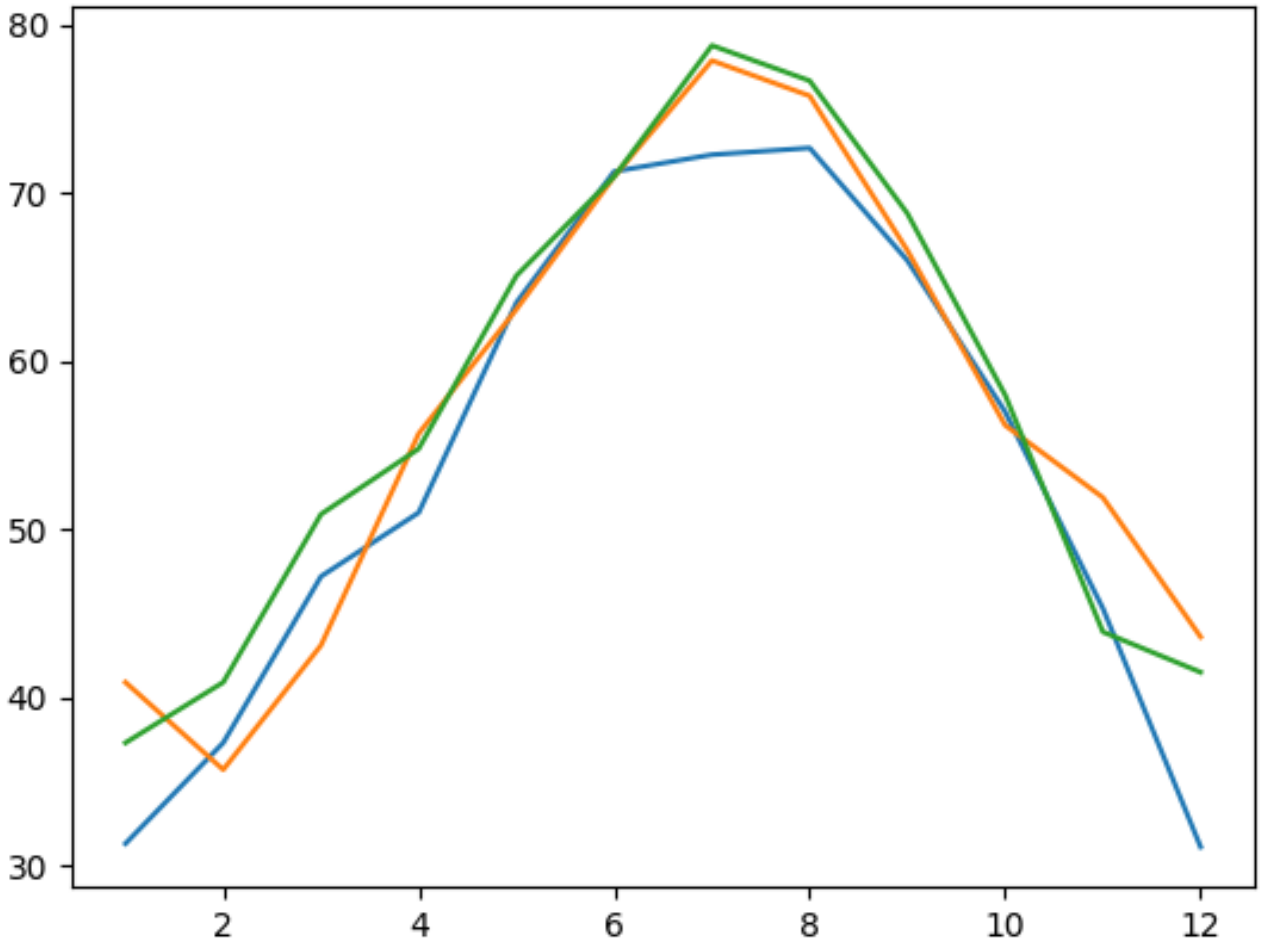
### Place in python3 or in a python3 program file

```
from pylab import plot, show, savefig #note savefig
months = range(1, 13)

nyc_temp_2000 = [31.3, 37.3, 47.2, 51.0, 63.5, 71.3,
72.3, 72.7, 66.0, 57.0, 45.3, 31.1]

nyc_temp_2006 = [40.9, 35.7, 43.1, 55.7, 63.1, 71.0,
77.9, 75.8, 66.6, 56.2, 51.9, 43.6]

nyc_temp_2012 = [37.3, 40.9, 50.9, 54.8, 65.1, 71.0,
78.8, 76.7, 68.8, 58.0, 43.9, 41.5]

plot(months, nyc_temp_2000, months, nyc_temp_2006,
months, nyc_temp_2012)
savefig('mygraph.png') #save in root directory
show() # draw the plot on canvas
```

# Three Plots Together! Amazing!

## Plot the temperature in NYC aggregated by time





# Three Plots Together! And a LEGEND too!

## Plot the temperature in NYC aggregated by time



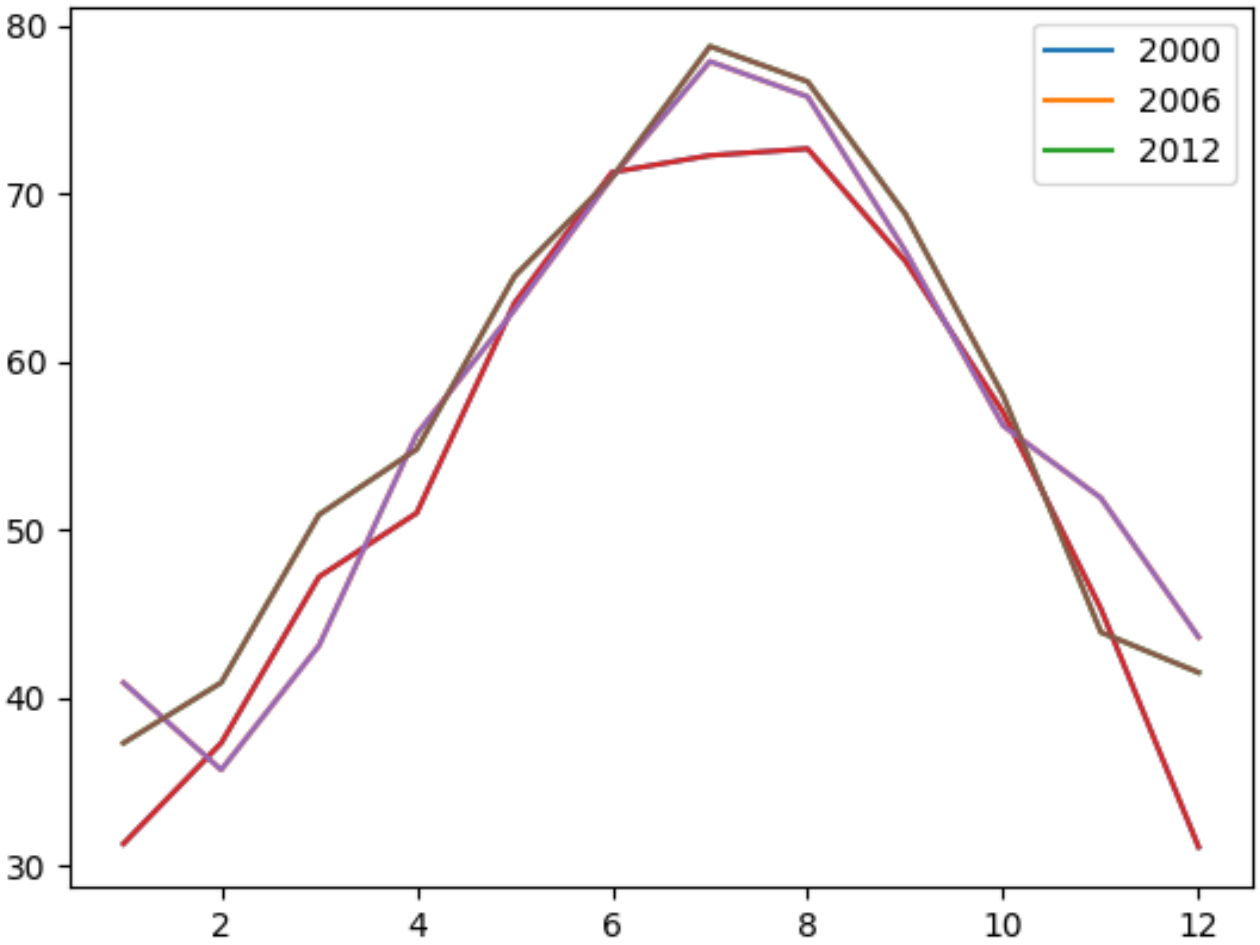
### Place in python3 or in a python3 program file

```
from pylab import plot, show, savefig, legend #note legend
months = range(1, 13)
nyc_temp_2000 = [31.3, 37.3, 47.2, 51.0, 63.5, 71.3,
72.3, 72.7, 66.0, 57.0, 45.3, 31.1]

nyc_temp_2006 = [40.9, 35.7, 43.1, 55.7, 63.1, 71.0,
77.9, 75.8, 66.6, 56.2, 51.9, 43.6]

nyc_temp_2012 = [37.3, 40.9, 50.9, 54.8, 65.1, 71.0,
78.8, 76.7, 68.8, 58.0, 43.9, 41.5]

plot(months, nyc_temp_2000, months, nyc_temp_2006,
months, nyc_temp_2012)
legend([2000, 2006, 2012]) # make the legend
savefig('mygraph.png') #save in root directory
show() # draw the plot on canvas
```

# Three Plots Together! And a LEGEND too!

## Plot the temperature in NYC aggregated by time





# Add Title and Axes Descriptions!

## Plot the temperature in NYC aggregated by time



### Place in python3 or in a python3 program file

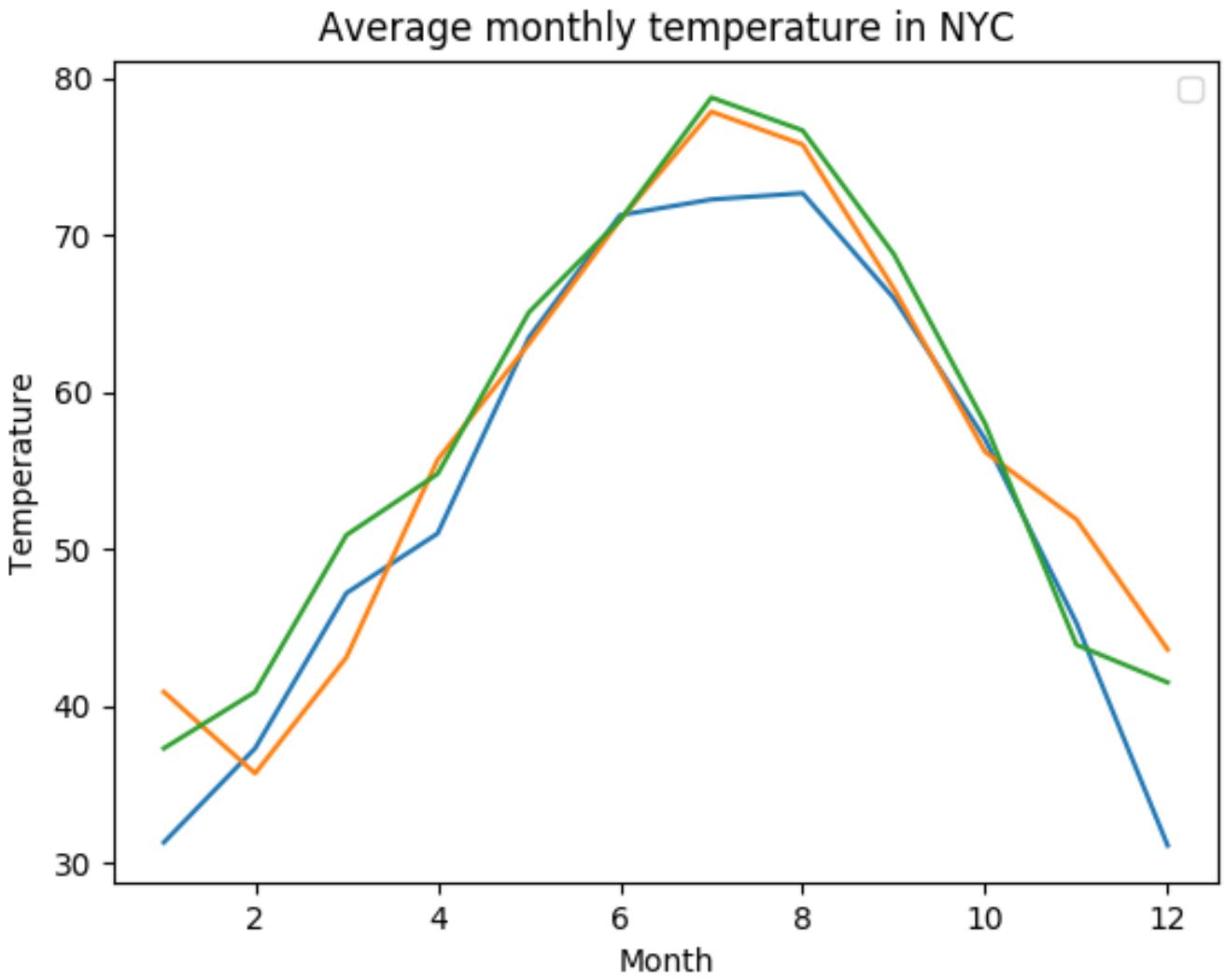
```
from pylab import plot, show, title, savefig, xlabel, ylabel, legend
months = range(1, 13)

nyc_temp_2000 = [31.3, 37.3, 47.2, 51.0, 63.5, 71.3,
72.3, 72.7, 66.0, 57.0, 45.3, 31.1]

nyc_temp_2006 = [40.9, 35.7, 43.1, 55.7, 63.1, 71.0,
77.9, 75.8, 66.6, 56.2, 51.9, 43.6]

nyc_temp_2012 = [37.3, 40.9, 50.9, 54.8, 65.1, 71.0,
78.8, 76.7, 68.8, 58.0, 43.9, 41.5]

plot(months, nyc_temp_2000, months, nyc_temp_2006, months, nyc_temp_2012)
title('Average monthly temperature in NYC')
xlabel('Month') #x-axis label
ylabel('Temperature') #y-axis label
legend([2000, 2006, 2012]) #legend

savefig('mygraph.png') #save in root directory
show() # draw the plot on canvas
```

**Sorry about the fine print. :-(**

# Add a Title and Axes Descriptions!

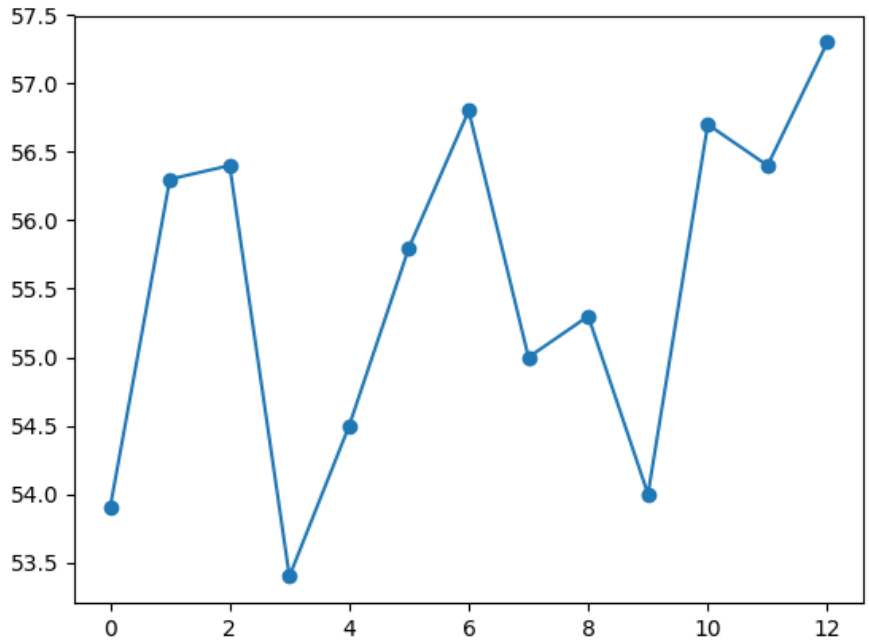
## Plot the temperature in NYC aggregated by time





# Changing the Field of View (Move the Axes)

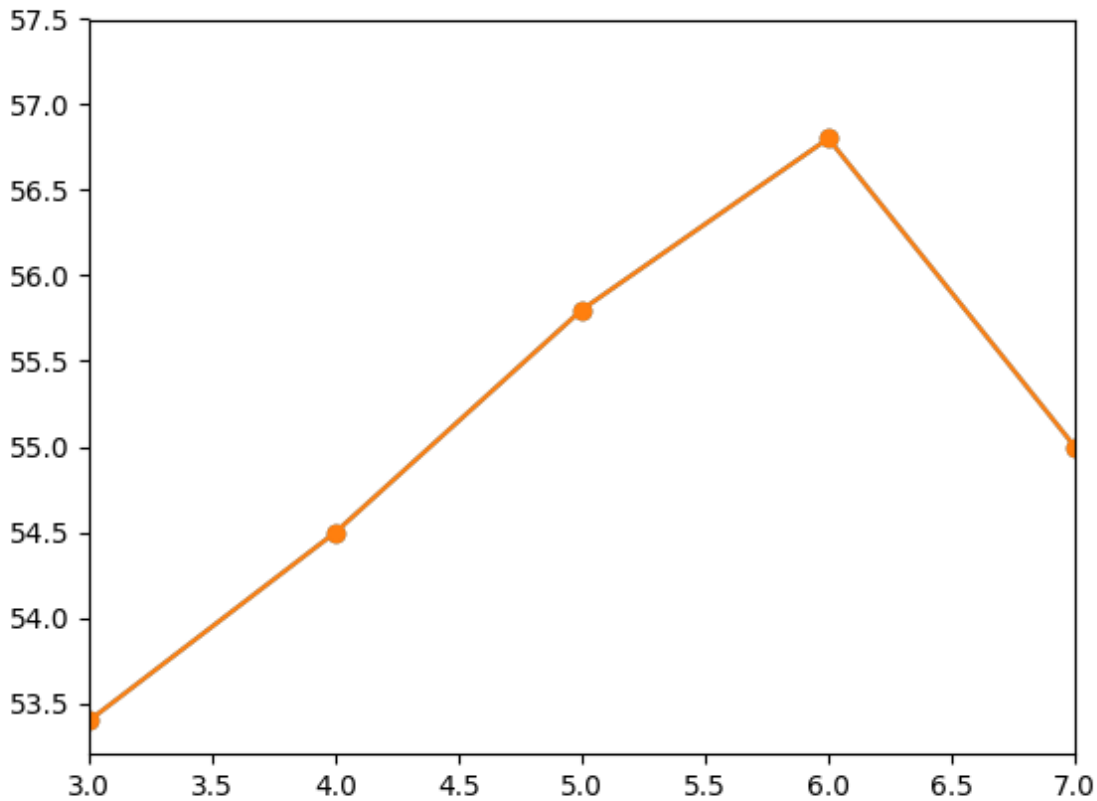
```
nyc_temp = [53.9, 56.3, 56.4, 53.4, 54.5, 55.8,
56.8, 55.0, 55.3, 54.0, 56.7, 56.4, 57.3]
plot(nyc_temp, marker='o')
axis()
#(-0.60, 12.6, 53.205, 57.495)
show()
```



# Changing the Field of View (using the Axes)

## Set the $x$-axis, min and max

```
plot(nyc_temp, marker='o')
axis(xmin = 3, xmax = 7 )
show()
```



# Plotting the Log Equation



## Log Plot

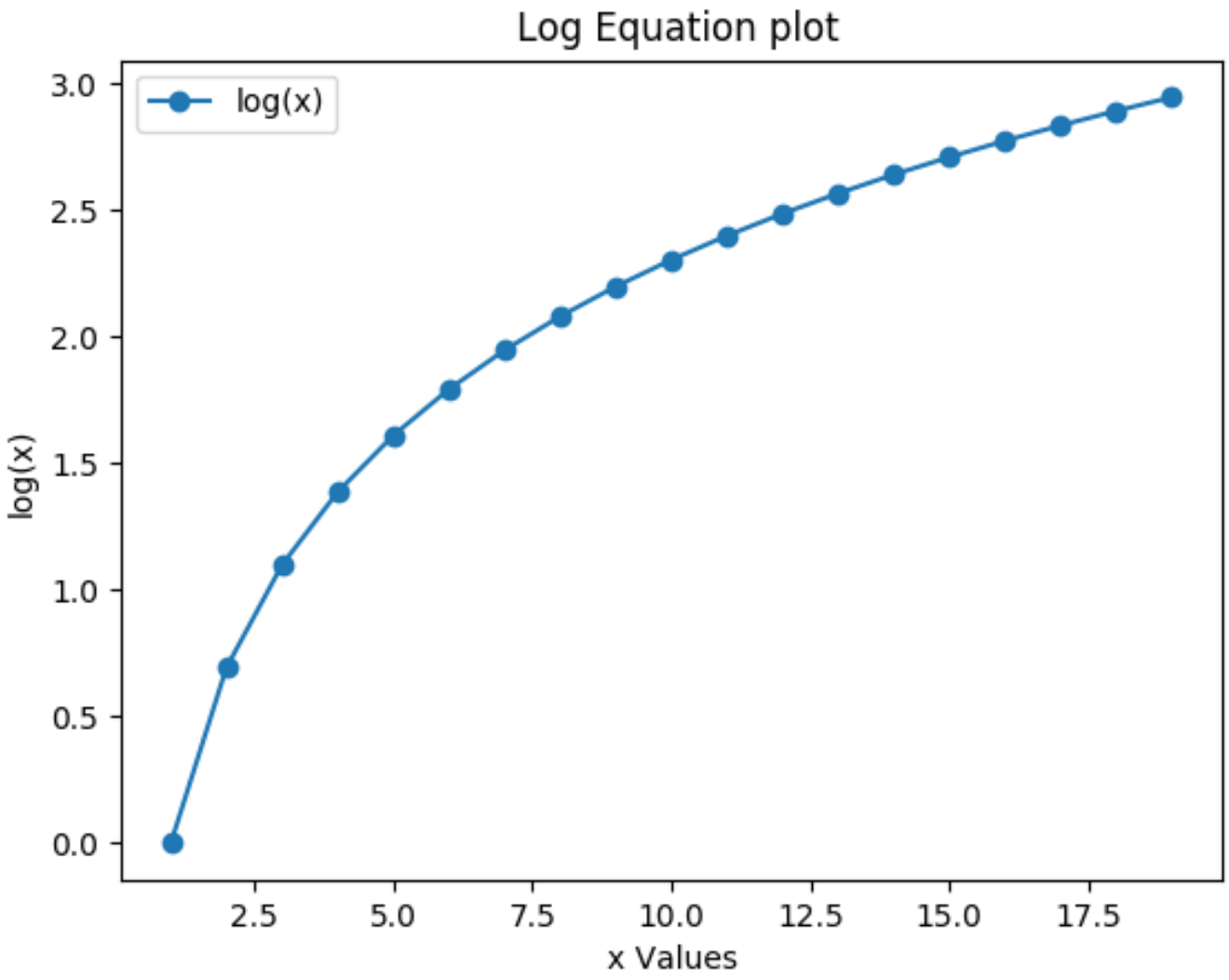
```
# date: 3 November 2018

from pylab import plot, show, title, savefig, xlabel, ylabel, legend
import math

x = [i for i in range(1,20)]
y = [math.log(i) for i in x]

plot(x,y, marker = 'o')

title(' Log Equation plot')
xlabel('x Values') #x-axis label
ylabel('log(x)') #y-axis label
legend(['log(x)']) #legend

savefig('myLogPlot.png') #save in root directory
show() # draw the plot on canvas
```

**Sorry about the fine print. :-(**

# The Plotted Log(x)

## Plot the temperature in NYC aggregated by time





# Let's Code



**We are going to code character frequency plotter.**