In [1]:
```
# Imports
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
```

In [2]:
```
# Read Data from CSV file
data = pd.read_csv('Dataset.csv')
#show Sample of data
data.head()
```

Out[2]:

	Population	Profit
0	6.1101	17.5920
1	5.5277	9.1302
2	8.5186	13.6620
3	7.0032	11.8540
4	5.8598	6.8233

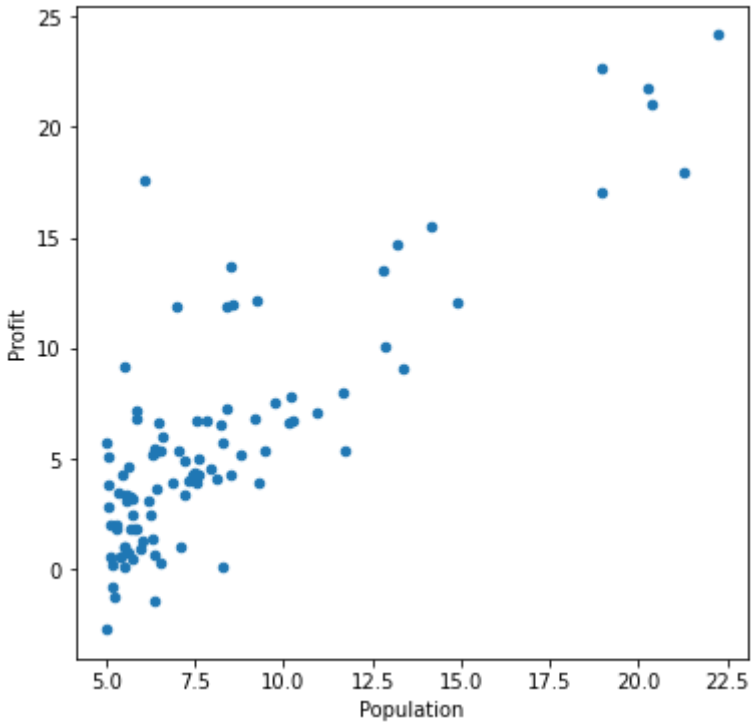
In [3]:
```
#show data details
data.describe()
```

Out[3]:

	Population	Profit
count	97.000000	97.000000
mean	8.159800	5.839135
std	3.869884	5.510262
min	5.026900	-2.680700
25%	5.707700	1.986900
50%	6.589400	4.562300
75%	8.578100	7.046700
max	22.203000	24.147000

In [4]:
```
#draw data
data.plot(kind='scatter', x='Population', y='Profit', figsize=(6,6))
```

Out[4]:
```
<AxesSubplot:xlabel='Population', ylabel='Profit'>
```



In [5]:
```
# adding a new column called ones before the data
data.insert(0, 'Ones', 1)
#show Sample of data after update
data.head()
```

Out[5]:

	Ones	Population	Profit
0	1	6.1101	17.5920
1	1	5.5277	9.1302
2	1	8.5186	13.6620
3	1	7.0032	11.8540
4	1	5.8598	6.8233

In [6]:
```
# separate X (training data) 'Input' from y (target variable) 'Output'
cols = data.shape[1]
X = data.iloc[:,0:cols-1]
y = data.iloc[:,cols-1:cols]
```

In [7]:
```
# Show sample of X Dataframe
X.head()
```

Out[7]:

	Ones	Population
0	1	6.1101
1	1	5.5277
2	1	8.5186
3	1	7.0032
4	1	5.8598

In [8]:
```
# Show sample of y Dataframe
y.head()
```

Out[8]:

	Profit
0	17.5920
1	9.1302
2	13.6620
3	11.8540
4	6.8233

In [9]:
```
# convert from data frames to numpy matrices
X = np.matrix(X.values)
y = np.matrix(y.values)
theta = np.matrix(np.array([0,0]))
```

In [10]:
```
def computeCost(X, y, theta):
    z = np.power(((X * theta.T) - y), 2)
#    print('z \n',z)
#    print('m ' ,len(X))
    return np.sum(z) / (2 * len(X))

computeCost(X, y, theta)
```

Out[10]:
```
32.072733877455676
```

In [11]:
```
# GD function
def gradientDescent(X, y, theta, alpha, iters):
    temp = np.matrix(np.zeros(theta.shape))
    parameters = int(theta.ravel().shape[1])
    cost = np.zeros(iters)

    for i in range(iters):
        error = (X * theta.T) - y

        for j in range(parameters):
            term = np.multiply(error, X[:,j])
            temp[0,j] = theta[0,j] - ((alpha / len(X)) * np.sum(term))

        theta = temp
        cost[i] = computeCost(X, y, theta)

    return theta, cost
```

In [12]:
```
# initialize variables for learning rate and iterations
alpha = 0.01
iters = 1000

# perform gradient descent to "fit" the model parameters
g, cost = gradientDescent(X, y, theta, alpha, iters)

#print('g = ' , g)
#print('cost  = ' , cost[-1] )

#Disply compute Cost
computeCost(X, y, g)
```

Out[12]:
```
4.515955503078912
```

In [13]:
```
# get best fit line
x = np.linspace(data.Population.min(), data.Population.max(), 100)
# point of fit line
```

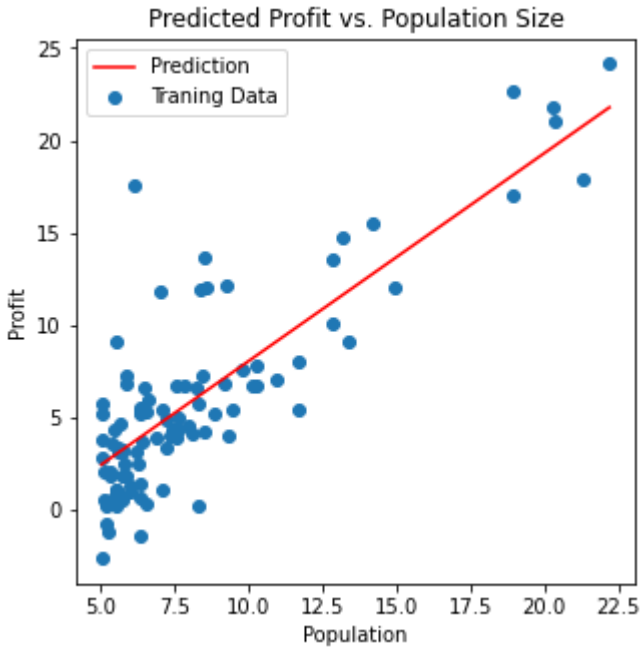
```
f = g[0, 0] + (g[0, 1] * x)
#Display point of fit line
f
```

Out[13]:
```
array([ 2.42539308,  2.62097407,  2.81655506,  3.01213605,  3.20771704,
        3.40329803,  3.59887902,  3.79446001,  3.990041  ,  4.18562199,
        4.38120298,  4.57678397,  4.77236495,  4.96794594,  5.16352693,
        5.35910792,  5.55468891,  5.7502699 ,  5.94585089,  6.14143188,
        6.33701287,  6.53259386,  6.72817485,  6.92375584,  7.11933683,
        7.31491782,  7.51049881,  7.7060798 ,  7.90166079,  8.09724177,
        8.29282276,  8.48840375,  8.68398474,  8.87956573,  9.07514672,
        9.27072771,  9.4663087 ,  9.66188969,  9.85747068, 10.05305167,
       10.24863266, 10.44421365, 10.63979464, 10.83537563, 11.03095662,
       11.2265376 , 11.42211859, 11.61769958, 11.81328057, 12.00886156,
       12.20444255, 12.40002354, 12.59560453, 12.79118552, 12.98676651,
       13.1823475 , 13.37792849, 13.57350948, 13.76909047, 13.96467146,
       14.16025245, 14.35583344, 14.55141442, 14.74699541, 14.9425764 ,
       15.13815739, 15.33373838, 15.52931937, 15.72490036, 15.92048135,
       16.11606234, 16.31164333, 16.50722432, 16.70280531, 16.8983863 ,
       17.09396729, 17.28954828, 17.48512927, 17.68071025, 17.87629124,
       18.07187223, 18.26745322, 18.46303421, 18.6586152 , 18.85419619,
       19.04977718, 19.24535817, 19.44093916, 19.63652015, 19.83210114,
       20.02768213, 20.22326312, 20.41884411, 20.6144251 , 20.81000609,
       21.00558707, 21.20116806, 21.39674905, 21.59233004, 21.78791103])
```

In [14]:
```
# draw the line

fig, ax = plt.subplots(figsize=(5,5))
ax.plot(x, f, 'r', label='Prediction')
ax.scatter(data.Population, data.Profit, label='Traning Data')
ax.legend(loc=2)
ax.set_xlabel('Population')
ax.set_ylabel('Profit')
ax.set_title('Predicted Profit vs. Population Size')
```

Out[14]:
```
Text(0.5, 1.0, 'Predicted Profit vs. Population Size')
```



In [15]:
```
# draw error graph

fig, ax = plt.subplots(figsize=(5,5))
ax.plot(np.arange(iters), cost, 'r')
ax.set_xlabel('Iterations')
ax.set_ylabel('Cost')
ax.set_title('Error vs. Training Epoch')
```

Out[15]: Text(0.5, 1.0, 'Error vs. Training Epoch')