Gradient Descent on Carsmall Data having 5 features and 1 output

In [291]:

```
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
from sklearn import preprocessing as p
```

Dataset Looks like this:

In [292]:

```
data=pd.read_csv('data_carsmall.csv')
feat_len=len(data.columns)-1
index_len=len(data.index)
data.head()
```

Out[292]:

	x1	x2	x3	x4	x5	y
0	12.0	8	307	130	3504	18.0
1	11.5	8	350	165	3693	15.0
2	11.0	8	318	150	3436	18.0
3	12.0	8	304	150	3433	16.0
4	10.5	8	302	140	3449	17.0

In [293]:

```
X=np.ones([len(data.index),feat_len+1])
```

In [294]:

```
X[0:5]
```

Out[294]:

```
array([[1., 1., 1., 1., 1., 1.],
       [1., 1., 1., 1., 1., 1.],
       [1., 1., 1., 1., 1., 1.],
       [1., 1., 1., 1., 1., 1.],
       [1., 1., 1., 1., 1., 1.]])
```

In [295]:

```
for i in range(index_len):
    for j in range(feat_len):
        X[i][j+1]=data.iloc[i][data.columns[j]]
```

In [296]:

```
X[0:5,:]
print(X[0:5,0:6])
```

```
[[1.000e+00 1.200e+01 8.000e+00 3.070e+02 1.300e+02 3.504e+03]
 [1.000e+00 1.150e+01 8.000e+00 3.500e+02 1.650e+02 3.693e+03]
 [1.000e+00 1.100e+01 8.000e+00 3.180e+02 1.500e+02 3.436e+03]
 [1.000e+00 1.200e+01 8.000e+00 3.040e+02 1.500e+02 3.433e+03]
 [1.000e+00 1.050e+01 8.000e+00 3.020e+02 1.400e+02 3.449e+03]]
```

In [297]:

```
data.iloc[1]
```

Out[297]:

```
x1      11.5
x2       8.0
x3     350.0
x4     165.0
x5    3693.0
y       15.0
Name: 1, dtype: float64
```

Data Preprocessing

In [298]:

```
Y=data['y']
Y = np.expand_dims(Y, axis=0)
Y=Y.T
print(Y.shape)
Y[0:5]
```

```
(93, 1)
```

Out[298]:

```
array([[18.],
       [15.],
       [18.],
       [16.],
       [17.]])
```

Normalizing Data with Mean 0 and Variance 1

In [299]:

```
m_x=np.mean(X)
s_x=np.std(X)
m_y=np.mean(Y)
s_y=np.std(Y)
print(m_x, s_x, m_y, s_y)

X[:,1:6] = p.scale(X[:,1:6])
Y= p.scale(Y)
```

```
549.1609318996416 1131.1092291298783 23.725806451612904 8.035377465701439
```

Data looks like this after normalization:

In [300]:

```
X[0:5,:]
```

Out[300]:

```
array([[ 1.        , -0.99504022,  1.41727109,  0.96195761,  0.4579008 ,
         0.67549877],
       [ 1.        , -1.15093433,  1.41727109,  1.35365585,  1.23378164,
         0.91127076],
       [ 1.        , -1.30682843,  1.41727109,  1.06215949,  0.90126128,
         0.59067075],
       [ 1.        , -0.99504022,  1.41727109,  0.93462982,  0.90126128,
         0.58692834],
       [ 1.        , -1.46272254,  1.41727109,  0.9164113 ,  0.67958104,
         0.60688787]])
```

In [301]:

```
Y[1:10]
```

Out[301]:

```
array([[-1.08592365],
       [-0.71257467],
       [-0.96147399],
       [-0.83702433],
       [-1.08592365],
       [-1.21037331],
       [-1.21037331],
       [-1.21037331],
       [-1.08592365]])
```

In [302]:

```
print(np.mean(X))
print(np.std(X))
print(np.mean(Y))
print(np.std(Y))
```

```
0.16666666666666644
0.9860132971832691
-9.072790308764721e-17
1.0
```

Data Dimensions

In [303]:

```
print(X.shape)
print(Y.shape)
m=5
```

```
(93, 6)
(93, 1)
```

Gradient Descent Function:

In [304]:

```
#GRADIENT DESCENT
def gradient_descent(x, y, theta, iterations, alpha):

    past_costs = []
    theta_not=theta[-1]
    past_thetas = [theta]

    for i in range(iterations):

        prediction = np.dot(x, theta)
        error = prediction - y
        cost = 1/(2*m) * np.dot(error.T, error)
        past_costs.append(cost)
        theta = theta - (alpha * (1/m) * np.dot(x.T, error))
        past_thetas.append(theta)

    return past_thetas, past_costs

```

Taking Random Thetas initially and with 1 bias

In [305]:

```
theta=np.random.rand(6,1)
theta
```

Out[305]:

```
array([[0.11668534],
       [0.17822676],
       [0.43545971],
       [0.5250513 ],
       [0.34166554],
       [0.36007403]])
```

Calling Gradient Descent with 1000 iterations and learning rate= 0.02

In [327]:

```
costs=[]
theta,costs=gradient_descent(X,Y,theta,1000,0.02)
```

In [328]:

```
theta=theta[-1]
theta.shape
```

Out[328]:

```
(6, 1)
```

Learned Parameters

In [329]:

```
#theta = np.expand_dims(theta, axis=0)
print(theta.shape)
cost_new=np.asarray(costs)
cost_new=cost_new[:,:,0]
theta
```

```
(6, 1)
```

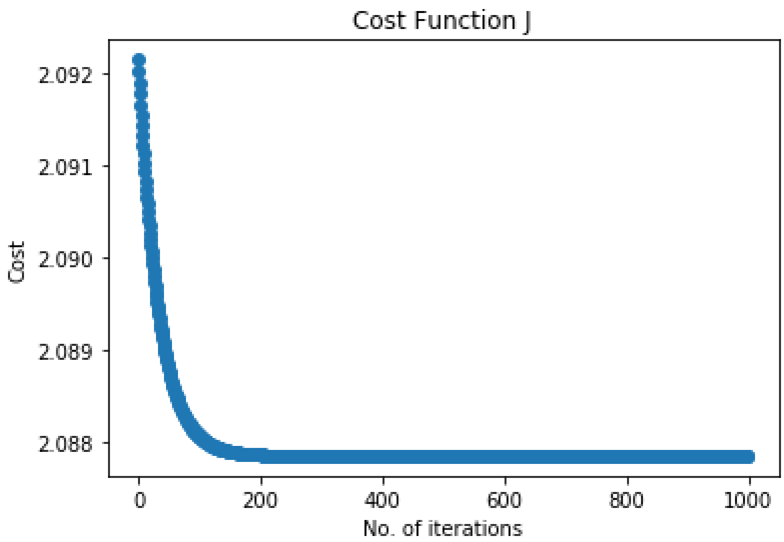
Out[329]:

```
array([[-2.33262644e-16],
       [-3.63945226e-02],
       [-5.08288193e-01],
       [ 3.19647034e-01],
       [-2.77685283e-01],
       [-4.67199579e-01]])
```

Cost Function Looks Like this

In [341]:

```
plt.title('Cost Function J')
plt.xlabel('No. of iterations')
plt.ylabel('Cost')
plt.plot(cost_new,'o')
plt.show()
cost_new[-1]
```



Out[341]:

```
array([2.08784933])
```

Testing the learned parameters

In [342]:

```
# Testing
data_test=pd.read_csv('data_carsmall_test.csv')
```

In [343]:

```
data_test
```

Out[343]:

	X1	X2	X3	X4	X5	Y
0	17.5	4	133	115.0	3090	NaN
1	11.5	8	350	165.0	4142	NaN
2	11.0	8	351	153.0	4034	NaN
3	10.5	8	383	175.0	4166	NaN
4	11.0	8	360	175.0	3850	NaN
5	8.0	8	302	140.0	3353	NaN
6	20.5	4	151	NaN	3035	23.0

In [344]:

```
print(m_x, s_x, m_y, s_y)
```

```
549.1609318996416 1131.1092291298783 23.725806451612904 8.035377465701439
```

In [345]:

```
# Normalizing X vector first and then finding out Y
```

In [346]:

```
X_test=np.ones([6,6])
for i in range(6):
    for j in range(1,6):
        X_test[i][j]=((data_test.iloc[i][data_test.columns[j-1]])-m_x )/s_x

```

Normalized X_test

In [347]:

```
X_test
```

Out[347]:

```
array([[ 1.        , -0.470035  , -0.48197019, -0.36792285, -0.38383643,
         2.24632511],
       [ 1.        , -0.47533953, -0.47843384, -0.17607577, -0.33963204,
         3.1763856 ],
       [ 1.        , -0.47578158, -0.47843384, -0.17519169, -0.35024109,
         3.08090411],
       [ 1.        , -0.47622362, -0.47843384, -0.14690087, -0.33079116,
         3.19760371],
       [ 1.        , -0.47578158, -0.47843384, -0.16723489, -0.33079116,
         2.91823193],
       [ 1.        , -0.47843384, -0.47843384, -0.21851199, -0.36173424,
         2.47884024]])
```

In [348]:

```
print(X_test.shape)
print(theta.shape)
```

```
(6, 6)
(6, 1)
```

In [349]:

```
pred=np.dot(X_test,theta)
pred
```

Out[349]:

```
array([[-0.79841541],
       [-1.18549527],
       [-1.13764169],
       [-1.1885055 ],
       [-1.06449892],
       [-0.86691691]])
```

Denormalizing the output ¶

In [350]:

```
pred=pred*s_y +m_y
```

In [351]:

```
pred
```

Out[351]:

```
array([[17.31023726],
       [14.19990448],
       [14.58442603],
       [14.17571617],
       [15.17215585],
       [16.75980186]])
```

In [ ]:

```

```