Practical-7

Objective: Design a multivariate linear regression classifier with gradient descent.

The implementation is done by creating 3 modules each used for performing different operations in the Training Process.

Linear regression:

It is the principal function that takes the features matrix (X), Target Variable Vector (y), learning rate (alpha) and number of iterations (num_iters) as input and outputs the final optimized theta i.e., the values of [theta_0, theta_1, theta_2, theta_3,….,theta_n] for which the cost function almost achieves minima following Batch Gradient Descent, and cost which stores the value of cost for every iteration.

Hypothesis:

It is the function that calculates and outputs the hypothesis value of the Target Variable, given theta (theta_0, theta_1, theta_2, theta_3, …., theta_n), Features in a matrix, X of dimension [m X (n+1)] where m is the number of samples and n is the number of features.

Batch Gradient descent:

It is the function that performs the Batch Gradient Descent Algorithm taking current value of theta (theta_0, theta_1,…, theta_n), learning rate (alpha), number of iterations (num_iters), list of hypothesis values of all samples (h), feature set (X), Target Variable set (y) and Number of Features (n) as input and outputs the optimized theta (theta_0, theta_1, theta_2, theta_3, …, theta_n) and the cost history or cost which contains the value of the cost function over all the iterations.

Problem Statement:

“Given the size of the house and number of bedrooms, analyze and predict the possible price of the house”.

Dataset:

Dataset consists of size of the house , number of bedrooms, price of the house.

Procedure:

1.Load the dataset.

2.Calculate the mean and standard deviation of each attribute of the data set.

3.Normalize each data point as follows,

x=(x-u)/Σ.

4.obtain theta and cost from linear regression function with some learning rate.

5.The cost has been reduced in the course of Batch Gradient Descent function iteration-by-iteration. The reduction in the cost is shown with the help of Line Curve.

6. Plot Side-by-Side Visualization of Features and Target Variable Actual and Prediction using 3-D Scatter Plots

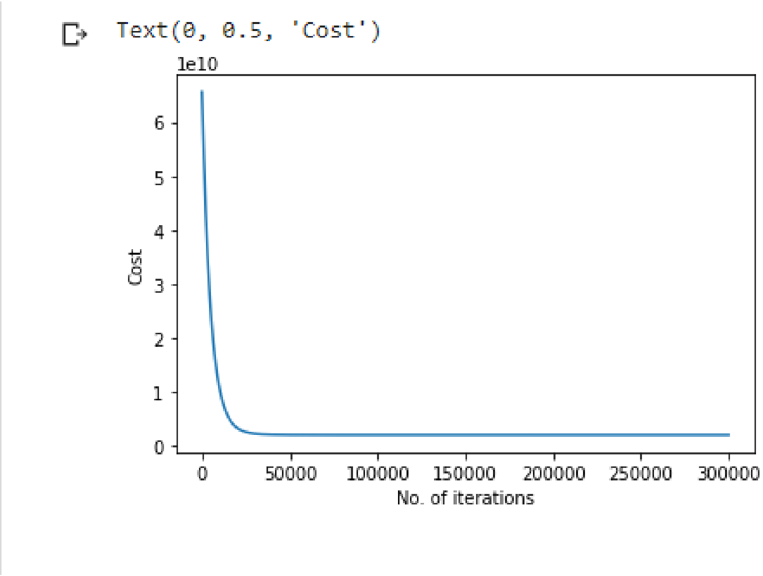
7.That's all about the Implementation of Multi-Variate Linear Regression in Python using Gradient Descent from scratch.

Code:

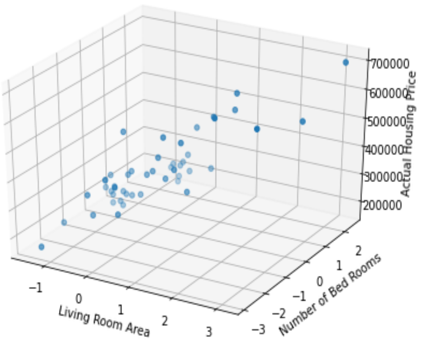
```
def hypothesis(theta, X, n):
    h = np.ones((X.shape[0],1))
    theta = theta.reshape(1,n+1)
    for i in range(0,X.shape[0]):
        h[i] = float(np.matmul(theta, X[i]))
    h = h.reshape(X.shape[0])
    return h

def BGD(theta, alpha, num_iters, h, X, y, n):
    cost = np.ones(num_iters)
    for i in range(0,num_iters):
        theta[0] = theta[0] - (alpha/X.shape[0]) * sum(h - y)
        for j in range(1,n+1):
            theta[j] = theta[j] - (alpha/X.shape[0]) * sum((h-y) * X.transpose()[j])
        h = hypothesis(theta, X, n)
        cost[i] = (1/X.shape[0]) * 0.5 * sum(np.square(h - y))
    theta = theta.reshape(1,n+1)
    return theta, cost

def linear_regression(X, y, alpha, num_iters):
    n = X.shape[1]
    one_column = np.ones((X.shape[0],1))
    X = np.concatenate((one_column, X), axis = 1)
    # initializing the parameter vector...
    theta = np.zeros(n+1)
    # hypothesis calculation....
    h = hypothesis(theta, X, n)
    # returning the optimized parameters by Gradient Descent...
    theta, cost = BGD(theta,alpha,num_iters,h,X,y,n)
    return theta, cost

data = np.loadtxt('data2.txt', delimiter=',')
X_train = data[:,[0,1]] #feature set
y_train = data[:,2] #label set

mean = np.ones(X_train.shape[1])
std = np.ones(X_train.shape[1])
for i in range(0, X_train.shape[1]):
    mean[i] = np.mean(X_train.transpose()[i])
    std[i] = np.std(X_train.transpose()[i])
    for j in range(0, X_train.shape[0]):
        X_train[j][i] = (X_train[j][i] - mean[i])/std[i]

# calling the principal function with learning_rate = 0.0001 and
# num_iters = 300000
theta, cost = linear_regression(X_train, y_train,0.0001, 300000)

import matplotlib.pyplot as plt
cost = list(cost)
n_iterations = [x for x in range(1,300001)]
plt.plot(n_iterations, cost)
plt.xlabel('No. of iterations')
plt.ylabel('Cost')

from matplotlib import pyplot
from mpl_toolkits.mplot3d import Axes3D
sequence_containing_x_vals = list(X_train.transpose()[0])
sequence_containing_y_vals = list(X_train.transpose()[1])
sequence_containing_z_vals = list(y_train)
fig = pyplot.figure()
ax = Axes3D(fig)
ax.scatter(sequence_containing_x_vals, sequence_containing_y_vals,
 sequence_containing_z_vals)
ax.set_xlabel('Living Room Area', fontsize=10)
ax.set_ylabel('Number of Bed Rooms', fontsize=10)
ax.set_zlabel('Actual Housing Price', fontsize=10)

X_train = np.concatenate((np.ones((X_train.shape[0],1)), X_train),axis = 1)
predictions = hypothesis(theta, X_train, X_train.shape[1] - 1)
from matplotlib import pyplot
from mpl_toolkits.mplot3d import Axes3D
sequence_containing_x_vals = list(X_train.transpose()[1])
sequence_containing_y_vals = list(X_train.transpose()[2])
sequence_containing_z_vals = list(predictions)
fig = pyplot.figure()
```

```
ax = Axes3D(fig)
ax.scatter(sequence_containing_x_vals, sequence_containing_y_vals,
          sequence_containing_z_vals)
ax.set_xlabel('Living Room Area', fontsize=10)
ax.set_ylabel('Number of Bed Rooms', fontsize=10)
ax.set_zlabel('Housing Price Predictions', fontsize=10)
```

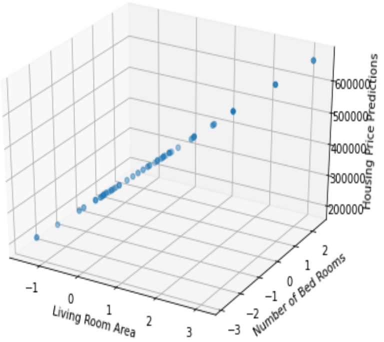
output:



```
Text(0, 0.5, 'Cost')
```



Actual Housing Price
Living Room Area
Number of Bed Rooms



Housing Price Predictions
Living Room Area
Number of Bed Rooms