Q1. Perform linear regression from scratch without any library on the dataset, and also calculate square sum of error, slope, and intercepts of the best fitting line, show the graphs. Show the error graph.

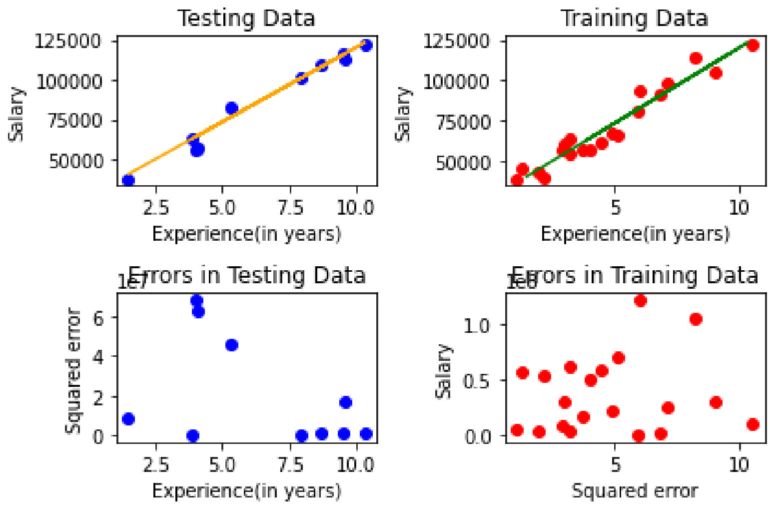
In [ ]:

```
# Importing libraries
import numpy as np
import pandas as pd
from sklearn.model_selection import train_test_split
import matplotlib.pyplot as plt

class LinearRegression() :
    def __init__( self, learning_rate, iterations ) :
        self.learning_rate = learning_rate
        self.iterations = iterations

    # Function for model training
    def fit( self, X, Y ) :
        # no_of_training_examples, no_of_features
        self.m, self.n = X.shape

        # weight initialization
        self.W = np.zeros( self.n )
        self.b = 0
        self.X = X
        self.Y = Y

        # gradient descent learning
        for i in range( self.iterations ):
            self.update_weights()
        return self

    # Helper function to update weights in gradient descent
    def update_weights( self ):
        Y_pred = self.predict( self.X )

        # calculate gradients
        dW = - ( 2 * ( self.X.T ).dot( self.Y - Y_pred )  ) / self.m
        db = - 2 * np.sum( self.Y - Y_pred ) / self.m

        # update weights
        self.W = self.W - self.learning_rate * dW
        self.b = self.b - self.learning_rate * db

        return self

    # Hypothetical function  h( x )
    def predict( self, X ) :
        return X.dot( self.W ) + self.b


def main() :

    # Importing dataset
    df = pd.read_csv( "lr_dataset.csv" )
    X = df.iloc[:,:-1].values
    Y = df.iloc[:,1].values

    print(X)
    print(Y)

    # Splitting dataset into train and test set
    X_train, X_test, Y_train, Y_test = train_test_split(X, Y, test_size = 1/3, random_st
```

```
ate = 0 )

    # Model training
    model = LinearRegression( iterations = 1000, learning_rate = 0.01 )
    model.fit( X_train, Y_train )

    # Prediction on test set
    Y_pred = model.predict( X_test )

    print( "Predicted values ", np.round( Y_pred[:10], 2 ) )
    print( "Real values      ", Y_test[:10] )
    print( "Trained W        ", round( model.W[0], 2 ) )
    print( "Trained b        ", round( model.b, 2 ) )
    print( "X-intercept      ", round( -model.b/model.W[0], 2 ) )
    print( "Y-intercept      ", round( model.b, 2 ) )
    print( "Slope            ", round( model.W[0], 2 ) )
    # Visualization on test set

    residual=[]
    for i in range(len(Y_test)):
        residual.append((Y_test[i] - Y_pred[i])**2)

    error=[]
    for i in range(len(Y_train)):
        Y=model.W[0] * X_train[i] + model.b
        error.append((Y - Y_train[i])**2)

    fig,axis = plt.subplots(2,2)

    axis[0,0].scatter( X_test, Y_test, color = 'blue' )
    axis[0,0].plot( X_test, Y_pred, color = 'orange' )

    axis[0,1].scatter( X_train,Y_train, color = 'red')
    axis[0,1].plot( X_test, Y_pred, color = 'green' )

    axis[1,0].scatter(X_test,residual,color='blue')

    axis[1,1].scatter(X_train,error,color='red')

    axis[0,0].set_title( 'Testing Data' )
    axis[0,1].set_title( 'Training Data' )
    axis[1,0].set_title( 'Errors in Testing Data' )
    axis[1,1].set_title( 'Errors in Training Data' )

    plt.setp(axis[0,0],xlabel="Experience(in years)")
    plt.setp(axis[0,0],ylabel="Salary")
    plt.setp(axis[0,1],xlabel="Experience(in years)")
    plt.setp(axis[0,1],ylabel="Salary")
    plt.setp(axis[1,0],xlabel="Experience(in years)")
    plt.setp(axis[1,0],ylabel="Squared error")
    plt.setp(axis[1,1],xlabel="Squared error")
    plt.setp(axis[1,1],ylabel="Salary")

    fig.tight_layout()
    plt.show()


if __name__ == "__main__" :
    main()
```

```
[[ 1.1]
 [ 1.3]
 [ 1.5]
 [ 2. ]
 [ 2.2]
 [ 2.9]
 [ 3. ]
 [ 3.2]
 [ 3.2]
 [ 3.7]
 [ 3.9]
 [ 4. ]
```

```
 [ 4. ]
 [ 4.1]
 [ 4.5]
 [ 4.9]
 [ 5.1]
 [ 5.3]
 [ 5.9]
 [ 6. ]
 [ 6.8]
 [ 7.1]
 [ 7.9]
 [ 8.2]
 [ 8.7]
 [ 9. ]
 [ 9.5]
 [ 9.6]
 [10.3]
 [10.5]]
[ 39343  46205  37731  43525  39891  56642  60150  54445  64445  57189
  63218  55794  56957  57081  61111  67938  66029  83088  81363  93940
  91738  98273 101302 113812 109431 105582 116969 112635 122391 121872]
Predicted values    [ 40594.69 123305.18  65031.88  63152.1  115786.04 108266.91 116725.93
  64091.99  76310.58 100747.77]
Real values         [ 37731 122391  57081  63218 116969 109431 112635  55794  83088 101302
]
Trained W           9398.92
Trained b           26496.31
X-intercept         -2.82
Y-intercept         26496.31
Slope               9398.92
```



Q2.

By late 1971, all cigarette packs had to be labeled with the words, "Warning: The Surgeon General Has Determined That Smoking Is Dangerous To Your Health." The case against smoking rested heavily on statistical, rather than laboratory, evidence. Extensive surveys of smokers and nonsmokers had revealed the former to have much higher risks of dying from a variety of causes, including heart disease.

(Continued on next page)

Typical of that research are the data in Table 11.3.1, showing the annual cigarette consumption, x, and the corresponding mortality rate, Y, due to coronary heart disease (CHD) for twenty-one countries (116). Do these data support the suspicion that smoking contributes to CHD mortality? Test $H_0: \beta_1 = 0$ versus $H_1: \beta_1 > 0$ at the $\alpha = 0.05$ level of significance.

Table 11.3.1

Country	Cigarette Consumption per Adult per Year, x	CHD Mortality per 100,000 (ages 35–64), y
United States	3900	256.9
Canada	3350	211.6
Australia	3220	238.1
New Zealand	3220	211.8
United Kingdom	2790	194.1
Switzerland	2780	124.5
Ireland	2770	187.3
Iceland	2290	110.5
Finland	2160	233.1
West Germany	1890	150.3
Netherlands	1810	124.7
Greece	1800	41.2
Austria	1770	182.1
Belgium	1700	118.1
Mexico	1680	31.9
Italy	1510	114.3
Denmark	1500	144.9
France	1410	59.7
Sweden	1270	126.9
Spain	1200	43.9
Norway	1090	136.3

In [ ]:

```
# Importing libraries
import matplotlib.pyplot as plt
import pandas as pd
import numpy as np
df=pd.read_csv('smoking_dataset.csv')
df.head()
```

Out[ ]:

	Country	Cigarette_consumption	CHD_Mortality
0	United States	3900	256.9
1	Canada	3350	211.6
2	Australia	3220	238.1
3	New Zealand	3220	211.8
4	United Kingdom	2790	194.1

In [9]:

```
list_of_columns=list(df.columns)
print(list_of_columns)
# df=df.drop(columns='Country')
```

```
['Cigarette_consumption', 'CHD_Mortality']
```

In [ ]:

```
X=df.drop(columns='CHD_Mortality')
Y=df['CHD_Mortality']
X=X/X.max()
print(X)
print(Y)
m=len(X)
```

```
    Cigarette_consumption
0                1.000000
1                0.858974
2                0.825641
3                0.825641
4                0.715385
5                0.712821
6                0.710256
7                0.587179
8                0.553846
9                0.484615
10               0.464103
11               0.461538
12               0.453846
13               0.435897
14               0.430769
15               0.387179
16               0.384615
17               0.361538
18               0.325641
19               0.307692
20               0.279487
0     256.9
1     211.6
2     238.1
3     211.8
4     194.1
5     124.5
6     187.3
7     110.5
8     233.1
9     150.3
10    124.7
11     41.2
12    182.1
13    118.1
14     31.9
15    114.3
16    114.9
17     59.7
18    126.9
19     43.9
20    136.3
```

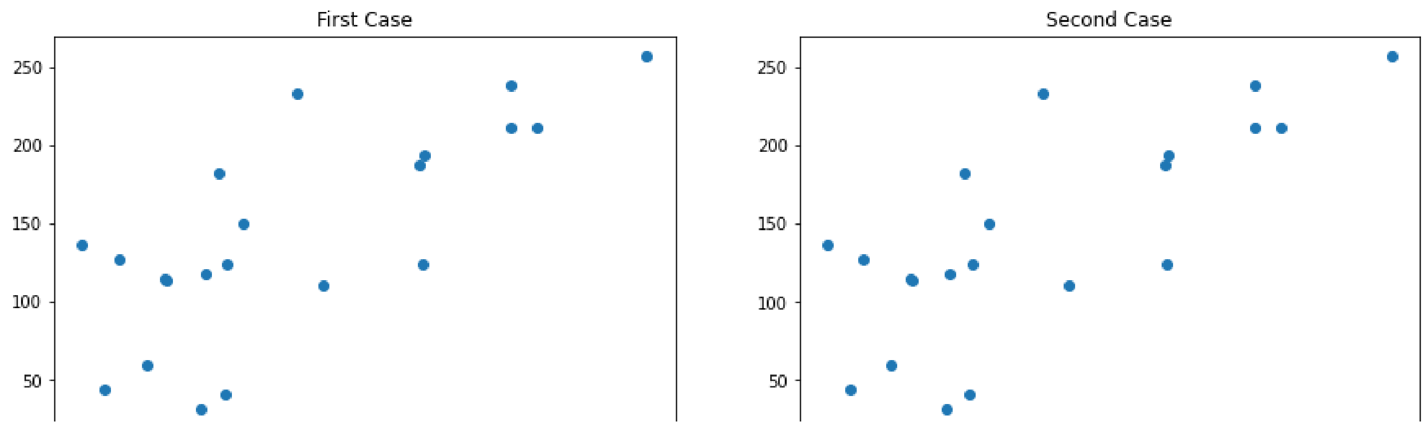
```
Name: CHD_Mortality, dtype: float64
```

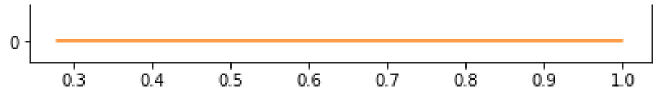
In [10]:

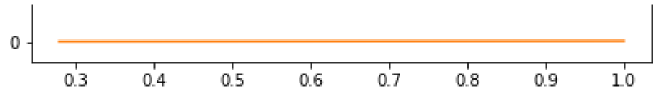
```
def hypothesis2(X,beta0,beta1): #findind h(x) for case2
    y1=beta1*X+beta0
    #print('printing y1 ')
    #print(y1)
    #print('printedd')
    return y1

def cost2(X,Y,beta0,beta1,m):   #cost func for case2
    y1=hypothesis2(X,beta0,beta1)
    return np.sum((y1-Y)**2)/(2*m)

def gradient_desc2(X,Y,theta0,theta1,alpha,epoch,m):
    J=[]
    k=0
    #print('new')
    while k<epoch:
        #print('here')
        y1=hypothesis2(X,theta0,theta1)
        dbeta1 = (1/m) * np.sum((y1 - Y) * X)
        dbeta0 = (1/m) * np.sum((y1 - Y) * 1)

        theta0=theta0-(alpha*dbeta0)
        theta1=theta1-(alpha*dbeta1)
        j=cost2(X,Y,theta0,theta1,m)
        J.append(j)
        k=k+1
    return J,theta0,theta1
```

In [12]:

```
# Y = beta0 + beta1(X)
beta0=0.0
beta1=0.0 #np.zeros(X.shape)  #case 1 - beta1=0
alpha=0.05
epoch=10

J,beta0,beta1=gradient_desc2(X,Y,beta0,beta1,alpha,epoch,m)
y1=hypothesis2(X,beta0,beta1)
plt.figure(figsize=(15,5))
plt.subplot(1,2,1)
plt.title('First Case')
plt.scatter(X,Y)
plt.plot(X,y1)
beta0=0.0
beta1=0.5
J,beta0,beta1=gradient_desc2(X,Y,beta0,beta1,alpha,epoch,m) #find the value of beta0 whi
ch minimizes cost func
y1=hypothesis2(X,beta0,beta1)
plt.subplot(1,2,2)
plt.title('Second Case')
plt.scatter(X,Y)
plt.plot(X,y1)
plt.show()
```







Q3. Perform polynomial regression from scratch without using library on the dataset. Choose dataset from internet. Take the polynomial degree as 3. Show the all graphs, and values.

In [ ]:

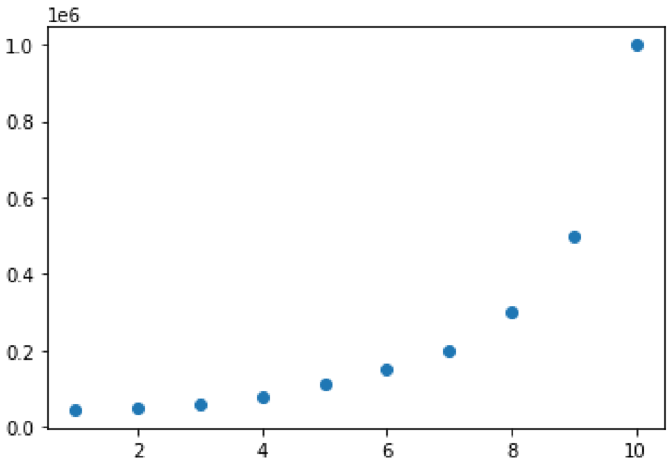
```
import pandas as pd
df = pd.read_csv('pr_dataset.csv')
df.head()
```

Out[ ]:

	Position	Level	Salary
0	Business Analyst	1	45000
1	Junior Consultant	2	50000
2	Senior Consultant	3	60000
3	Manager	4	80000
4	Country Manager	5	110000

In [ ]:

```
m=len(df)

%matplotlib inline
import matplotlib.pyplot as plt
plt.figure()
plt.scatter(df['Level'], df['Salary'])
plt.show()
```



In [ ]:

```
df = pd.concat([pd.Series(1, index=df.index, name='00'), df], axis=1)
df.head()
```

Out[ ]:

	00	Position	Level	Salary
0	1	Business Analyst	1	45000
1	1	Junior Consultant	2	50000
2	1	Senior Consultant	3	60000
3	1	Manager	4	80000

	00	Position	Level	Salary
4	1	Country Manager	5	110000

In [ ]:

```
df = df.drop(columns='Position')

y = df['Salary']
y[:5]
```

Out[ ]:

```
0     45000
1     50000
2     60000
3     80000
4    110000
Name: Salary, dtype: int64
```

In [ ]:

```
X = df.drop(columns = 'Salary')
X.head()
```

Out[ ]:

	00	Level
0	1	1
1	1	2
2	1	3
3	1	4
4	1	5

In [ ]:

```
X['Level1'] = X['Level']**2
X['Level2'] = X['Level']**3
X.head()
```

Out[ ]:

	00	Level	Level1	Level2
0	1	1	1	1
1	1	2	4	8
2	1	3	9	27
3	1	4	16	64
4	1	5	25	125

In [ ]:

```
X = X/X.max()
import numpy as np
theta = np.array([0]*len(X.columns))

def hypothesis(X, theta):
    y1 = theta*X
    return np.sum(y1, axis=1)

def cost(X, y, theta):
    y1 = hypothesis(X, theta)
    return sum(np.sqrt((y1-y)**2))/(2*m)

def gradientDescent(X, y, theta, alpha, epoch):
    J=[]
    k=0
```

```
    while k < epoch:
        y1 = hypothesis(X, theta)
        for c in range(0, len(X.columns)):
            theta[c] = theta[c] - alpha*sum((y1-y)* X.iloc[:, c])/m
        j = cost(X, y, theta)
        J.append(j)
        k += 1
    return J, j, theta

theta = np.array([0.0]*len(X.columns))
J, j, theta = gradientDescent(X, y, theta, 0.05, 700)

print(theta)
```

```
[-38494.26294331  66878.12378747 287369.29171661 460744.26580885]
```

In [ ]:

```
y_hat = theta*X
y_hat = np.sum(y_hat, axis=1)

%matplotlib inline
import matplotlib.pyplot as plt
plt.figure()
plt.scatter(x=X['Level'],y= y)
plt.scatter(x=X['Level'], y=y_hat)
plt.show()
```