```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
```

```
df = pd.read_csv('/content/sample_data/D3.csv')
print(df)
df.head() # To get first n rows from the dataset default value of n is 5
M=len(df)
M
```

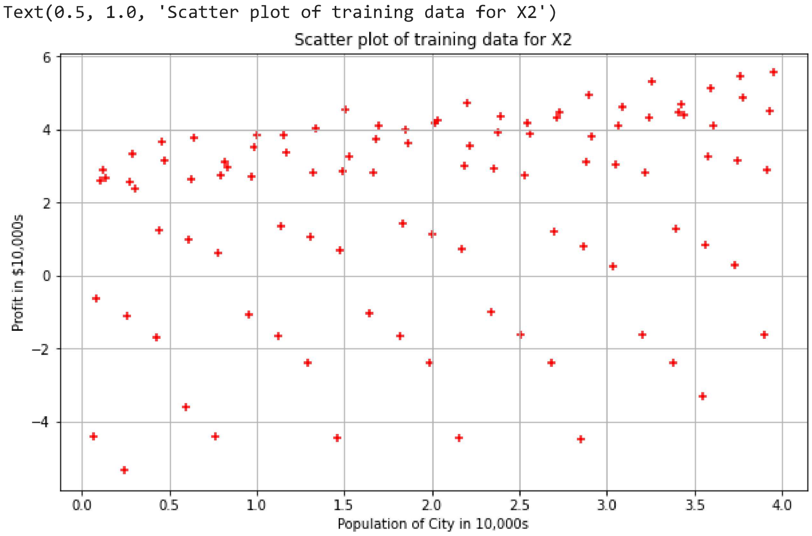
```
          X1        X2        X3         Y
0   0.000000  3.440000  0.440000  4.387545
1   0.040404  0.134949  0.888485  2.679650
2   0.080808  0.829899  1.336970  2.968490
3   0.121212  1.524848  1.785455  3.254065
4   0.161616  2.219798  2.233939  3.536375
..       ...       ...       ...       ...
95  3.838384  1.460202  3.046061 -4.440595
96  3.878788  2.155152  3.494545 -4.458663
97  3.919192  2.850101  3.943030 -4.479995
98  3.959596  3.545051  0.391515 -3.304593
99  4.000000  0.240000  0.840000 -5.332455

[100 rows x 4 columns]
100
```

```
X2 = df.values[:,1] # get input values from X2 column
y = df.values[:, 3]  # get output values from Y column
m = len(y) # Number of training examples
print('X2 = ', X2[: 5]) # Show only first 5 records
print('y = ', y[: 5])
```

```
X2 =  [3.44       0.1349495  0.82989899 1.52484848 2.21979798]
y =  [4.38754501 2.6796499  2.96848981 3.25406475 3.53637472]
```

```
plt.scatter(X2,y, color='red',marker= '+')
plt.grid()
plt.rcParams["figure.figsize"] = (10,6)
plt.xlabel('Population of City in 10,000s')
plt.ylabel('Profit in $10,000s')
plt.title('Scatter plot of training data for X2')
```

```
Text(0.5, 1.0, 'Scatter plot of training data for X2')
```




```
#Lets create a matrix with single column of ones
X_0 = np.ones((m, 1))
X_0[:5]
X_2 = X2.reshape(m,1)
X_2[:10]
print('X_2:',X_2)
```

```
X_2: [[3.44      ]
 [0.1349495 ]
```

```
       [0.82989899]
       [1.52484848]
       [2.21979798]
       [2.91474747]
       [3.60969697]
       [0.30464646]
       [0.99959596]
       [1.69454546]
       [2.38949495]
       [3.08444444]
       [3.77939394]
       [0.47434343]
       [1.16929293]
       [1.86424242]
       [2.55919192]
       [3.25414141]
       [3.94909091]
       [0.6440404 ]
       [1.3389899 ]
       [2.03393939]
       [2.72888889]
       [3.42383838]
       [0.11878788]
       [0.81373737]
       [1.50868687]
       [2.20363636]
       [2.89858586]
       [3.59353535]
       [0.28848485]
       [0.98343434]
       [1.67838384]
       [2.37333333]
       [3.06828283]
       [3.76323232]
       [0.45818182]
       [1.15313131]
       [1.84808081]
       [2.5430303 ]
       [3.2379798 ]
       [3.93292929]
       [0.62787879]
       [1.32282828]
       [2.01777778]
       [2.71272727]
       [3.40767677]
       [0.10262626]
       [0.79757576]
       [1.49252525]
       [2.18747475]
       [2.88242424]
       [3.57737374]
       [0.27232323]
       [0.96727273]
       [1.66222222]
       [2.35717172]
```

```
# Lets use hstack() function from numpy to stack X_0 and X_2 horizontally (i.e. column
# This will be our final X matrix (feature matrix)
X02 = np.hstack((X_0, X_2))
X02[:5]
```

```
array([[1.        , 3.44      ],
       [1.        , 0.1349495 ],
       [1.        , 0.82989899],
       [1.        , 1.52484848],
       [1.        , 2.21979798]])
```

```
theta = np.zeros(2)
theta
```

```
array([0., 0.])
```

```
def compute_cost(X, y, theta):
  """
  Compute cost for linear regression.

  Input Parameters
  ----------------
  X : 2D array where each row represent the training example and each column represent
      m= number of training examples
```

```
        n= number of features (including X_0 column of ones)
    y : 1D array of labels/target value for each traing example. dimension(1 x m)

    theta : 1D array of fitting parameters or weights. Dimension (1 x n)

    Output Parameters
    -----------------
    J : Scalar value.
    """
    predictions = X.dot(theta)
    errors = np.subtract(predictions, y)
    sqrErrors = np.square(errors)
    J = 1 / (2 * m) * np.sum(sqrErrors)

    return J

# Lets compute the cost for theta values
cost02 = compute_cost(X02, y, theta)
print('The cost for given values of theta_0 and theta_1 =', cost02)
```

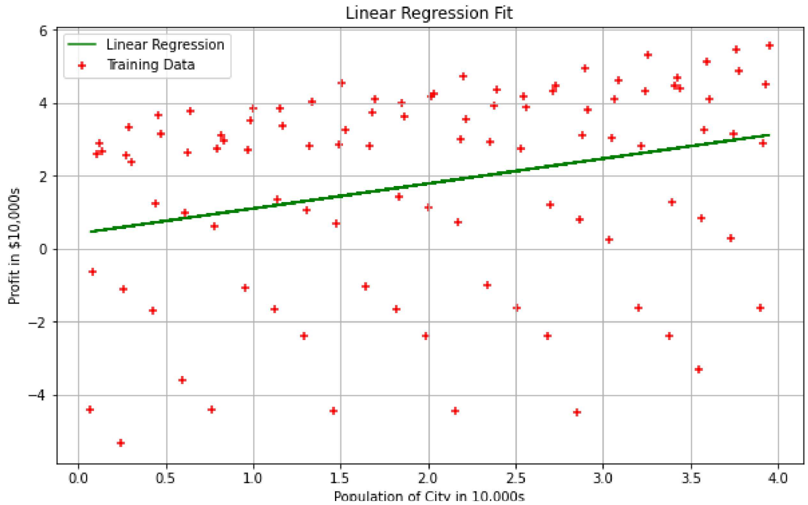
```
The cost for given values of theta_0 and theta_1 = 5.524438459196242
```

```
def gradient_descent(X, y, theta, alpha, iterations):
    """
    Compute cost for linear regression.

    Input Parameters
    ----------------
    X : 2D array where each row represent the training example and each column represent
        m= number of training examples
        n= number of features (including X_0 column of ones)
    y : 1D array of labels/target value for each traing example. dimension(m x 1)
    theta : 1D array of fitting parameters or weights. Dimension (1 x n)
    alpha : Learning rate. Scalar value
    iterations: No of iterations. Scalar value.

    Output Parameters
    -----------------
    theta : Final Value. 1D array of fitting parameters or weights. Dimension (1 x n)
    cost_history: Conatins value of cost for each iteration. 1D array. Dimansion(m x 1)
     """
    cost_history = np.zeros(iterations)

    for i in range(iterations):
      predictions = X.dot(theta)
      errors = np.subtract(predictions, y)
      sum_delta = (alpha / m) * X.transpose().dot(errors);
      theta = theta - sum_delta;
      cost_history[i] = compute_cost(X, y, theta)

    return theta, cost_history


theta = [0., 0.]
iterations = 1500;
alpha = 0.001;


theta, cost_history02 = gradient_descent(X02, y, theta, alpha, iterations)
print('Final value of theta =', theta)
print('cost_history =', cost_history02)
```

```
Final value of theta = [0.41275557 0.68335862]
cost_history = [5.50118218 5.47821041 5.45551967 ... 3.61271034 3.61270443 3.61269852]
```

```
# Since X is list of list (feature matrix) lets take values of column of index 1 only
plt.scatter(X02[:,1], y, color='red', marker= '+', label= 'Training Data')
plt.plot(X02[:,1],X02.dot(theta), color='green', label='Linear Regression')

plt.rcParams["figure.figsize"] = (10,6)
plt.grid()
plt.xlabel('Population of City in 10,000s')
plt.ylabel('Profit in $10,000s')
plt.title('Linear Regression Fit')
plt.legend()
```

```
<matplotlib.legend.Legend at 0x7f4f0ee648e0>
```




```
plt.plot(range(1, iterations + 1),cost_history02, color='blue')
plt.rcParams["figure.figsize"] = (10,6)
plt.grid()
plt.xlabel('Number of iterations')
plt.ylabel('Cost (J)')
plt.title('Convergence of gradient descent')
```

```
Text(0.5, 1.0, 'Convergence of gradient descent')
```