```
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
```

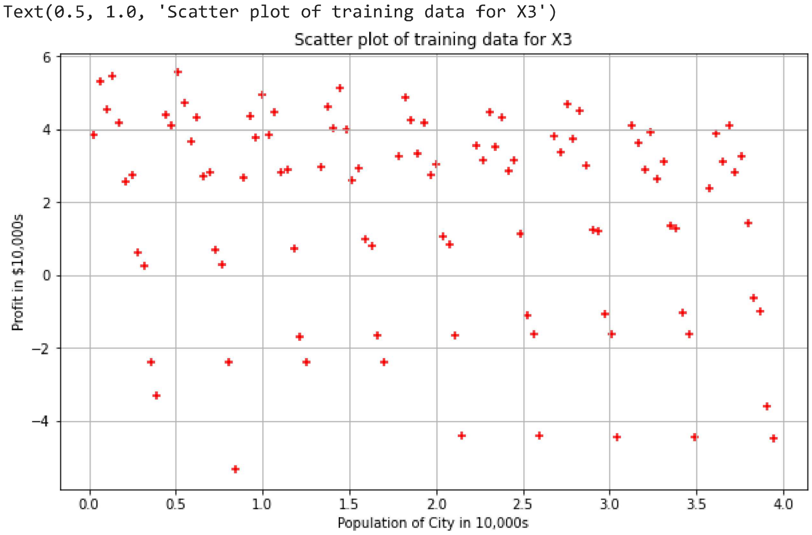
```
          X1        X2        X3         Y
0   0.000000  3.440000  0.440000  4.387545
1   0.040404  0.134949  0.888485  2.679650
2   0.080808  0.829899  1.336970  2.968490
3   0.121212  1.524848  1.785455  3.254065
4   0.161616  2.219798  2.233939  3.536375
..       ...       ...       ...       ...
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
```

```
X3 = df.values[:,2] # get input values from X2 column
y = df.values[:, 3]  # get output values from Y column
m = len(y) # Number of training examples
print('X3 = ', X3[: 5]) # Show only first 5 records
print('y = ', y[: 5])
```

```
X3 =  [0.44       0.88848485 1.3369697  1.78545454 2.23393939]
y =  [4.38754501 2.6796499  2.96848981 3.25406475 3.53637472]
```

```
plt.scatter(X3,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 X3')
```

```
Text(0.5, 1.0, 'Scatter plot of training data for X3')
```




```
#Lets create a matrix with single column of ones
X_0 = np.ones((m, 1))
X_0[:5]
X_3 = X3.reshape(m,1)
X_3[:10]
print('X_3:',X_3)
```

```
       [3.27636364]
       [3.72484848]
       [0.17333333]
       [0.62181818]
       [1.07030303]
       [1.51878788]
       [1.96727273]
       [2.41575758]
       [2.86424242]
       [3.31272727]
       [3.76121212]
       [0.20969697]
       [0.65818182]
       [1.10666667]
       [1.55515151]
       [2.00363636]
       [2.45212121]
       [2.90060606]
       [3.34909091]
       [3.79757576]
       [0.24606061]
       [0.69454545]
       [1.1430303 ]
       [1.59151515]
       [2.04      ]
       [2.48848485]
       [2.9369697 ]
       [3.38545454]
       [3.83393939]
       [0.28242424]
       [0.73090909]
       [1.17939394]
       [1.62787879]
       [2.07636364]
       [2.52484849]
       [2.97333333]
       [3.42181818]
       [3.87030303]
       [0.31878788]
       [0.76727273]
       [1.21575758]
       [1.66424242]
       [2.11272727]
       [2.56121212]
       [3.00969697]
       [3.45818182]
       [3.90666667]
       [0.35515151]
       [0.80363636]
       [1.25212121]
       [1.70060606]
       [2.14909091]
       [2.59757576]
       [3.04606061]
       [3.49454545]
       [3.9430303 ]
       [0.39151515]
       [0.84      ]]
```

```
# 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)
X03 = np.hstack((X_0, X_3))
X03[:5]
```

```
array([[1.        , 0.44      ],
       [1.        , 0.88848485],
       [1.        , 1.3369697 ],
       [1.        , 1.78545454],
       [1.        , 2.23393939]])
```

```
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
cost03 = compute_cost(X03, y, theta)
print('The cost for given values of theta_0 and theta_1 =', cost03)
```

```
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 = 0.01;
```

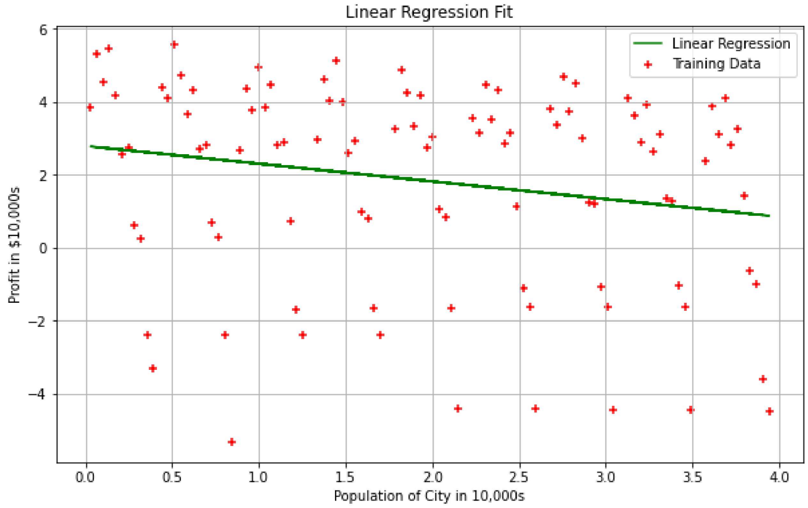
```
theta, cost_history03 = gradient_descent(X03, y, theta, alpha, iterations)
print('Final value of theta =', theta)
print('cost_history =', cost_history03)
```

```
Final value of theta = [ 2.78048129 -0.48451631]
cost_history = [5.40768785 5.30397076 5.21178297 ... 3.63053597 3.6305311  3.63052625]
```

```
# Since X is list of list (feature matrix) lets take values of column of index 1 only
plt.scatter(X03[:,1], y, color='red', marker= '+', label= 'Training Data')
plt.plot(X03[:,1],X03.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')
```

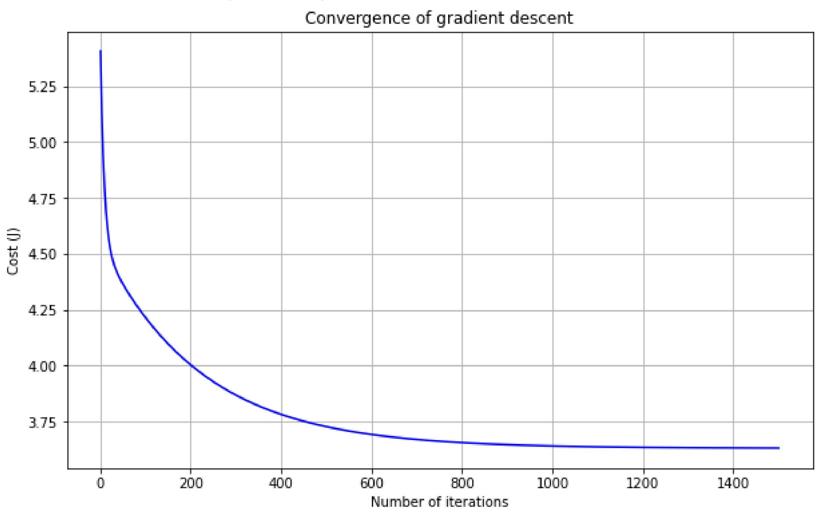
```
plt.title('Linear Regression Fit')
plt.legend()
```

```
<matplotlib.legend.Legend at 0x7f60987dcac0>
```




```
plt.plot(range(1, iterations + 1),cost_history03, 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')
```



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