

```
In [11]: %matplotlib inline
import matplotlib.pyplot as plt
import numpy as np
import os
import pandas as pd
```

```
In [12]: df = pd.read_csv('HW1.csv')
df.head() # To get first n rows from the dataset default value of n is 5
M=len(df)
M
```

```
Out[12]: 100
```

```
In [13]: df.describe()
```

```
Out[13]:
```

	X1	X2	X3	Y
count	100.000000	100.000000	100.000000	100.000000
mean	2.000000	2.000000	1.960000	1.851276
std	1.172181	1.172154	1.163005	2.774643
min	0.000000	0.070303	0.027879	-5.332455
25%	1.000000	0.979394	0.952121	0.527533
50%	2.000000	2.009697	1.949091	2.879003
75%	3.000000	3.040000	2.946061	3.925389
max	4.000000	3.949091	3.943030	5.545892

```
In [14]: # Separate features and labels
X = df.values[:, 1] # get input values from first column -- X is a list here
y = df.values[:, 3] # get output values from forth column -- Y is the list here
m = len(y) # Number of training examples
n = len(X) # Number of training examples

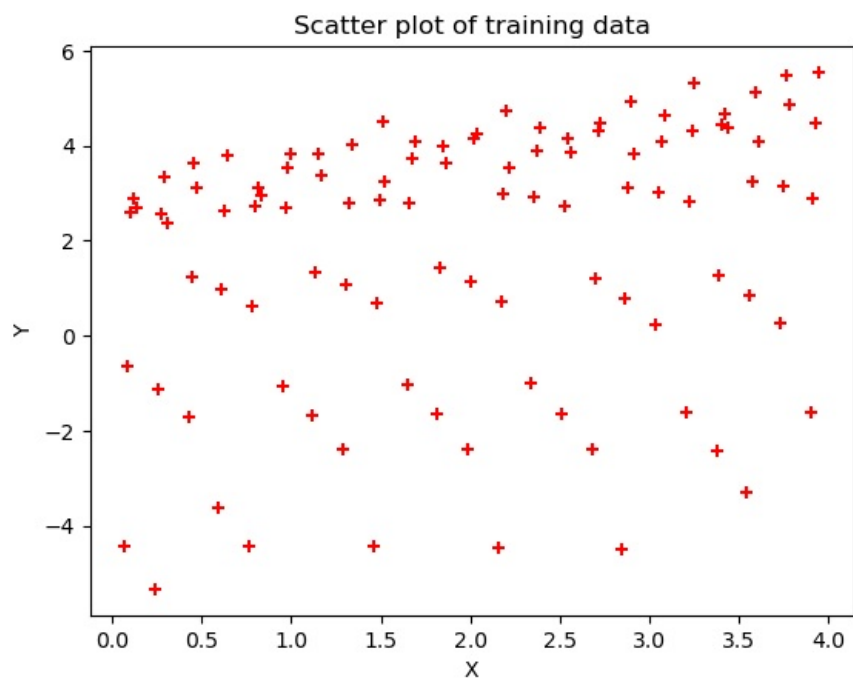
# Display first 5 records and the total number of training examples
print('X = ', X[: 5])
print('y = ', y[: 5])
print('m = ', m)
print('n = ', n)

X = [3.44      0.1349495  0.82989899 1.52484848 2.21979798]
y = [4.38754501 2.6796499  2.96848981 3.25406475 3.53637472]
m = 100
n = 100
```

```
In [15]: # Scatter plot
plt.scatter(X, y, color='red', marker='+')

# Grid, labels, and title
# plt.grid(True)
plt.rcParams["figure.figsize"] = (10, 10)
plt.xlabel('X')
plt.ylabel('Y')
plt.title('Scatter plot of training data')

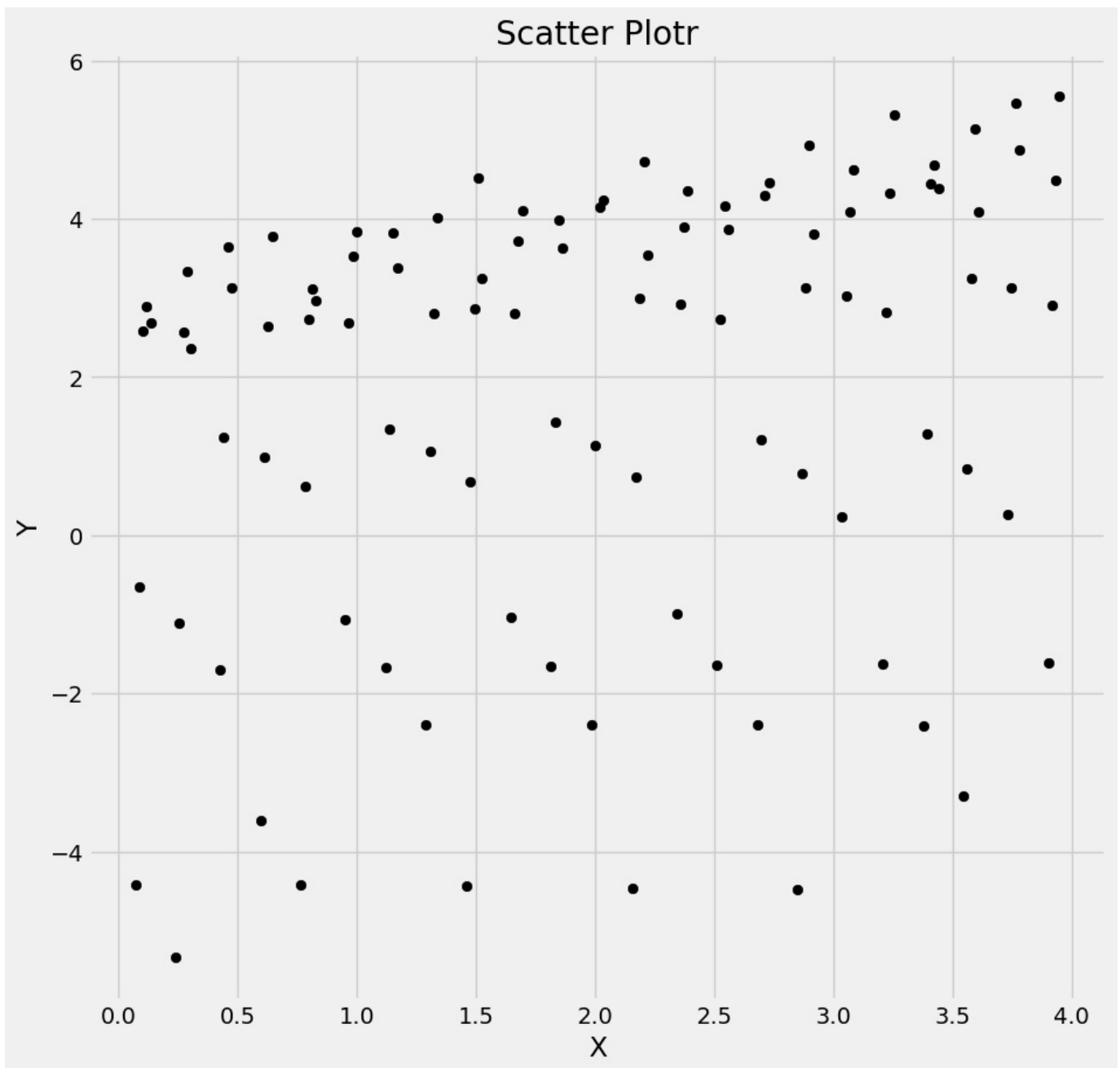
# Show the plot
plt.show()
```



```
In [16]: import matplotlib.pyplot as plt
plt.style.use('fivethirtyeight')

plt.scatter(X, y, color='black')
plt.xlabel('X')
plt.ylabel('Y')
plt.gca().set_title("Scatter Plotr")
```

```
Out[16]: Text(0.5, 1.0, 'Scatter Plotr')
```



```
In [17]: m = len(y) # Number of training examples
         n = len(X) # Number of training examples
```

```
In [18]: X_0 = np.ones((m, 1))
         X_0[:5]
```

```
Out[18]: array([[1.],
                [1.],
                [1.],
                [1.],
                [1.]])
```

```
In [19]: X_1 = X.reshape(m, 1)
         X_1[:10]
```

```
Out[19]: array([[3.44      ],
                [0.1349495 ],
                [0.82989899],
                [1.52484848],
                [2.21979798],
                [2.91474747],
                [3.60969697],
                [0.30464646],
                [0.99959596],
                [1.69454546]])
```

```
In [20]: # Lets use hstack() function from numpy to stack X_0 and X_1 horizontally (i.e. column
         # This will be our final X matrix (feature matrix)
         X = np.hstack((X_0, X_1))
         X[:5]
```

```
Out[20]: array([[1.      , 3.44      ],
               [1.      , 0.1349495 ],
               [1.      , 0.82989899],
               [1.      , 1.52484848],
               [1.      , 2.21979798]])
```

```
In [21]: theta = np.zeros(2)
theta
```

```
Out[21]: array([0., 0.])
```

```
In [22]: 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

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
```

```
In [23]: # Lets compute the cost for theta values
cost = compute_cost(X, y, theta)
print('The cost for given values of theta_0 and theta_1 =', cost)
```

The cost for given values of theta_0 and theta_1 = 5.524438459196242

```
In [24]: theta = [0., 0.]
iterations = 1500;
alpha = 0.01;

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

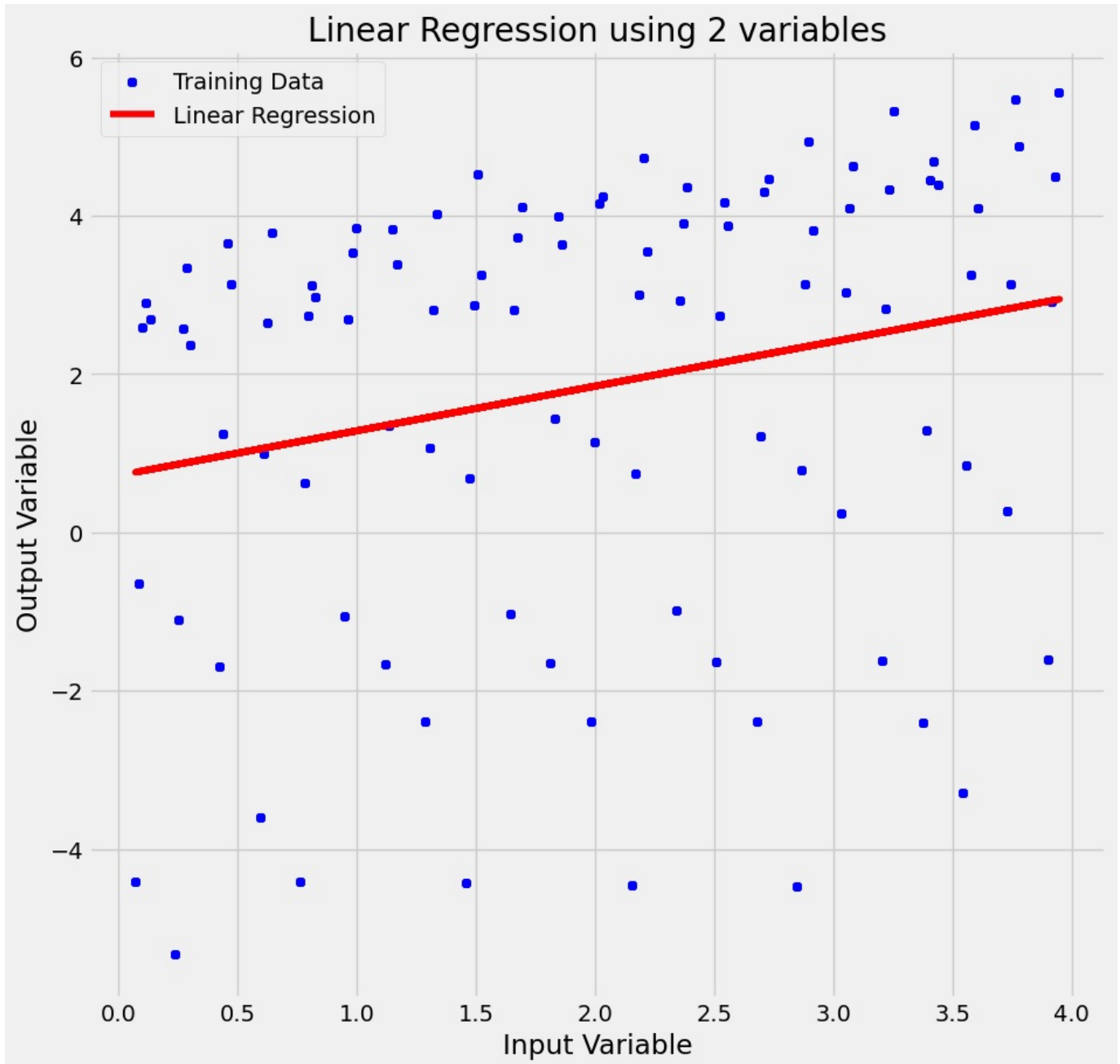
Final value of theta = [0.71988473 0.56390334]
cost_history = [5.29831663 5.09909109 4.92356115 ... 3.5993997 3.59939955 3.5993994]

```
In [25]: # Since X is list of list (feature matrix) lets take values of column of index 1 only
plt.scatter(X[:,1], y, color='b', marker='+', label= 'Training Data')
plt.plot(X[:,1],X.dot(theta), color='r', label='Linear Regression')
plt.rcParams["figure.figsize"] = (10,6)

plt.xlabel('Input Variable')
plt.ylabel('Output Variable')
```

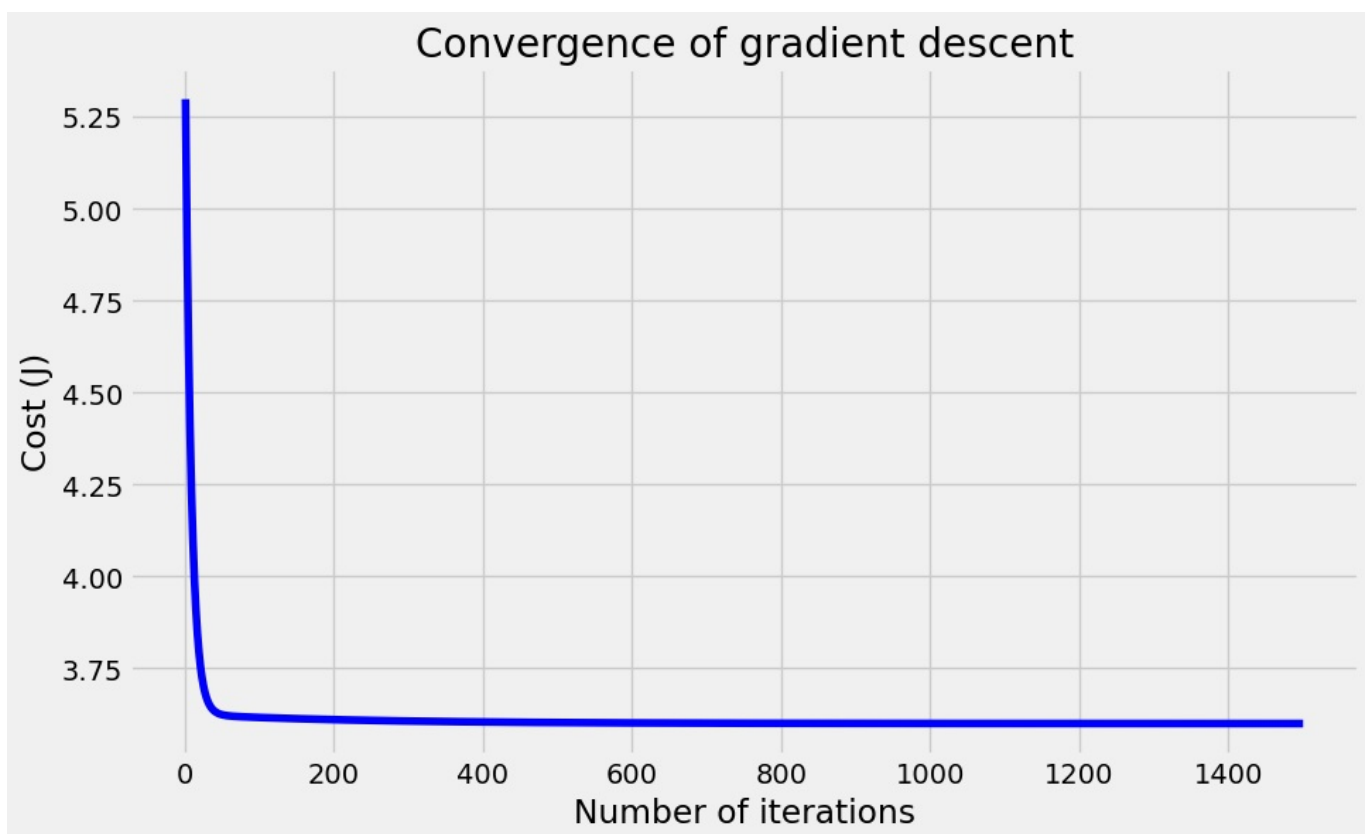
```
plt.title('Linear Regression using 2 variables')
plt.legend()
```

Out[25]: <matplotlib.legend.Legend at 0x1c6bf8c79d0>



```
In [26]: plt.plot(range(1, iterations + 1), cost_history, 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')
```

Out[26]: Text(0.5, 1.0, 'Convergence of gradient descent')



In []:

In []:

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