In [1]:
```
%matplotlib inline
import matplotlib.pyplot as plt
import numpy as np
import os
import pandas as pd
```

In [2]:
```
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[2]: 100

In [3]:
```
df.describe()
```

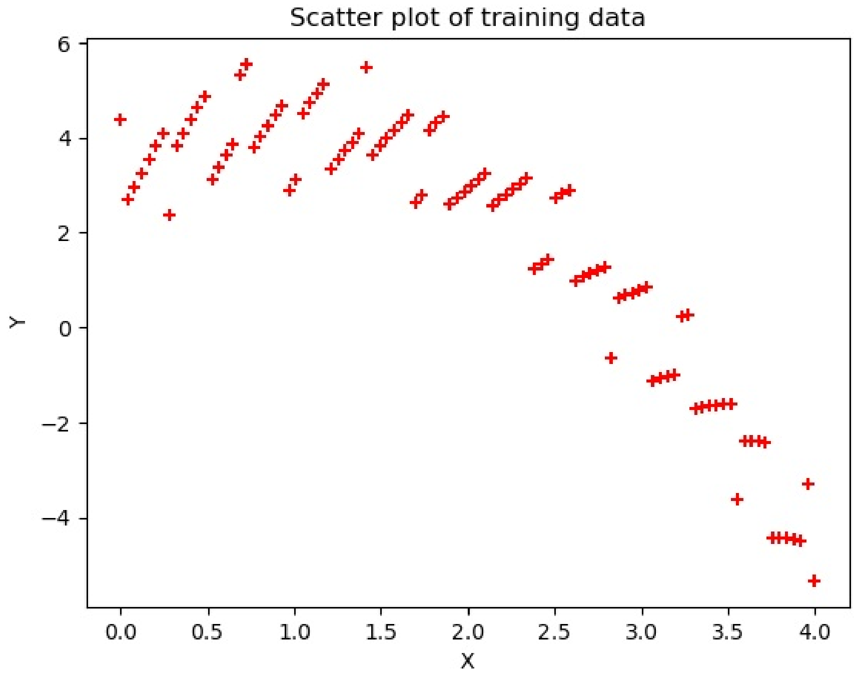
Out[3]:

	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 [4]:
```
# Separate features and labels
X = df.values[:, 0]  # 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)
```

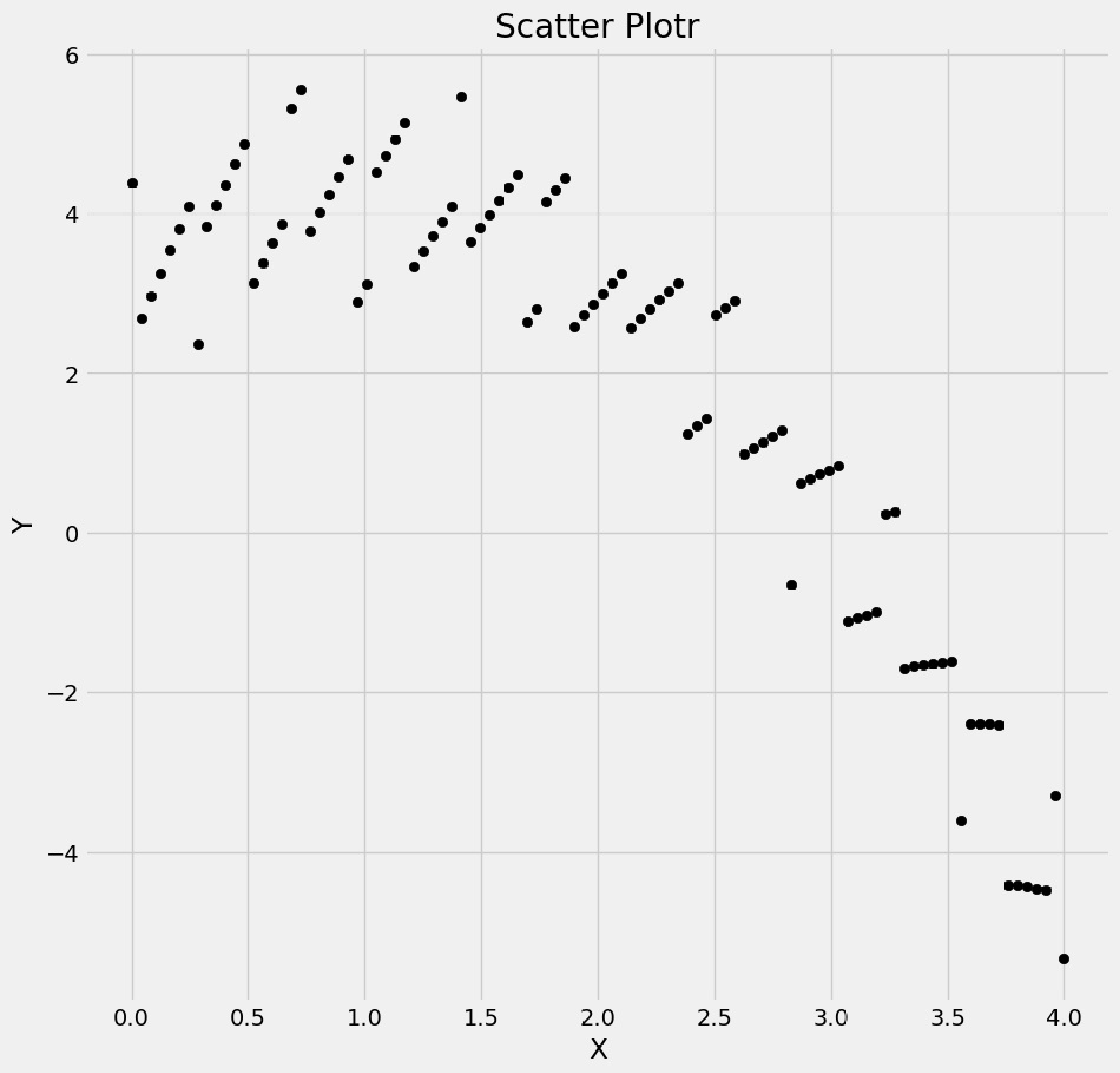
```
X =  [0.         0.04040404 0.08080808 0.12121212 0.16161616]
y =  [4.38754501 2.6796499  2.96848981 3.25406475 3.53637472]
m =  100
n =  100
```

In [5]:
```
# 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 [6]:
```
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[6]:
```
Text(0.5, 1.0, 'Scatter Plotr')
```



In [7]:
```
m = len(y)  # Number of training examples
n = len(X)  # Number of training examples
```

In [8]:
```
X_0 = np.ones((m, 1))
X_0[:5]
```

Out[8]:
```
array([[1.],
       [1.],
       [1.],
       [1.],
       [1.]])
```

In [9]:
```
X_1 = X.reshape(m, 1)
X_1[:10]
```

Out[9]:
```
array([[0.        ],
       [0.04040404],
       [0.08080808],
       [0.12121212],
       [0.16161616],
       [0.2020202 ],
       [0.24242424],
       [0.28282828],
       [0.32323232],
       [0.36363636]])
```

In [10]:
```
# 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[10]:
```
array([[1.        , 0.        ],
       [1.        , 0.04040404],
       [1.        , 0.08080808],
       [1.        , 0.12121212],
       [1.        , 0.16161616]])
```

In [11]:
```python
theta = np.zeros(2)
theta
```

Out[11]:
```
array([0., 0.])
```

In [12]:
```python
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 [13]:
```python
# 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
```

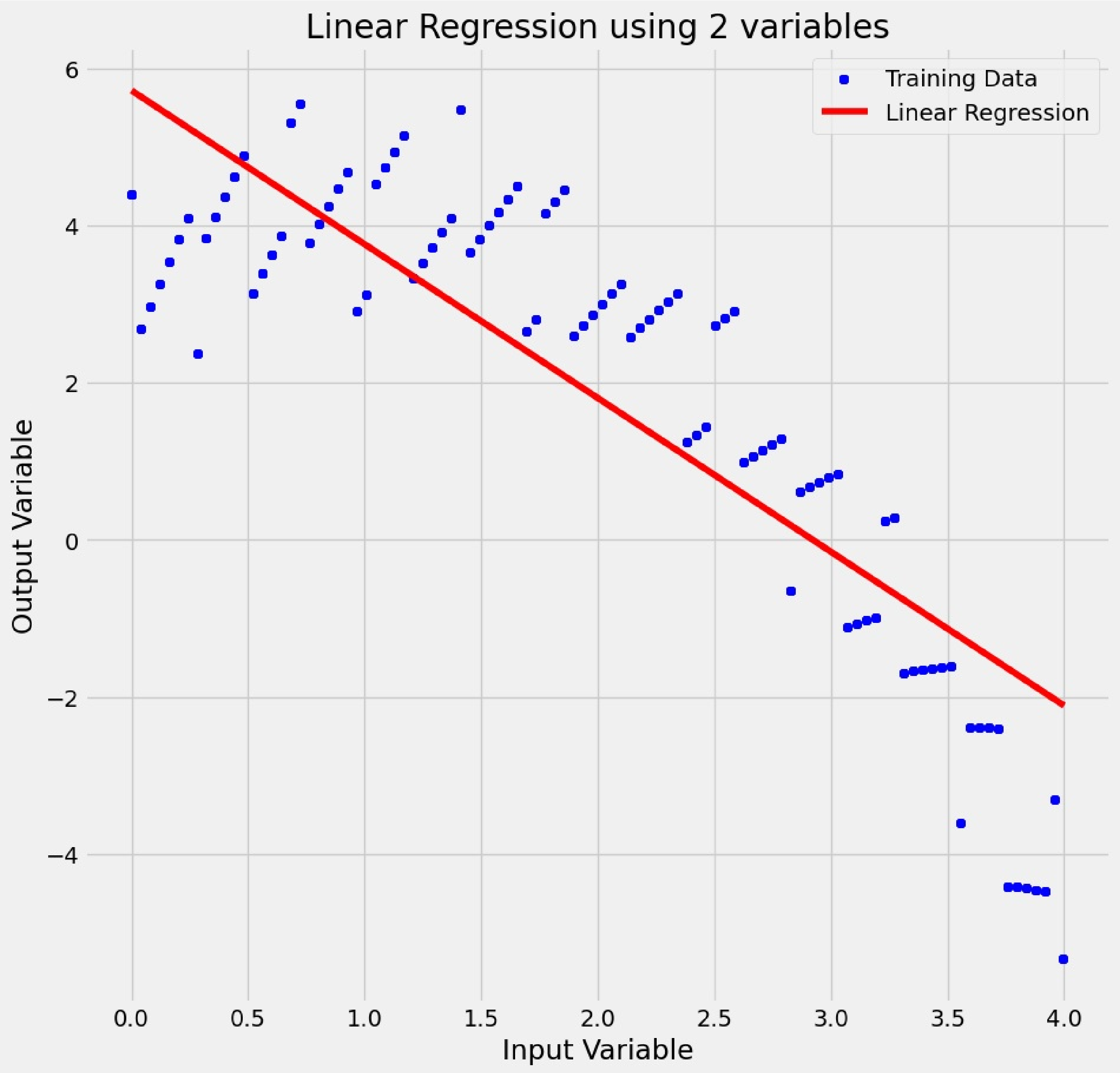
In [14]:
```python
theta = [0., 0.]
iterations = 1500;
alpha = 0.01;

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 = [ 5.71850653 -1.9568206 ]
cost_history = [5.48226715 5.44290965 5.40604087 ... 0.99063932 0.99061433 0.99058944]
```

In [15]:
```python
# 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')
```

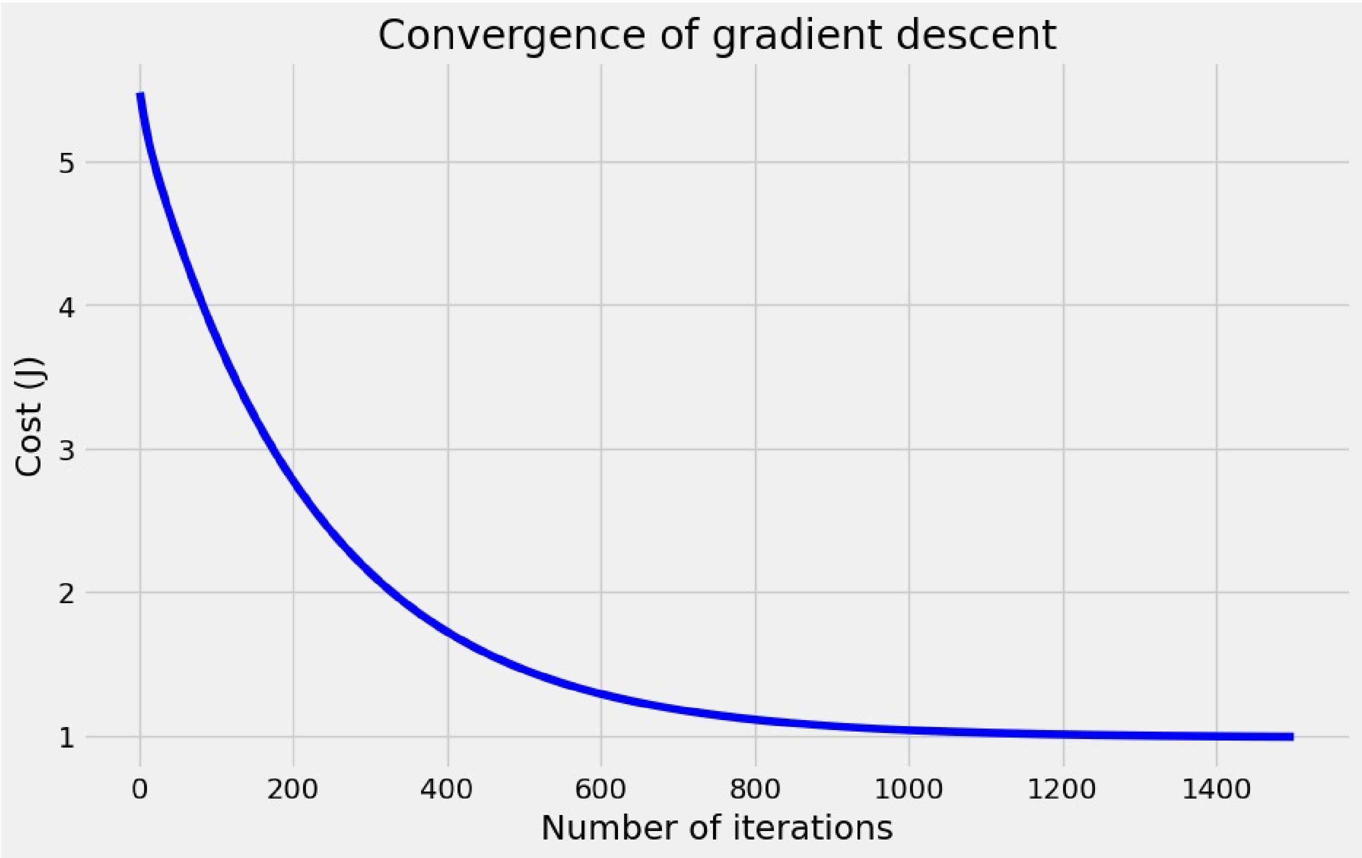
```python
plt.title('Linear Regression using 2 variables')
plt.legend()
```

Out[15]: <matplotlib.legend.Legend at 0x15923b1fd90>



In [16]:
```python
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[16]: Text(0.5, 1.0, 'Convergence of gradient descent')



In [ ]:

In [ ]:

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