To obtain the best fit line over multiple feature scattered datapoints using Linear Regression

In [2]:
```python
# 1.    Load the basic libraries and packages

import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
import warnings
warnings.filterwarnings('ignore')
```

In [3]:
```python
# 2. Load the dataset

dataset = pd.read_csv("https://raw.githubusercontent.com/nishithkotak/machine-learning/m
dataset.head()
```

Out[3]:

	Area	Rooms	Prices
0	2104	3	399900
1	1600	3	329900
2	2400	3	369000
3	1416	2	232000
4	3000	4	539900

In [4]:
```python
# 3.    Analyse the dataset

dataset.describe()
```

Out[4]:

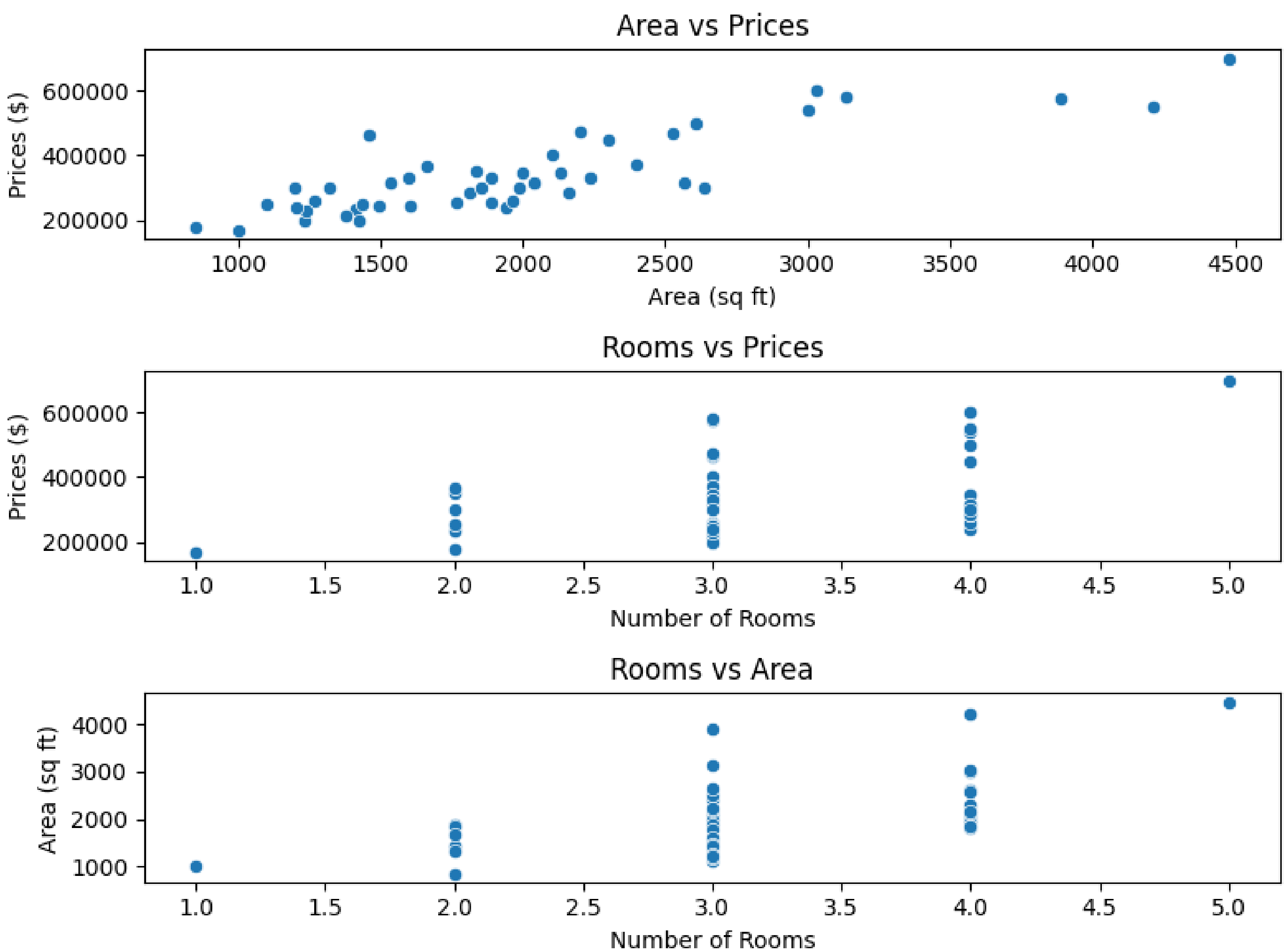
	Area	Rooms	Prices
count	47.000000	47.000000	47.000000
mean	2000.680851	3.170213	340412.659574
std	794.702354	0.760982	125039.899586
min	852.000000	1.000000	169900.000000
25%	1432.000000	3.000000	249900.000000
50%	1888.000000	3.000000	299900.000000
75%	2269.000000	4.000000	384450.000000
max	4478.000000	5.000000	699900.000000

In [5]:
```python
# 4.    Normalize the data

def Feature_Normalization(X):
  X = (X - np.mean(X , axis = 0)) / np.std(X , axis = 0)
  return X , np.mean(X , axis = 0) ,  np.std(X , axis = 0)
```

In [7]:
```python
# 5.    Pre-process the data

dataset_norm = dataset.values
m = len(dataset_norm[:,0])

# X_in = dataset_norm[:,0:2].reshape(m,2)
# X , mean_x , std_x = Feature_Normalization(X_in)
X1 = dataset_norm[:,0].reshape(m,1)
```

```
X2 = dataset_norm[:,1].reshape(m,1)
X1_norm  , mean_x1 , std_x1 = Feature_Normalization(X1)
X2_norm  , mean_x2 , std_x2 = Feature_Normalization(X2)
Y = dataset_norm[:,-1].reshape(m,1)
```

In [8]:
```
# 6.    Visualize the Data

plt.figure(figsize=(8, 6))

plt.subplot(3, 1, 1)
sns.scatterplot(x='Area', y='Prices', data=dataset,palette='viridis')
plt.title('Area vs Prices')
plt.xlabel('Area (sq ft)')
plt.ylabel('Prices ($)')

plt.subplot(3, 1, 2)
sns.scatterplot(x='Rooms', y='Prices', data=dataset, palette='viridis')
plt.title('Rooms vs Prices')
plt.xlabel('Number of Rooms')
plt.ylabel('Prices ($)')

plt.subplot(3, 1, 3)
sns.scatterplot(x='Rooms', y='Area', data=dataset, palette='viridis')
plt.title('Rooms vs Area')
plt.xlabel('Number of Rooms')
plt.ylabel('Area (sq ft)')

plt.tight_layout()
plt.show()
```



In [9]:
```
# 7.    Separate the feature and prediction value columns
```

```
area = dataset.iloc[:,0].values
room = dataset.iloc[:,1].values
price = dataset.iloc[:,2].values
```

In [10]:
```
# 8.    Write the Hypothesis Function

def Hypothesis(theta_array , x1 , x2) :
  return theta_array[0] + theta_array[1]*x1 + theta_array[2]*x2
```

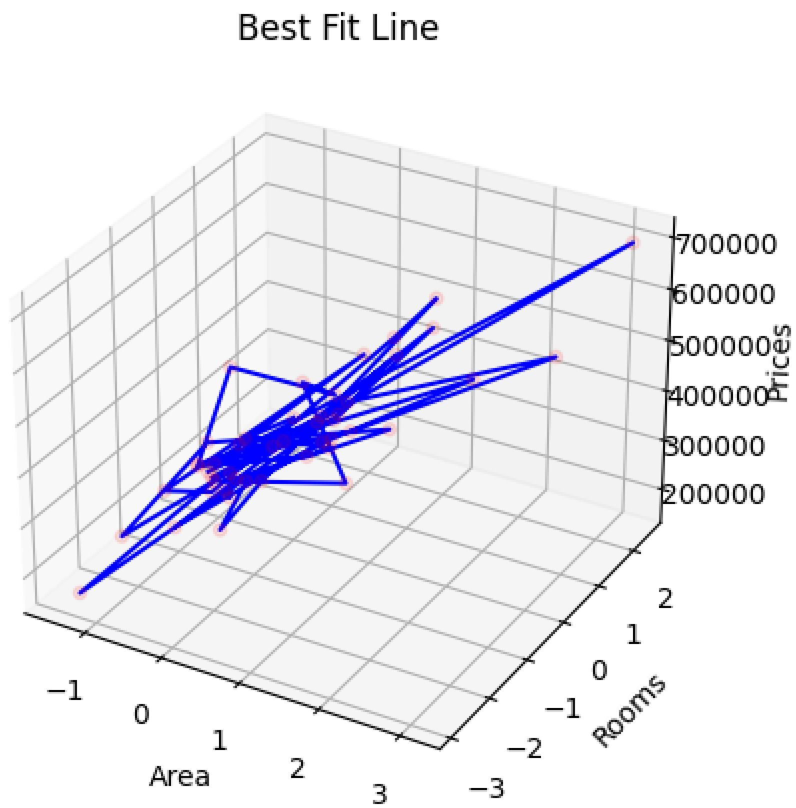
In [11]:
```
# 9.    Write the Cost Function

def  Cost_Function(theta_array,x1,x2,y , m):
  total_cost = 0
  for i in range(m):
    total_cost += (Hypothesis(theta_array,x1[i] , x2[i]) - y[i])**2
  return total_cost/(2*m)
```

In [12]:
```
# 10.   Write the Gradient Descent optimization algorithm

def Gradient_Descent(theta_array , x1, x2, y , m ,alpha) :
  summation_0 = 0
  summation_1 = 0
  summation_2 = 0

  for i in range(m):
    summation_0 += (Hypothesis(theta_array,x1[i] , x2[i]) - y[i])
    summation_1 += ((Hypothesis(theta_array,x1[i] , x2[i]) - y[i])*x1[i])
    summation_2 += ((Hypothesis(theta_array,x1[i] , x2[i]) - y[i])*x2[i])
  new_theta0 = theta_array[0] - (alpha/m)*summation_0
  new_theta1 = theta_array[1] - (alpha/m)*summation_1
  new_theta2 = theta_array[2] - (alpha/m)*summation_2

  new_theta = [new_theta0 , new_theta1 , new_theta2]

  return new_theta
```

In [13]:
```
# 11.   Apply the training over the dataset to minimize the loss

def Training(x1, x2, y, alpha, epochs):
    theta_0 = 0
    theta_1 = 0
    theta_2 = 0
    theta_array = [theta_0, theta_1  ,theta_2]
    m = len(x1)
    cost_values = []

    for i in range(epochs):
        theta_array = Gradient_Descent(theta_array, x1  ,x2, y, m, alpha)
        loss = Cost_Function(theta_array, x1  ,x2, y, m)
        cost_values.append(loss)
        y_new = theta_array[0] + theta_array[1]*x1 + theta_array[2]*x2

    return theta_array , cost_values
```

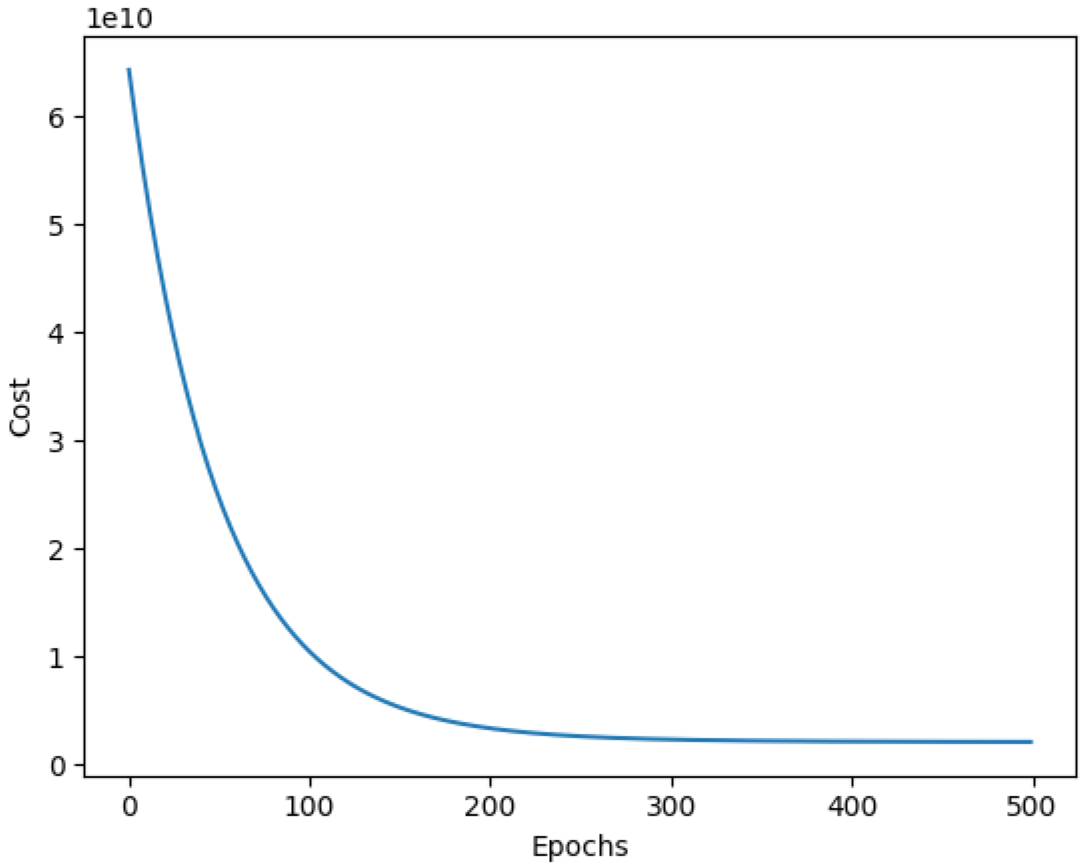
In [14]:
```
# 12.   Find the best fit line to the given dataset

alpha = 0.01
epochs = 500
area_norm = X1_norm
room_norm =  X2_norm
price_norm = Y
theta_array , cost_per_itr = Training(area_norm, room_norm, price_norm, alpha, epochs)
predicred_price = theta_array[0] + theta_array[1]*area_norm + theta_array[2]*room_norm
ax = plt.axes(projection="3d")
```

```python
ax.scatter(area_norm, room_norm, price_norm, alpha=0.1, c='#FF0000')
ax.plot(area_norm , room_norm , price_norm , c = "#0000FF")
ax.set_xlabel("Area")
ax.set_ylabel("Rooms")
ax.set_zlabel("Prices")
ax.set_title("Best Fit Line")
plt.show()
```



In [15]:
```python
# 13.   Observe the cost function vs iterations learning curve

print(f"Predicred Price = {theta_array[0]} + {theta_array[1]} * Area(Normalized) + {thet
x = np.arange(0, epochs)
plt.plot(x, cost_per_itr)
plt.xlabel('Epochs')
plt.ylabel('Cost')
plt.show()
```

```
Predicred Price = [338175.98396731] + [103032.12432974] * Area(Normalized) + [-202.32523
31]*Rooms(Normalized)
```

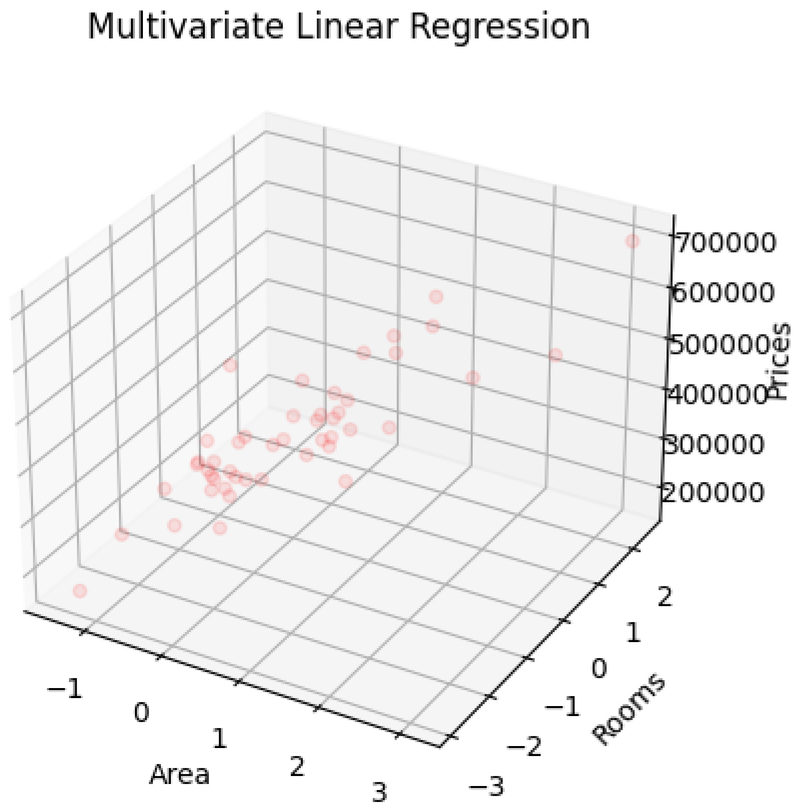


In [19]:
```
# Statistics After Normalization

Normalized_data = pd.DataFrame()
Normalized_data["Area"] = X1_norm.flatten()
Normalized_data["Rooms"] = X2_norm.flatten()
Normalized_data['Price'] = Y.flatten()
Normalized_data.describe()
```

Out[19]:

	Area	Rooms	Price
count	4.700000e+01	4.700000e+01	47.000000
mean	9.448707e-18	2.710598e-16	340412.659574
std	1.010811e+00	1.010811e+00	125039.899586
min	-1.461049e+00	-2.882690e+00	169900.000000
25%	-7.233261e-01	-2.260934e-01	249900.000000
50%	-1.433229e-01	-2.260934e-01	299900.000000
75%	3.412850e-01	1.102205e+00	384450.000000
max	3.150993e+00	2.430504e+00	699900.000000

In [21]:
```
# Datapoints scattering (without best fit line)

ax = plt.axes(projection="3d")
ax.scatter(area_norm, room_norm, price_norm, alpha=0.1, c='#FF0000')
ax.set_xlabel("Area")
ax.set_ylabel("Rooms")
ax.set_zlabel("Prices")
ax.set_title("Multivariate Linear Regression")
plt.show()
```



Multivariate Linear Regression
700000
600000
500000
400000
300000
200000
Prices
−1
0
1
2
3
Area
2
1
0
−1
−2
−3
Rooms