Multiple Linear Regression

Import the required libraries

In [77]:

```python
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns

import warnings
warnings.filterwarnings('ignore')
```

Read the data

In [78]:

```python
housing = pd.read_csv(r"C:\Users\Bhupendra\Desktop\DataCenter\Regressions\Ho
housing
```

Out[78]:

	price	area	bedrooms	bathrooms	stories	mainroad	guestroom	basement	hotwaterhea
0	13300000	7420	4	2	3	yes	no	no	
1	12250000	8960	4	4	4	yes	no	no	
2	12250000	9960	3	2	2	yes	no	yes	
3	12215000	7500	4	2	2	yes	no	yes	
4	11410000	7420	4	1	2	yes	yes	yes	
...	...	...	...	...	...	...	...	...	
540	1820000	3000	2	1	1	yes	no	yes	
541	1767150	2400	3	1	1	no	no	no	
542	1750000	3620	2	1	1	yes	no	no	
543	1750000	2910	3	1	1	no	no	no	
544	1750000	3850	3	1	2	yes	no	no	

545 rows × 13 columns

In [79]:

```
housing.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 545 entries, 0 to 544
Data columns (total 13 columns):
 #   Column            Non-Null Count  Dtype 
---  ------            --------------  ----- 
 0   price             545 non-null    int64 
 1   area              545 non-null    int64 
 2   bedrooms          545 non-null    int64 
 3   bathrooms         545 non-null    int64 
 4   stories           545 non-null    int64 
 5   mainroad          545 non-null    object
 6   guestroom         545 non-null    object
 7   basement          545 non-null    object
 8   hotwaterheating   545 non-null    object
 9   airconditioning   545 non-null    object
 10  parking           545 non-null    int64 
 11  prefarea          545 non-null    object
 12  furnishingstatus  545 non-null    object
dtypes: int64(6), object(7)
memory usage: 55.5+ KB
```

In [80]:

```
housing.describe()
```

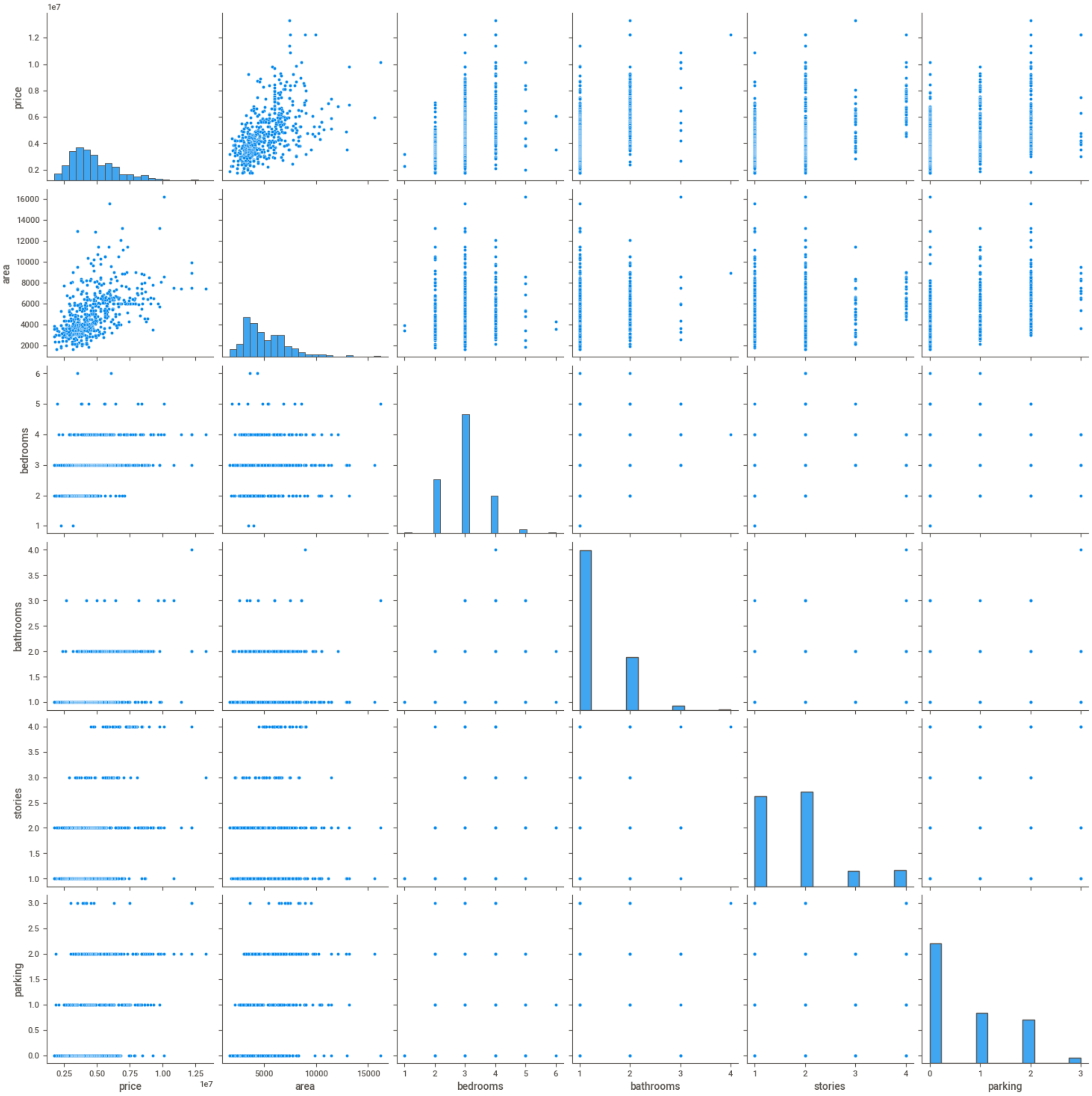
Out[80]:

	price	area	bedrooms	bathrooms	stories	parking
count	5.450000e+02	545.000000	545.000000	545.000000	545.000000	545.000000
mean	4.766729e+06	5150.541284	2.965138	1.286239	1.805505	0.693578
std	1.870440e+06	2170.141023	0.738064	0.502470	0.867492	0.861586
min	1.750000e+06	1650.000000	1.000000	1.000000	1.000000	0.000000
25%	3.430000e+06	3600.000000	2.000000	1.000000	1.000000	0.000000
50%	4.340000e+06	4600.000000	3.000000	1.000000	2.000000	0.000000
75%	5.740000e+06	6360.000000	3.000000	2.000000	2.000000	1.000000
max	1.330000e+07	16200.000000	6.000000	4.000000	4.000000	3.000000

Visualization

In [81]:

```
sns.pairplot(housing)
plt.show()
```



In [82]:

```
numeric_cols = housing.select_dtypes(['int', 'float']).columns
numeric_cols
```

Out[82]:

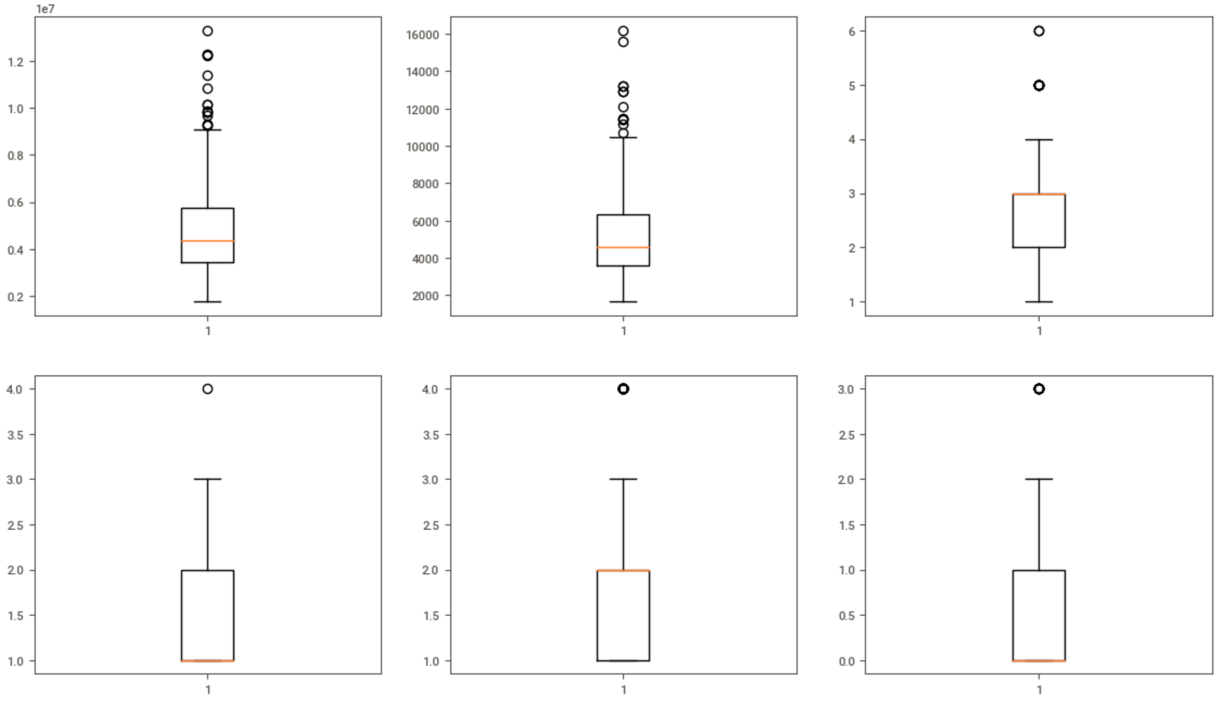
```
Index(['price', 'area', 'bedrooms', 'bathrooms', 'stories', 'parking'], dtype
='object')
```

In [83]:

```
fig,ax = plt.subplots(2,3, figsize = (14,8))

k=0
for i in  range(0,2):
    for j in range(0,3):
        ax[i,j].boxplot(housing[numeric_cols[k]])
        k+=1

plt.show()
```



In [84]:

```
cat_cols = housing.select_dtypes('object').columns
cat_cols
```

Out[84]:

```
Index(['mainroad', 'guestroom', 'basement', 'hotwaterheating',
       'airconditioning', 'prefarea', 'furnishingstatus'],
      dtype='object')
```

SweetViz : automating the data analysis part

In [86]:

```python
import sweetviz as sv
sweet_report = sv.analyze(housing)
sweet_report.show_html('housing_analysis.html')
```

```
                                                    |
| [  0%]   00:00 ->…

Report housing_analysis.html was generated! NOTEBOOK/COLAB USERS: the web brows
er MAY not pop up, regardless, the report IS saved in your notebook/colab file
s.
```

Label Encoding

In [87]:

```python
housing.head()
```

Out[87]:

	price	area	bedrooms	bathrooms	stories	mainroad	guestroom	basement	hotwaterheati
0	13300000	7420	4	2	3	yes	no	no	
1	12250000	8960	4	4	4	yes	no	no	
2	12250000	9960	3	2	2	yes	no	yes	
3	12215000	7500	4	2	2	yes	no	yes	
4	11410000	7420	4	1	2	yes	yes	yes	

In [88]:

```python
housing.mainroad=housing.mainroad.map({'yes':1,'no':0})
housing.guestroom=housing.guestroom.map({'yes':1,'no':0})
housing.basement=housing.basement.map({'yes':1,'no':0})
housing.hotwaterheating=housing.hotwaterheating.map({'yes':1,'no':0})
housing.airconditioning=housing.airconditioning.map({'yes':1,'no':0})
housing.prefarea=housing.prefarea.map({'yes':1,'no':0})
```

In [89]:

```python
housing.head()
```

Out[89]:

	price	area	bedrooms	bathrooms	stories	mainroad	guestroom	basement	hotwaterheati
0	13300000	7420	4	2	3	1	0	0	
1	12250000	8960	4	4	4	1	0	0	
2	12250000	9960	3	2	2	1	0	1	
3	12215000	7500	4	2	2	1	0	1	
4	11410000	7420	4	1	2	1	1	1	

In [90]:
```
housing.furnishingstatus.value_counts()
```

Out[90]:
```
semi-furnished    227
unfurnished       178
furnished         140
Name: furnishingstatus, dtype: int64
```

Using LabelEncoder class for label encoding

In [91]:
```
from sklearn.preprocessing import LabelEncoder

encoder = LabelEncoder()
encoder.fit_transform(housing.furnishingstatus)[:10]
```

Out[91]:
```
array([0, 0, 1, 0, 0, 1, 1, 2, 0, 2])
```

In [92]:
```
encoder.classes_
```

Out[92]:
```
array(['furnished', 'semi-furnished', 'unfurnished'], dtype=object)
```

In [93]:
```
housing.furnishingstatus = encoder.fit_transform(housing.furnishingstatus)
```

In [94]:
```
housing.head()
```

Out[94]:

	price	area	bedrooms	bathrooms	stories	mainroad	guestroom	basement	hotwaterheati
0	13300000	7420	4	2	3	1	0	0	
1	12250000	8960	4	4	4	1	0	0	
2	12250000	9960	3	2	2	1	0	1	
3	12215000	7500	4	2	2	1	0	1	
4	11410000	7420	4	1	2	1	1	1	

After converting all categorical columns into numerical ones now our data is ready for modelling

Model Training

train_test_split

In [116]:

```python
from sklearn.model_selection import train_test_split

X = housing.drop('price', axis = 1)
y = housing.price

X_train, X_test, y_train, y_test = train_test_split(X,y, test_size = 0.30, r
```

Model 1

In [98]:

```python
from sklearn.linear_model import LinearRegression

# Training
model1 = LinearRegression()
model1.fit(X_train, y_train)
```

Out[98]:

```
LinearRegression()
```

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prediction

In [100]:

```python
y_pred = model1.predict(X_test)
y_pred[:5]
```

Out[100]:

```
array([5407508.87024418, 7097185.46706855, 3055462.44314053,
       4476945.19636315, 3315983.65663579])
```

In [101]:

```python
y_test[:5]
```

Out[101]:

```
316    4060000
77     6650000
360    3710000
90     6440000
493    2800000
Name: price, dtype: int64
```

Model Evaluation

r2 score

In [102]:

```python
model1.score(X_test,y_test)
```

Out[102]:

```
0.6435419628959107
```

Model is able to explain **64.35%** variance in the data which is an average score.

root mean square error

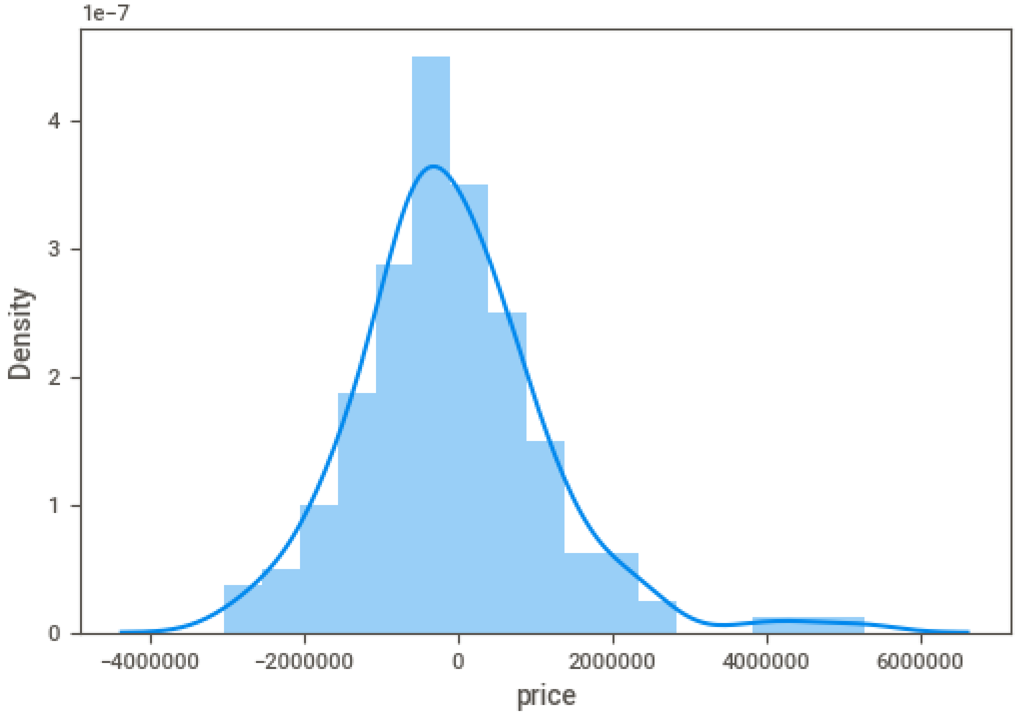
In [104]:
```
from sklearn.metrics import mean_squared_error

np.sqrt(mean_squared_error(y_test, y_pred))
```

Out[104]:
```
1238970.4429194627
```

distribution of residuals

In [105]:
```
sns.distplot(y_test-y_pred);
```



residuals are normally distributed, satisfying one of the assumptions of OLS(Ordinary Least Square) model

Improving the model performance

Model 2

In [107]:

```
housing.head()
```

Out[107]:

	price	area	bedrooms	bathrooms	stories	mainroad	guestroom	basement	hotwaterheati
0	13300000	7420	4	2	3	1	0	0	
1	12250000	8960	4	4	4	1	0	0	
2	12250000	9960	3	2	2	1	0	1	
3	12215000	7500	4	2	2	1	0	1	
4	11410000	7420	4	1	2	1	1	1	

Scaling the predictor variables

In [121]:

```
from sklearn.preprocessing import StandardScaler, MinMaxScaler
```

In [117]:

```
X = housing.drop('price', axis = 1)
y = housing.price
```

In [118]:

```
X.head(2)
```

Out[118]:

	area	bedrooms	bathrooms	stories	mainroad	guestroom	basement	hotwaterheating	aircond
0	7420	4	2	3	1	0	0	0	
1	8960	4	4	4	1	0	0	0	

In [119]:

```
X.columns
```

Out[119]:

```
Index(['area', 'bedrooms', 'bathrooms', 'stories', 'mainroad', 'guestroom',
       'basement', 'hotwaterheating', 'airconditioning', 'parking', 'prefarea',
       'furnishingstatus'],
      dtype='object')
```

In [120]:

```
ss = StandardScaler()
X = pd.DataFrame(ss.fit_transform(X), columns = X.columns)
X.head(2)
```

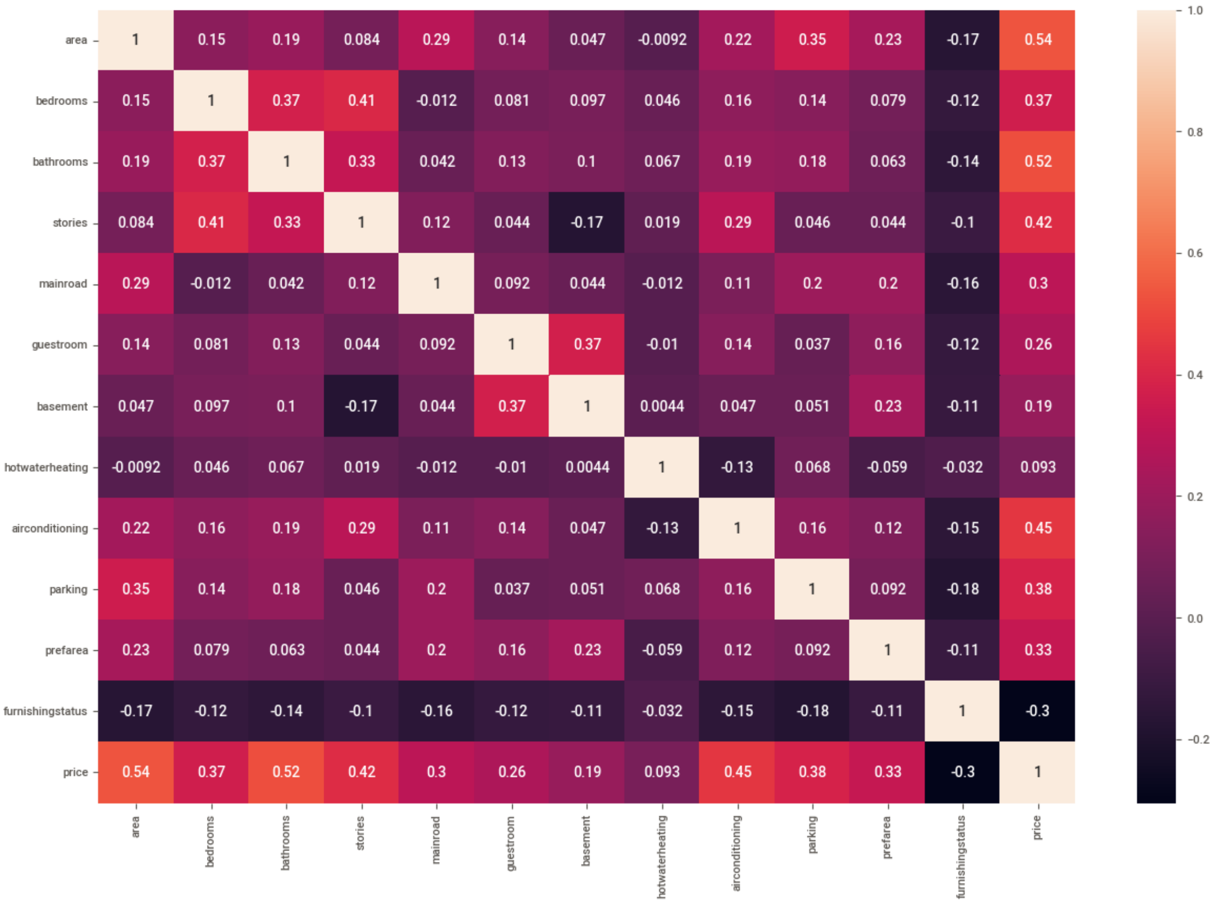
Out[120]:

	area	bedrooms	bathrooms	stories	mainroad	guestroom	basement	hotwaterheating	a
0	1.046726	1.403419	1.421812	1.378217	0.405623	-0.465315	-0.734539	-0.219265	
1	1.757010	1.403419	5.405809	2.532024	0.405623	-0.465315	-0.734539	-0.219265	

Feature Selection

In [128]:

```python
plt.figure(figsize = (15,10))
sns.heatmap(pd.concat([X,y], axis = 1).corr(), annot = True)
plt.show()
```



In [140]:

```python
X.shape
```

Out[140]:

```
(545, 12)
```

In [141]:

```python
y.shape
```

Out[141]:

```
(545,)
```

In [139]:

```python
from sklearn.feature_selection import SelectKBest
```

In [151]:

```python
SKB  = SelectKBest(k = 8)
SKB.fit(X,y)
```

Out[151]:

```
SelectKBest(k=8)
```

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In [155]:
```
imp_cols = SKB.get_feature_names_out()
imp_cols
```

Out[155]:
```
array(['area', 'bedrooms', 'bathrooms', 'stories', 'guestroom',
       'airconditioning', 'prefarea', 'furnishingstatus'], dtype=object)
```

In [157]:
```
SKB.n_features_in_
```

Out[157]:
```
12
```

In [162]:
```
X.columns
```

Out[162]:
```
Index(['area', 'bedrooms', 'bathrooms', 'stories', 'mainroad', 'guestroom',
       'basement', 'hotwaterheating', 'airconditioning', 'parking', 'prefarea',
       'furnishingstatus'],
      dtype='object')
```

In [161]:
```
SKB.get_support()
```

Out[161]:
```
array([ True,  True,  True,  True, False,  True, False, False,  True,
       False,  True,  True])
```

In [163]:
```
imp_cols = X.columns[SKB.get_support()]
imp_cols
```

Out[163]:
```
Index(['area', 'bedrooms', 'bathrooms', 'stories', 'guestroom',
       'airconditioning', 'prefarea', 'furnishingstatus'],
      dtype='object')
```

In [164]:
```
X = X[imp_cols]
X.head()
```

Out[164]:

	area	bedrooms	bathrooms	stories	guestroom	airconditioning	prefarea	furnishingstat
0	1.046726	1.403419	1.421812	1.378217	-0.465315	1.472618	1.804941	-1.4062
1	1.757010	1.403419	5.405809	2.532024	-0.465315	1.472618	-0.554035	-1.4062
2	2.218232	0.047278	1.421812	0.224410	-0.465315	-0.679063	1.804941	-0.0916
3	1.083624	1.403419	1.421812	0.224410	-0.465315	1.472618	1.804941	-1.4062
4	1.046726	1.403419	-0.570187	0.224410	2.149083	1.472618	-0.554035	-1.4062

In [ ]:

In [ ]:

In [ ]:

In [ ]:

```

```

In [ ]:

```

```

In [ ]:

```

```

In [122]:

```
X_train, X_test, y_train, y_test = train_test_split(X,y, test_size = 0.30, r
```

In [123]:

```
from sklearn.linear_model import LinearRegression

# Training
model1 = LinearRegression()
model1.fit(X_train, y_train)
```

Out[123]:

```
LinearRegression()
```

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In [124]:

```
model1.score(X_test,y_test)
```

Out[124]:

```
0.6435419628959108
```

Model Building

In [167]:

```
X_train, X_test, y_train, y_test = train_test_split(X,y, test_size = 0.30, r
```

In [168]:

```
model2 = LinearRegression()
model2.fit(X_train, y_train)
```

Out[168]:

```
LinearRegression()
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
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In [171]:

```
y_pred = model2.predict(X_test)
```

In [172]:

```
model2.score(X_test,y_test)
```

Out[172]:

```
0.6193144896868267
```

In [173]:

```
np.sqrt(mean_squared_error(y_test, y_pred))
```

Out[173]:

```
1280383.042743209
```

In [ ]:

```

```