House Price prediction using Multiple Linear Regression

We are building a Multiple linear regression model here in order to predict the price of a house based on its features like space, area and other aspects.

In [2]:
```
#getting packages
import pandas as pd# For manipulating the data
import numpy as np # For mathematical calculations
import seaborn as sns # For data visualization
import matplotlib.pyplot as plt # For plotting graphs
%matplotlib inline
import warnings # For error messages
```

In [3]:
```
#getting the dataset

file_path = 'C:\\Users\\sujoydutta\\Desktop\\Data analysis\\Datasets for ML\\Regression\

data = pd.read_csv(file_path)
data.head()
```

Out[3]:

	Sale_Price	No of Bedrooms	No of Bathrooms	Flat Area (in Sqft)	Lot Area (in Sqft)	No of Floors	No of Times Visited	Overall Grade	Area of the House from Basement (in Sqft)	Basement Area (in Sqft)	...	Waterfr
0	221900.0	3	1.00	1180.0	5650.0	1.0	0	7	1180.0	0	...	
1	538000.0	3	2.25	2570.0	7242.0	2.0	0	7	2170.0	400	...	
2	180000.0	2	1.00	770.0	10000.0	1.0	0	6	770.0	0	...	
3	604000.0	4	3.00	1960.0	5000.0	1.0	0	7	1050.0	910	...	
4	510000.0	3	2.00	1680.0	8080.0	1.0	0	8	1680.0	0	...	

5 rows × 31 columns

In [4]:
```
#getting description of the data
data.describe()
```

Out[4]:

	Sale_Price	No of Bedrooms	No of Bathrooms	Flat Area (in Sqft)	Lot Area (in Sqft)	No of Floors	No of Times Visited	
count	2.160900e+04	21609.000000	21609.000000	21609.000000	2.160900e+04	21609.000000	21609.000000	21609.
mean	5.116186e+05	3.370771	2.114709	2079.872553	1.510641e+04	1.494215	0.234347	7.
std	2.500620e+05	0.929916	0.770097	918.347816	4.142353e+04	0.539909	0.766382	1.
min	7.500000e+04	0.000000	0.000000	290.000000	5.200000e+02	1.000000	0.000000	1.
25%	3.219500e+05	3.000000	1.750000	1430.000000	5.040000e+03	1.000000	0.000000	7.
50%	4.500000e+05	3.000000	2.250000	1910.000000	7.619000e+03	1.500000	0.000000	7.
75%	6.450000e+05	4.000000	2.500000	2550.000000	1.068700e+04	2.000000	0.000000	8.

max	1.129575e+06	33.000000	8.000000	13540.000000	1.651359e+06	3.500000	4.000000	10.(

8 rows × 31 columns

In [5]:
```
#getting null values in each column
data.isnull().sum()
```

Out[5]:
```
Sale_Price                                  0
No of Bedrooms                              0
No of Bathrooms                             0
Flat Area (in Sqft)                         0
Lot Area (in Sqft)                          0
No of Floors                                0
No of Times Visited                         0
Overall Grade                               0
Area of the House from Basement (in Sqft)   0
Basement Area (in Sqft)                     0
Age of House (in Years)                     0
Latitude                                    0
Longitude                                   0
Living Area after Renovation (in Sqft)      0
Lot Area after Renovation (in Sqft)         0
Years Since Renovation                      0
Condition_of_the_House_Excellent            0
Condition_of_the_House_Fair                 0
Condition_of_the_House_Good                 0
Condition_of_the_House_Okay                 0
Ever_Renovated_Yes                          0
Waterfront_View_Yes                         0
Zipcode_Group_Zipcode_Group_1               0
Zipcode_Group_Zipcode_Group_2               0
Zipcode_Group_Zipcode_Group_3               0
Zipcode_Group_Zipcode_Group_4               0
Zipcode_Group_Zipcode_Group_5               0
Zipcode_Group_Zipcode_Group_6               0
Zipcode_Group_Zipcode_Group_7               0
Zipcode_Group_Zipcode_Group_8               0
Zipcode_Group_Zipcode_Group_9               0
dtype: int64
```

In [6]:
```
#values in sale price variable before deleting outliers
print("Before deleting outliers length = " , len(data.Sale_Price))
```

```
Before deleting outliers length =  21609
```

In [7]:
```
# Calculating mean and standard deviation of Sale_Price
mean_price = data['Sale_Price'].mean()
std_dev = data['Sale_Price'].std()
print(mean_price)
print(std_dev)
```

```
511618.55814706837
250062.01350117987
```

In [8]:
```
# Defining the threshold for removing rows
threshold = 2 * std_dev
```

In [9]:
```
# Filter rows where SalePrice is within 2 standard deviations from the mean
filtered_data = data[(data['Sale_Price'] >= (mean_price - threshold)) & (data['Sale_Pric
filtered_data
```

Out[9]:

	Sale_Price	No of Bedrooms	No of Bathrooms	Flat Area	Lot Area	No of Floors	No of Times Visited	Overall Grade	Area of the House	Basement Area (in Sqft)	...	Wa

				(in Sqft)	(in Sqft)				from Basement (in Sqft)		
0	221900.0	3	1.00	1180.0	5650.0	1.0	0	7	1180.0	0	...
1	538000.0	3	2.25	2570.0	7242.0	2.0	0	7	2170.0	400	...
2	180000.0	2	1.00	770.0	10000.0	1.0	0	6	770.0	0	...
3	604000.0	4	3.00	1960.0	5000.0	1.0	0	7	1050.0	910	...
4	510000.0	3	2.00	1680.0	8080.0	1.0	0	8	1680.0	0	...
...	...	...	...	...	...	...	...	...	...	...	...
21604	360000.0	3	2.50	1530.0	1131.0	3.0	0	8	1530.0	0	...
21605	400000.0	4	2.50	2310.0	5813.0	2.0	0	8	2310.0	0	...
21606	402101.0	2	0.75	1020.0	1350.0	2.0	0	7	1020.0	0	...
21607	400000.0	3	2.50	1600.0	2388.0	2.0	0	8	1600.0	0	...
21608	325000.0	2	0.75	1020.0	1076.0	2.0	0	7	1020.0	0	...

20173 rows × 31 columns

In [10]:
```
#removing outliers from sale price column
print("After deleting outliers length = " , len(filtered_data.Sale_Price))
```

```
After deleting outliers length =  20173
```

In [11]:
```
#outliers count
print("The outliers removed total around = " , len(data.Sale_Price)-len(filtered_data.Sa
```

```
The outliers removed total around =  1436
```

In [12]:
```
#segregating numerical and categorical columns
Numerical_Type = data.iloc[:,0:16]
Categorical_Type = data.iloc[:, 16:]
numerical_features = data[Numerical_Type.columns]

categorical_features = data[Categorical_Type.columns]
numerical_features,categorical_features
```

Out[12]:
```
(       Sale_Price  No of Bedrooms  No of Bathrooms  Flat Area (in Sqft)  \
 0        221900.0               3             1.00                1180.0
 1        538000.0               3             2.25                2570.0
 2        180000.0               2             1.00                 770.0
 3        604000.0               4             3.00                1960.0
 4        510000.0               3             2.00                1680.0
 ...           ...             ...              ...                   ...
 21604    360000.0               3             2.50                1530.0
 21605    400000.0               4             2.50                2310.0
 21606    402101.0               2             0.75                1020.0
 21607    400000.0               3             2.50                1600.0
 21608    325000.0               2             0.75                1020.0

        Lot Area (in Sqft)  No of Floors  No of Times Visited  Overall Grade  \
 0                  5650.0           1.0                    0              7
 1                  7242.0           2.0                    0              7
 2                 10000.0           1.0                    0              6
 3                  5000.0           1.0                    0              7
 4                  8080.0           1.0                    0              8
 ...                   ...           ...                  ...            ...
 21604              1131.0           3.0                    0              8
 21605              5813.0           2.0                    0              8
```

```
21606             1350.0           2.0                    0              7
21607             2388.0           2.0                    0              8
21608             1076.0           2.0                    0              7

       Area of the House from Basement (in Sqft)  Basement Area (in Sqft)  \
0                                         1180.0                       0
1                                         2170.0                     400
2                                          770.0                       0
3                                         1050.0                     910
4                                         1680.0                       0
...                                          ...                     ...
21604                                     1530.0                       0
21605                                     2310.0                       0
21606                                     1020.0                       0
21607                                     1600.0                       0
21608                                     1020.0                       0

       Age of House (in Years)  Latitude  Longitude  \
0                           63   47.5112   -122.257
1                           67   47.7210   -122.319
2                           85   47.7379   -122.233
3                           53   47.5208   -122.393
4                           31   47.6168   -122.045
...                        ...       ...        ...
21604                        9   47.6993   -122.346
21605                        4   47.5107   -122.362
21606                        9   47.5944   -122.299
21607                       14   47.5345   -122.069
21608                       10   47.5941   -122.299

       Living Area after Renovation (in Sqft)  \
0                                      1340.0
1                                      1690.0
2                                      2720.0
3                                      1360.0
4                                      1800.0
...                                       ...
21604                                  1530.0
21605                                  1830.0
21606                                  1020.0
21607                                  1410.0
21608                                  1020.0

       Lot Area after Renovation (in Sqft)  Years Since Renovation
0                                     5650                       0
1                                     7639                      26
2                                     8062                       0
3                                     5000                       0
4                                     7503                       0
...                                    ...                     ...
21604                                 1509                       0
21605                                 7200                       0
21606                                 2007                       0
21607                                 1287                       0
21608                                 1357                       0

[21609 rows x 16 columns],
       Condition_of_the_House_Excellent  Condition_of_the_House_Fair  \
0                                     0                           1
1                                     0                           1
2                                     0                           1
3                                     1                           0
4                                     0                           1
...                                 ...                         ...
21604                                 0                           1
21605                                 0                           1
```

```
21606                                  0                                  1
21607                                  0                                  1
21608                                  0                                  1

       Condition_of_the_House_Good  Condition_of_the_House_Okay  \
0                                0                            0
1                                0                            0
2                                0                            0
3                                0                            0
4                                0                            0
...                            ...                          ...
21604                            0                            0
21605                            0                            0
21606                            0                            0
21607                            0                            0
21608                            0                            0

       Ever_Renovated_Yes  Waterfront_View_Yes  Zipcode_Group_Zipcode_Group_1  \
0                       0                    0                              0
1                       1                    0                              0
2                       0                    0                              0
3                       0                    0                              0
4                       0                    0                              0
...                   ...                  ...                            ...
21604                   0                    0                              0
21605                   0                    0                              1
21606                   0                    0                              0
21607                   0                    0                              0
21608                   0                    0                              0

       Zipcode_Group_Zipcode_Group_2  Zipcode_Group_Zipcode_Group_3  \
0                                  0                              0
1                                  1                              0
2                                  1                              0
3                                  0                              1
4                                  0                              0
...                              ...                            ...
21604                              0                              1
21605                              0                              0
21606                              0                              1
21607                              0                              0
21608                              0                              1

       Zipcode_Group_Zipcode_Group_4  Zipcode_Group_Zipcode_Group_5  \
0                                  0                              0
1                                  0                              0
2                                  0                              0
3                                  0                              0
4                                  1                              0
...                              ...                            ...
21604                              0                              0
21605                              0                              0
21606                              0                              0
21607                              1                              0
21608                              0                              0

       Zipcode_Group_Zipcode_Group_6  Zipcode_Group_Zipcode_Group_7  \
0                                  0                              0
1                                  0                              0
2                                  0                              0
3                                  0                              0
4                                  0                              0
...                              ...                            ...
21604                              0                              0
21605                              0                              0
21606                              0                              0
```

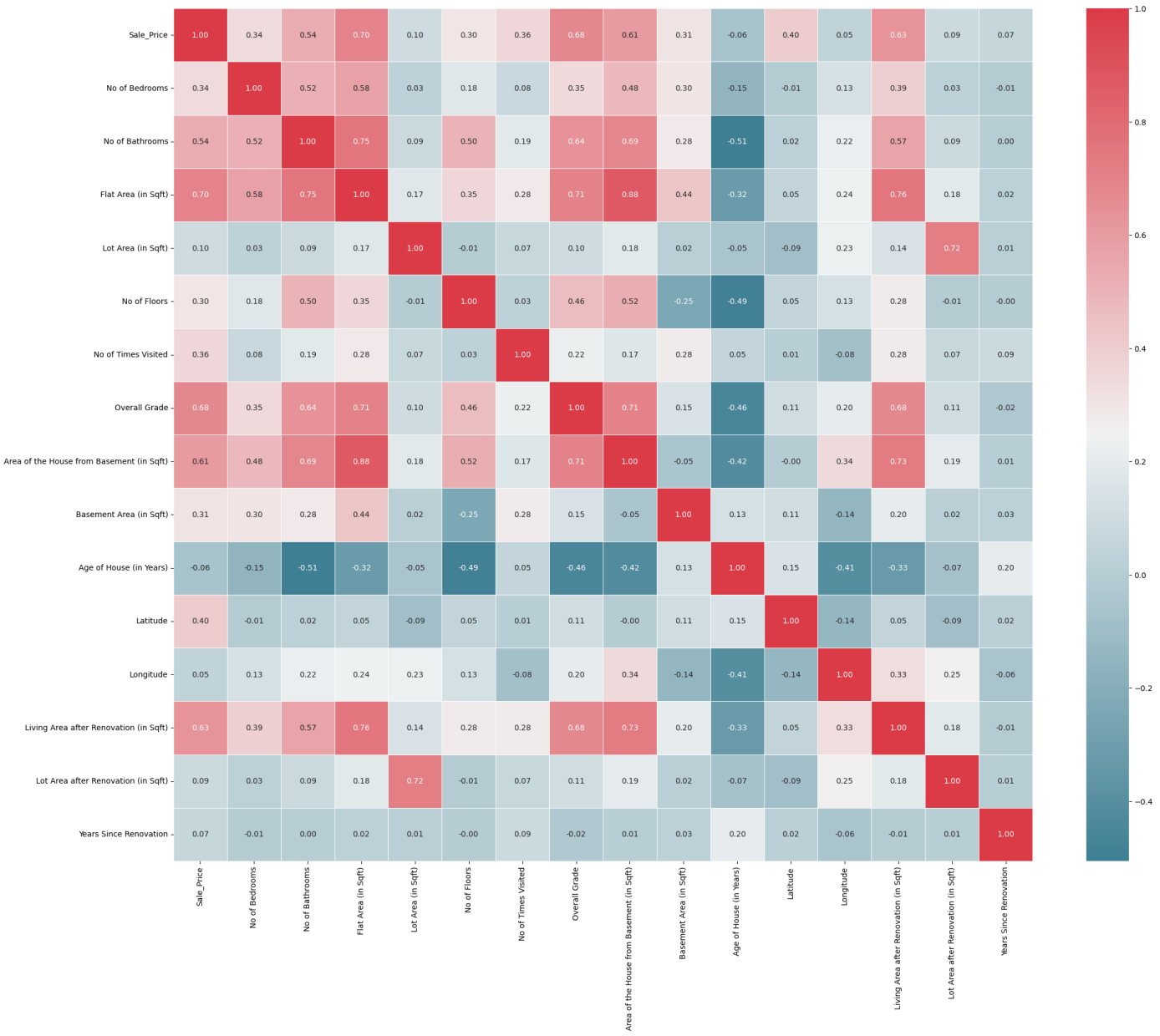
```
21607                                   0                                   0
21608                                   0                                   0

       Zipcode_Group_Zipcode_Group_8  Zipcode_Group_Zipcode_Group_9
0                                  0                              0
1                                  0                              0
2                                  0                              0
3                                  0                              0
4                                  0                              0
...                              ...                            ...
21604                              0                              0
21605                              0                              0
21606                              0                              0
21607                              0                              0
21608                              0                              0

[21609 rows x 15 columns])
```

In [13]:
```
#building a correlation heatmap
def correlation_heatmap(numerical_features):
    _, ax = plt.subplots(figsize=(25, 20))
    colormap = sns.diverging_palette(220, 10, as_cmap=True)
    sns.heatmap(numerical_features.corr(), annot=True, cmap=colormap, fmt=".2f", linewid
```

In [14]:
```
#plotting the heatmap
correlation_heatmap(numerical_features)
plt.show()
```



The following variables have a positive correlation with the saleprice of the apartment: 1)low- bedroom, floors, number of times visited,basement area 2)moderate- bathroom 3)significant-flat area,overall grade,area of house from basement,living area

In [15]:
```
#seperating independent and dependent variables
data_x = data.drop(['Sale_Price'], axis=1)
data_y = data['Sale_Price']
```

In [16]:
```
#splitting the dataset into train,test and validation
from sklearn.model_selection import train_test_split as tts
train1_x, test_x , train1_y, test_y = tts( data_x, data_y , test_size
= 0.2 , random_state = 50)
train_x, val_x, train_y, val_y = tts(train1_x, train1_y, test_size =
0.2 , random_state = 51)
```

In [17]:
```
#building the linear regression model
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error

linear_model = LinearRegression()
```

In [18]:
```
# Training the model on the training set
linear_model.fit(train_x, train_y)
```

Out[18]:
```
LinearRegression()
```

In [19]:
```
# Predicting on the validation set
val_predictions = linear_model.predict(val_x)
```

In [20]:
```
# Evaluating the model on the validation set
val_mse = mean_squared_error(val_y, val_predictions)
print(f'Mean Squared Error on Validation Set: {val_mse}')
```

```
Mean Squared Error on Validation Set: 9765406197.364662
```

In [21]:
```
# Predicting on the test set
test_predictions = linear_model.predict(test_x)
```

In [22]:
```
# Evaluating the model on the test set
test_mse = mean_squared_error(test_y, test_predictions)
print(f'Mean Squared Error on Test Set: {test_mse}')
```

```
Mean Squared Error on Test Set: 10023945275.436543
```

In [23]:
```
# Getting the StandardScaler and running it
from sklearn.preprocessing import StandardScaler


ss = StandardScaler()
```

In [25]:
```
# Fitting and transforming all the sets
train_x = ss.fit_transform(train_x)

test_x = ss.transform(test_x)

val_x = ss.transform(val_x)
```

```
C:\Users\sujoydutta\anaconda\Lib\site-packages\sklearn\base.py:457: UserWarning: X has f
eature names, but StandardScaler was fitted without feature names
  warnings.warn(
C:\Users\sujoydutta\anaconda\Lib\site-packages\sklearn\base.py:457: UserWarning: X has f
eature names, but StandardScaler was fitted without feature names
  warnings.warn(
```

In [33]:
```
#splitting the dataset again
from sklearn.model_selection import train_test_split
train_x, test_x, train_y, test_y = train_test_split(data_x, data_y, test_size
= 0.2, random_state=86)
train_x, val_x, train_y, val_y = train_test_split(data_x, data_y, test_size
= 0.2, random_state=42)
```

In [34]:
```
# Training the model on the training set
linear_model.fit(train_x, train_y)
```

Out[34]:
```
LinearRegression()
```

In [35]:
```
# Predicting on the test set
test_predictions = linear_model.predict(test_x)
```

In [36]:
```
# Evaluating the model on the test set
test_mse = mean_squared_error(test_y, test_predictions)
print(f'Mean Squared Error on Test Set: {test_mse}')
```

```
Mean Squared Error on Test Set: 9938686947.324406
```

In [37]:
```
# Predicting on the validation set
val_predictions = linear_model.predict(val_x)
```

In [38]:
```
# Evaluating the model on the validation set
val_mse = mean_squared_error(val_y, val_predictions)
print(f'Mean Squared Error on Validation Set: {val_mse}')
```

```
Mean Squared Error on Validation Set: 9953546811.365582
```

Remark:There is significant reduction in MSE after scaling the dataset. Validation set has lower MSE than test set.