

DONE BY ATHAVAN T

## Importing the necessary libraries for EDA and data preprocessing

```
In [2]: import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import folium
from scipy import stats
```

## Converting csv file into dataframe

```
In [3]: df=pd.read_csv('C:/Users/Reshma/Downloads/House Price India.csv')
```

```
In [4]: df=df.drop(['Date'],axis=1)
```

```
In [5]: df
```

Out[5]:

	id	number of bedrooms	number of bathrooms	living area	lot area	number of floors	waterfront present	number of views	condition of the house	grade of the house	...	Built Year	Renovatio Year
0	6762810145	5	2.50	3650	9050	2.0	0	4	5	10	...	1921	
1	6762810635	4	2.50	2920	4000	1.5	0	0	5	8	...	1909	
2	6762810998	5	2.75	2910	9480	1.5	0	0	3	8	...	1939	
3	6762812605	4	2.50	3310	42998	2.0	0	0	3	9	...	2001	
4	6762812919	3	2.00	2710	4500	1.5	0	0	4	8	...	1929	
...	...	...	...	...	...	...	...	...	...	...	...	...	...
14615	6762830250	2	1.50	1556	20000	1.0	0	0	4	7	...	1957	
14616	6762830339	3	2.00	1680	7000	1.5	0	0	4	7	...	1968	
14617	6762830618	2	1.00	1070	6120	1.0	0	0	3	6	...	1962	
14618	6762830709	4	1.00	1030	6621	1.0	0	0	4	6	...	1955	
14619	6762831463	3	1.00	900	4770	1.0	0	0	3	6	...	1969	200

14620 rows x 22 columns



In [6]: df.head()

Out[6]:

	id	number of bedrooms	number of bathrooms	living area	lot area	number of floors	waterfront present	number of views	condition of the house	grade of the house	...	Built Year	Renovation Year	...
0	6762810145	5	2.50	3650	9050	2.0	0	4	5	10	...	1921	0	1921
1	6762810635	4	2.50	2920	4000	1.5	0	0	5	8	...	1909	0	1909
2	6762810998	5	2.75	2910	9480	1.5	0	0	3	8	...	1939	0	1939
3	6762812605	4	2.50	3310	42998	2.0	0	0	3	9	...	2001	0	1921
4	6762812919	3	2.00	2710	4500	1.5	0	0	4	8	...	1929	0	1921

5 rows × 22 columns

In [7]: `df.tail()`

Out[7]:

	id	number of bedrooms	number of bathrooms	living area	lot area	number of floors	waterfront present	number of views	condition of the house	grade of the house	...	Built Year	Renovation Year	...
14615	6762830250	2	1.5	1556	20000	1.0	0	0	4	7	...	1957	0	1957
14616	6762830339	3	2.0	1680	7000	1.5	0	0	4	7	...	1968	0	1968
14617	6762830618	2	1.0	1070	6120	1.0	0	0	3	6	...	1962	0	1962
14618	6762830709	4	1.0	1030	6621	1.0	0	0	4	6	...	1955	0	1955
14619	6762831463	3	1.0	900	4770	1.0	0	0	3	6	...	1969	2001	1969

5 rows × 22 columns

## Checking for null and duplicated values

```
In [8]: df.isna().sum()
```

```
Out[8]: id                                0
        number of bedrooms                 0
        number of bathrooms                0
        living area                        0
        lot area                           0
        number of floors                   0
        waterfront present                 0
        number of views                    0
        condition of the house             0
        grade of the house                 0
        Area of the house(excluding basement) 0
        Area of the basement               0
        Built Year                         0
        Renovation Year                    0
        Postal Code                        0
        Latitude                           0
        Longitude                          0
        living_area_renov                  0
        lot_area_renov                     0
        Number of schools nearby            0
        Distance from the airport          0
        Price                              0
        dtype: int64
```

```
In [9]: df.duplicated().sum()
```

```
Out[9]: 0
```

```
In [10]: df.info()
```

```

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 14620 entries, 0 to 14619
Data columns (total 22 columns):
#   Column                                     Non-Null Count  Dtype
---  -
0   id                                         14620 non-null  int64
1   number of bedrooms                       14620 non-null  int64
2   number of bathrooms                      14620 non-null  float64
3   living area                              14620 non-null  int64
4   lot area                                  14620 non-null  int64
5   number of floors                         14620 non-null  float64
6   waterfront present                       14620 non-null  int64
7   number of views                          14620 non-null  int64
8   condition of the house                   14620 non-null  int64
9   grade of the house                      14620 non-null  int64
10  Area of the house(excluding basement)    14620 non-null  int64
11  Area of the basement                     14620 non-null  int64
12  Built Year                              14620 non-null  int64
13  Renovation Year                         14620 non-null  int64
14  Postal Code                             14620 non-null  int64
15  Lattitude                               14620 non-null  float64
16  Longitude                               14620 non-null  float64
17  living_area_renov                        14620 non-null  int64
18  lot_area_renov                          14620 non-null  int64
19  Number of schools nearby                  14620 non-null  int64
20  Distance from the airport                14620 non-null  int64
21  Price                                    14620 non-null  int64
dtypes: float64(4), int64(18)
memory usage: 2.5 MB

```

```
In [11]: df.describe()
```

Out[11]:

	id	number of bedrooms	number of bathrooms	living area	lot area	number of floors	waterfront present	number of views	condi the
<b>count</b>	1.462000e+04	14620.000000	14620.000000	14620.000000	1.462000e+04	14620.000000	14620.000000	14620.000000	14620.
<b>mean</b>	6.762821e+09	3.379343	2.129583	2098.262996	1.509328e+04	1.502360	0.007661	0.233105	3.
<b>std</b>	6.237575e+03	0.938719	0.769934	928.275721	3.791962e+04	0.540239	0.087193	0.766259	0.
<b>min</b>	6.762810e+09	1.000000	0.500000	370.000000	5.200000e+02	1.000000	0.000000	0.000000	1.
<b>25%</b>	6.762815e+09	3.000000	1.750000	1440.000000	5.010750e+03	1.000000	0.000000	0.000000	3.
<b>50%</b>	6.762821e+09	3.000000	2.250000	1930.000000	7.620000e+03	1.500000	0.000000	0.000000	3.
<b>75%</b>	6.762826e+09	4.000000	2.500000	2570.000000	1.080000e+04	2.000000	0.000000	0.000000	4.
<b>max</b>	6.762832e+09	33.000000	8.000000	13540.000000	1.074218e+06	3.500000	1.000000	4.000000	5.

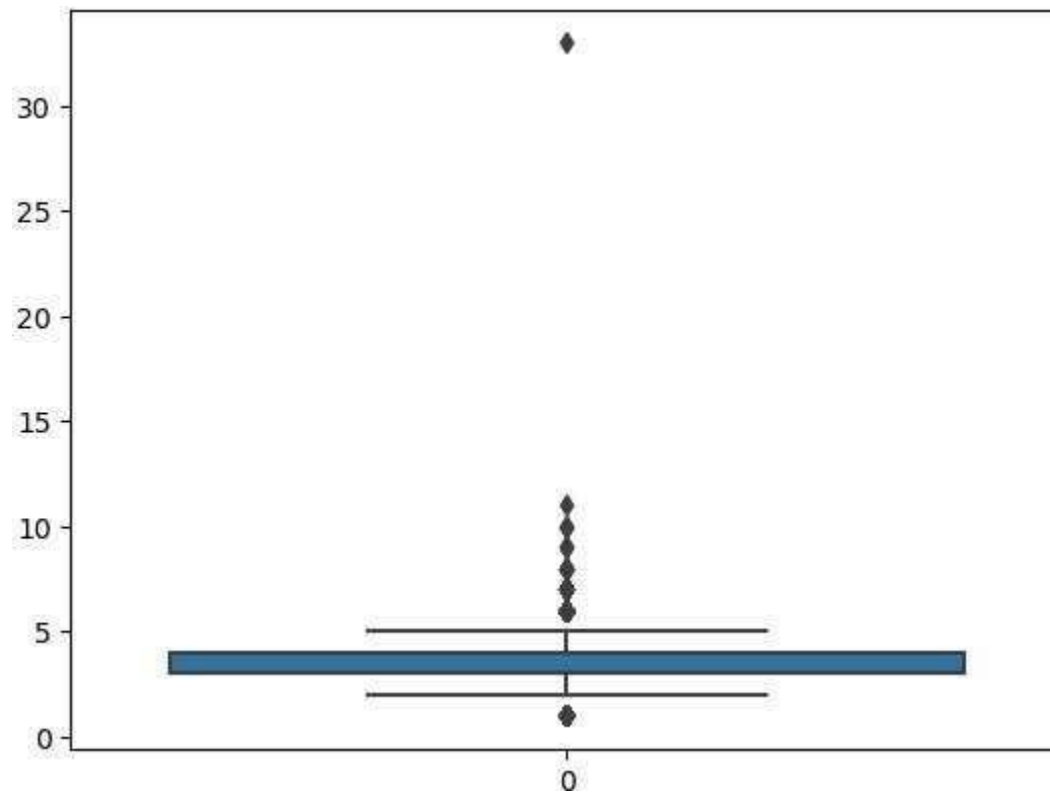
8 rows × 22 columns

## UNIVARIATE ANALYSIS

### Checking for outliers

```
In [12]: sns.boxplot(df['number of bedrooms'])
```

Out[12]: <AxesSubplot:>



```
In [13]: z=np.abs(stats.zscore(df['number of bedrooms']))
```

```
In [14]: threshold=3
print(np.where(z>3),len(np.where(z>3)[0]))
```

```
(array([ 76, 243, 268, 275, 624, 785, 1512, 1519, 1553,
        1706, 2814, 3109, 3114, 3322, 3532, 3600, 4207, 4486,
        4658, 4680, 6591, 6596, 6730, 6982, 6998, 7003, 7454,
        8559, 8650, 9282, 9629, 9810, 9955, 10168, 10177, 10676,
        10748, 10916, 10944, 11247, 11441, 11547, 11877, 12273, 13048,
        13444, 13825, 14220, 14481]),) 49
```

```
In [15]: print(np.where(z<-3))
```

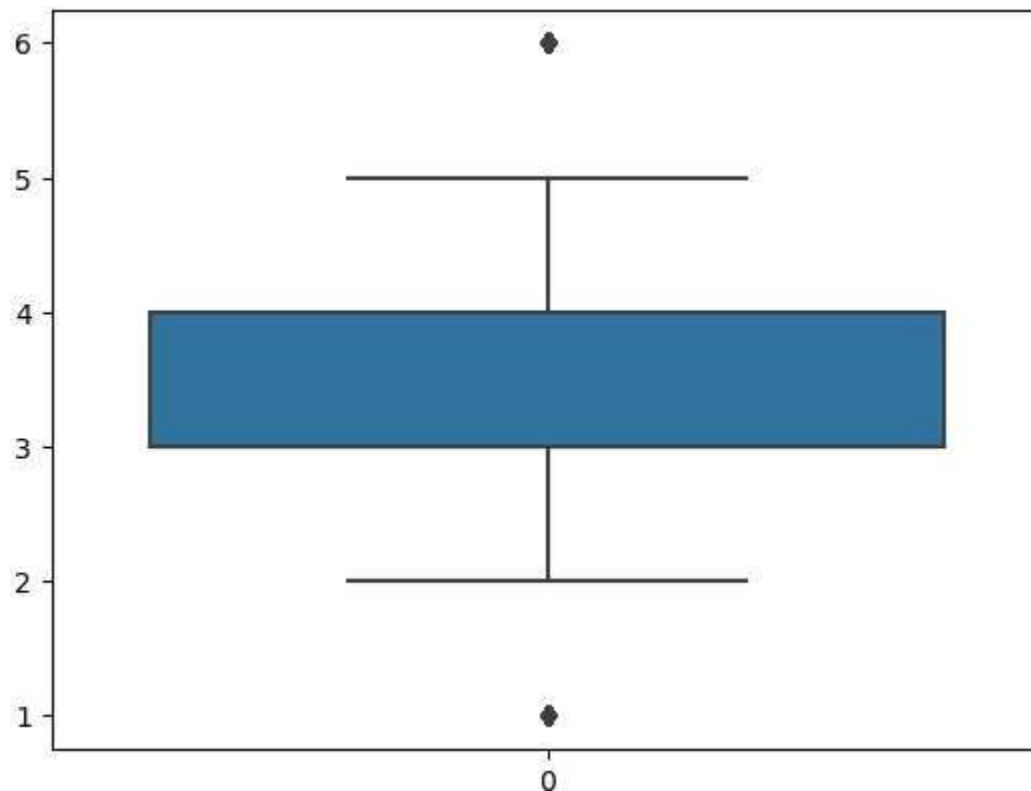
```
(array([], dtype=int64),)
```

**There are 138 outliers in number of bedrooms as proved from the boxplot and the fact that there are observations whose z-score is beyond 3**

```
In [16]: df1=df[(z < 3)]
```

```
In [17]: sns.boxplot(df1['number of bedrooms'])
```

```
Out[17]: <AxesSubplot:>
```



```
In [18]: df1
```



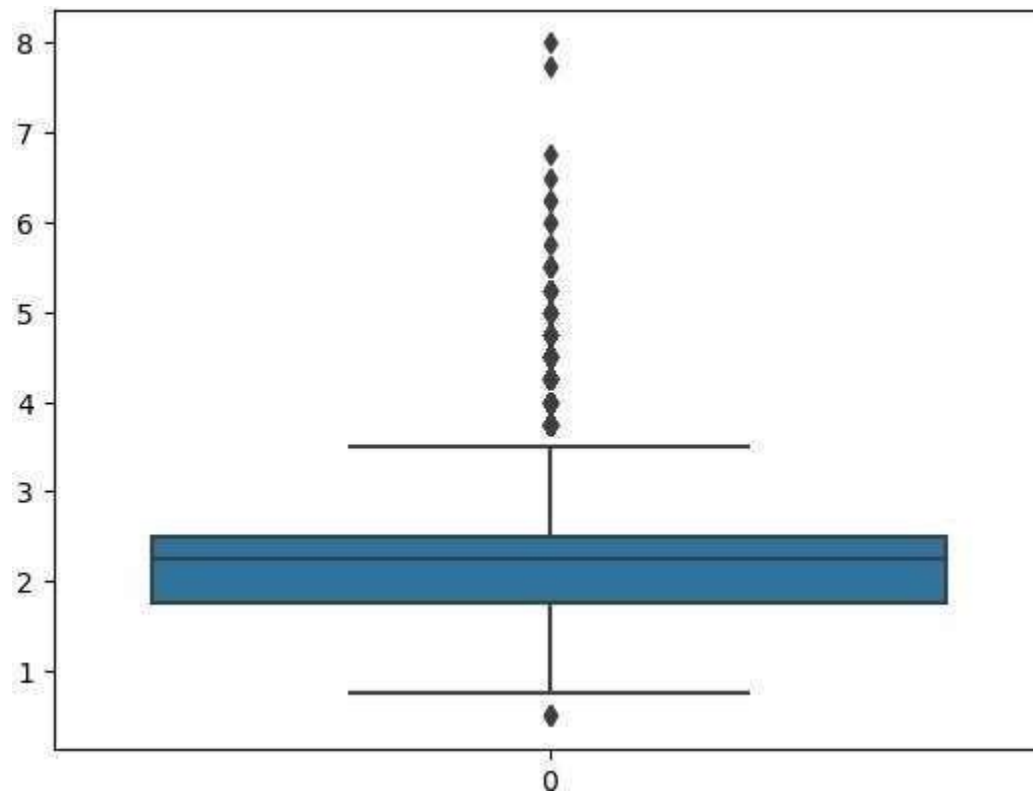
Out[18]:

	id	number of bedrooms	number of bathrooms	living area	lot area	number of floors	waterfront present	number of views	condition of the house	grade of the house	...	Built Year	Renovatio Year
0	6762810145	5	2.50	3650	9050	2.0	0	4	5	10	...	1921	
1	6762810635	4	2.50	2920	4000	1.5	0	0	5	8	...	1909	
2	6762810998	5	2.75	2910	9480	1.5	0	0	3	8	...	1939	
3	6762812605	4	2.50	3310	42998	2.0	0	0	3	9	...	2001	
4	6762812919	3	2.00	2710	4500	1.5	0	0	4	8	...	1929	
...	...	...	...	...	...	...	...	...	...	...	...	...	...
14615	6762830250	2	1.50	1556	20000	1.0	0	0	4	7	...	1957	
14616	6762830339	3	2.00	1680	7000	1.5	0	0	4	7	...	1968	
14617	6762830618	2	1.00	1070	6120	1.0	0	0	3	6	...	1962	
14618	6762830709	4	1.00	1030	6621	1.0	0	0	4	6	...	1955	
14619	6762831463	3	1.00	900	4770	1.0	0	0	3	6	...	1969	200

14571 rows × 22 columns

```
In [19]: sns.boxplot(df1['number of bathrooms'])
```

Out[19]: <AxesSubplot:>



```
In [20]: z=np.abs(stats.zscore(df1['number of bathrooms']))
```

```
In [21]: len(np.where(z>3)[0])
```

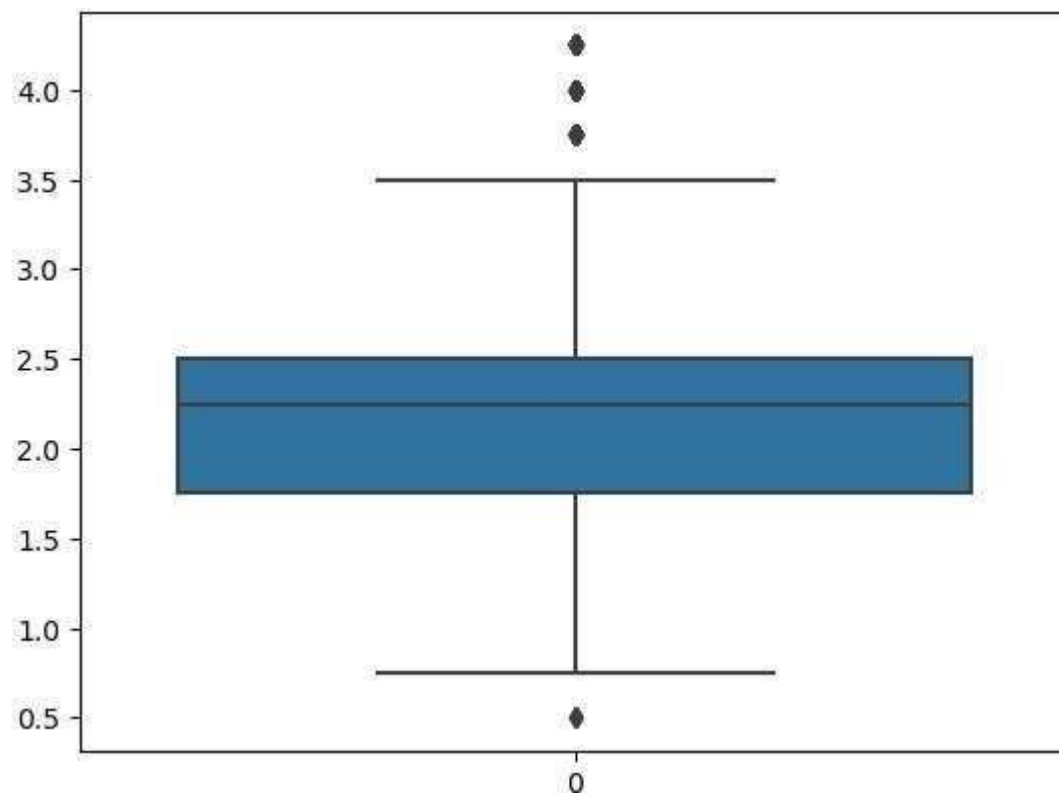
```
Out[21]: 124
```

```
In [22]: print(np.where(z<-3))
(array([], dtype=int64),)
```

```
In [23]: df1=df1[(z< 3)]
```

```
In [24]: sns.boxplot(df1['number of bathrooms'])
```

```
Out[24]: <AxesSubplot:>
```



In [25]: df1

Out[25]:

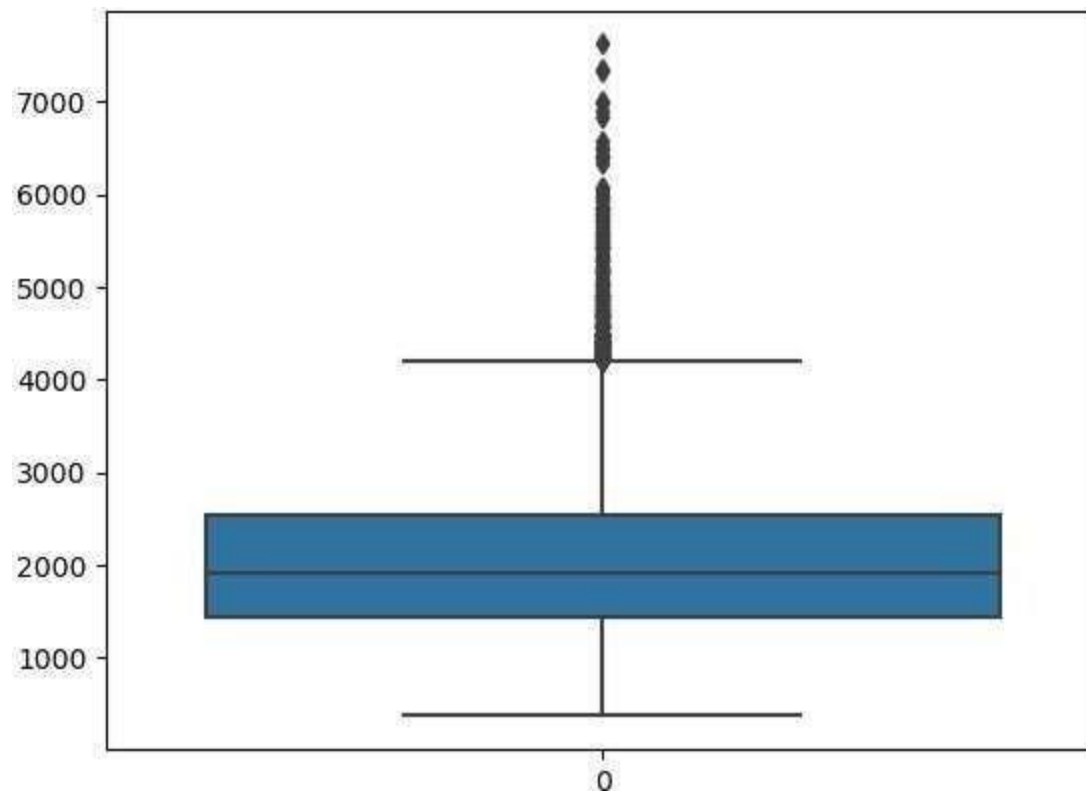
	id	number of bedrooms	number of bathrooms	living area	lot area	number of floors	waterfront present	number of views	condition of the house	grade of the house	...	Built Year	Renovatio Year
0	6762810145	5	2.50	3650	9050	2.0	0	4	5	10	...	1921	
1	6762810635	4	2.50	2920	4000	1.5	0	0	5	8	...	1909	
2	6762810998	5	2.75	2910	9480	1.5	0	0	3	8	...	1939	
3	6762812605	4	2.50	3310	42998	2.0	0	0	3	9	...	2001	
4	6762812919	3	2.00	2710	4500	1.5	0	0	4	8	...	1929	
...	...	...	...	...	...	...	...	...	...	...	...	...	...
14615	6762830250	2	1.50	1556	20000	1.0	0	0	4	7	...	1957	
14616	6762830339	3	2.00	1680	7000	1.5	0	0	4	7	...	1968	
14617	6762830618	2	1.00	1070	6120	1.0	0	0	3	6	...	1962	
14618	6762830709	4	1.00	1030	6621	1.0	0	0	4	6	...	1955	
14619	6762831463	3	1.00	900	4770	1.0	0	0	3	6	...	1969	200

14447 rows × 22 columns

**There are 124 outliers in number of bathrooms as proved from the boxplot and the fact that there are observations whose z-score is beyond 3**

```
In [26]: sns.boxplot(df1['living area'])
```

Out[26]: <AxesSubplot:>



```
In [27]: z=np.abs(stats.zscore(df1['living area']))
```

```
In [28]: len(np.where(z>3)[0])
```

```
Out[28]: 136
```

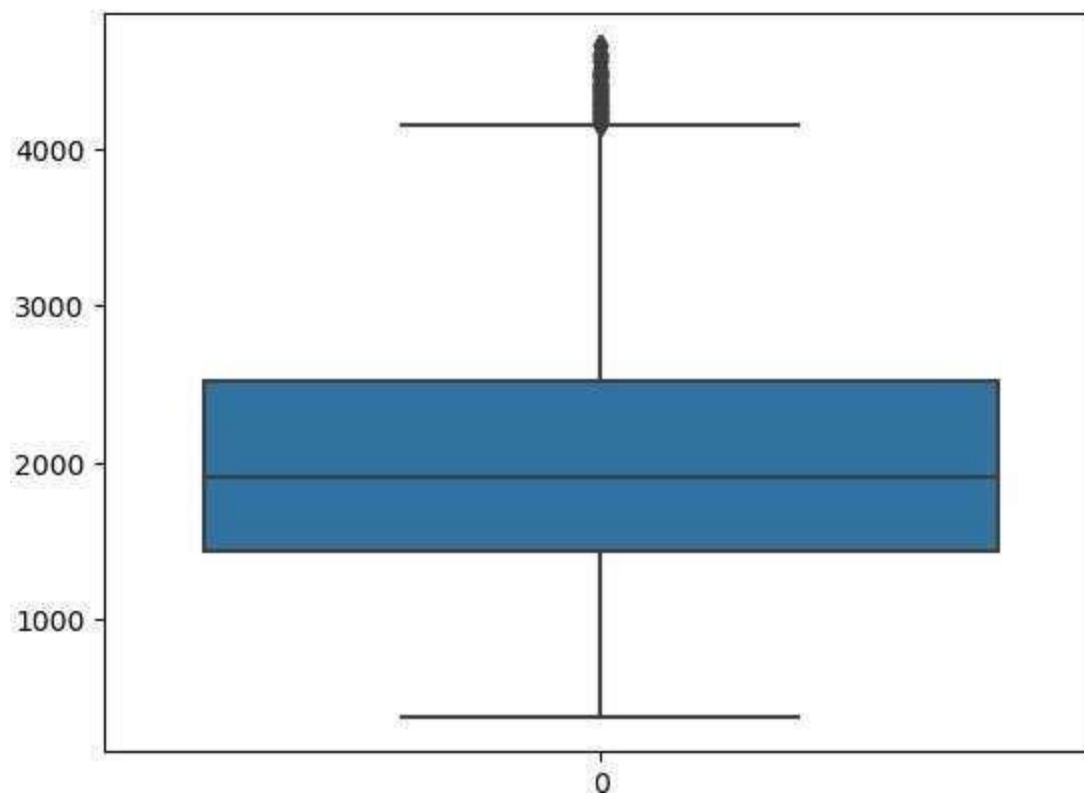
```
In [29]: len(np.where(z<-3)[0])
```

```
Out[29]: 0
```

```
In [30]: df1=df1[(z<3)]
```

```
In [31]: sns.boxplot(df1['living area'])
```

```
Out[31]: <AxesSubplot:>
```



```
In [32]: z=np.abs(stats.zscore(df1['living area']))
```

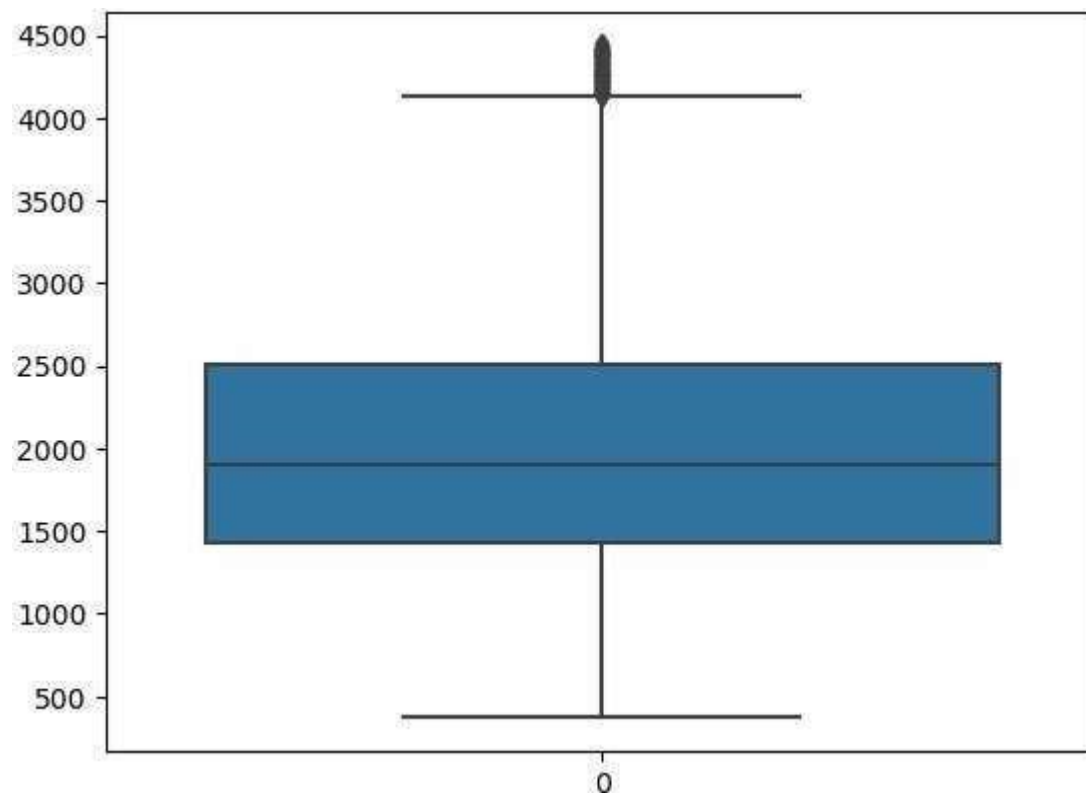
```
In [33]: len(np.where(z>3)[0])
```

```
Out[33]: 67
```

```
In [34]: df1=df1[(z<3)]
```

```
In [35]: sns.boxplot(df1['living area'])
```

```
Out[35]: <AxesSubplot:>
```



In [36]: df1

Out[36]:

	id	number of bedrooms	number of bathrooms	living area	lot area	number of floors	waterfront present	number of views	condition of the house	grade of the house	...	Built Year	Renovatio Yea
0	6762810145	5	2.50	3650	9050	2.0	0	4	5	10	...	1921	
1	6762810635	4	2.50	2920	4000	1.5	0	0	5	8	...	1909	
2	6762810998	5	2.75	2910	9480	1.5	0	0	3	8	...	1939	
3	6762812605	4	2.50	3310	42998	2.0	0	0	3	9	...	2001	
4	6762812919	3	2.00	2710	4500	1.5	0	0	4	8	...	1929	
...	...	...	...	...	...	...	...	...	...	...	...	...	...
14615	6762830250	2	1.50	1556	20000	1.0	0	0	4	7	...	1957	
14616	6762830339	3	2.00	1680	7000	1.5	0	0	4	7	...	1968	
14617	6762830618	2	1.00	1070	6120	1.0	0	0	3	6	...	1962	
14618	6762830709	4	1.00	1030	6621	1.0	0	0	4	6	...	1955	
14619	6762831463	3	1.00	900	4770	1.0	0	0	3	6	...	1969	200

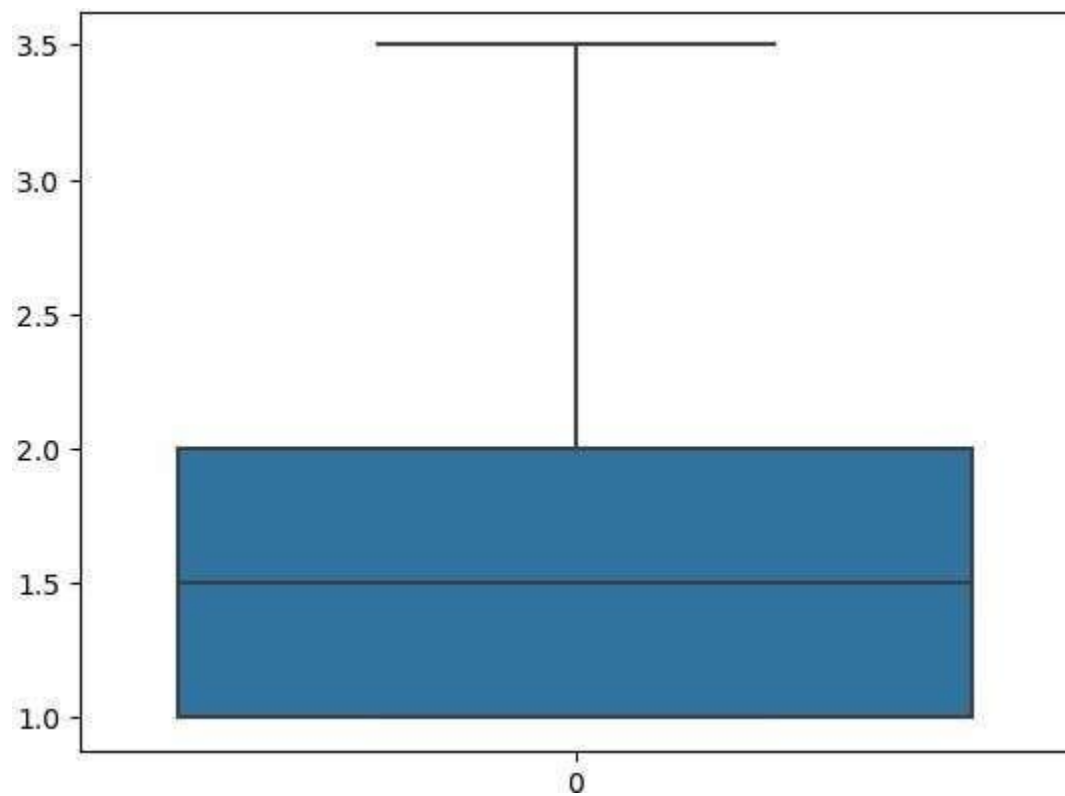
14244 rows × 22 columns

**There are 205 outliers in living as proved from the boxplot and the fact that there are observations whose z-score is beyond 3**

```
In [37]: sns.boxplot(df1['number of floors'])
```

Out[37]: <AxesSubplot:>





```
In [38]: z=np.abs(stats.zscore(df1['number of floors']))
```

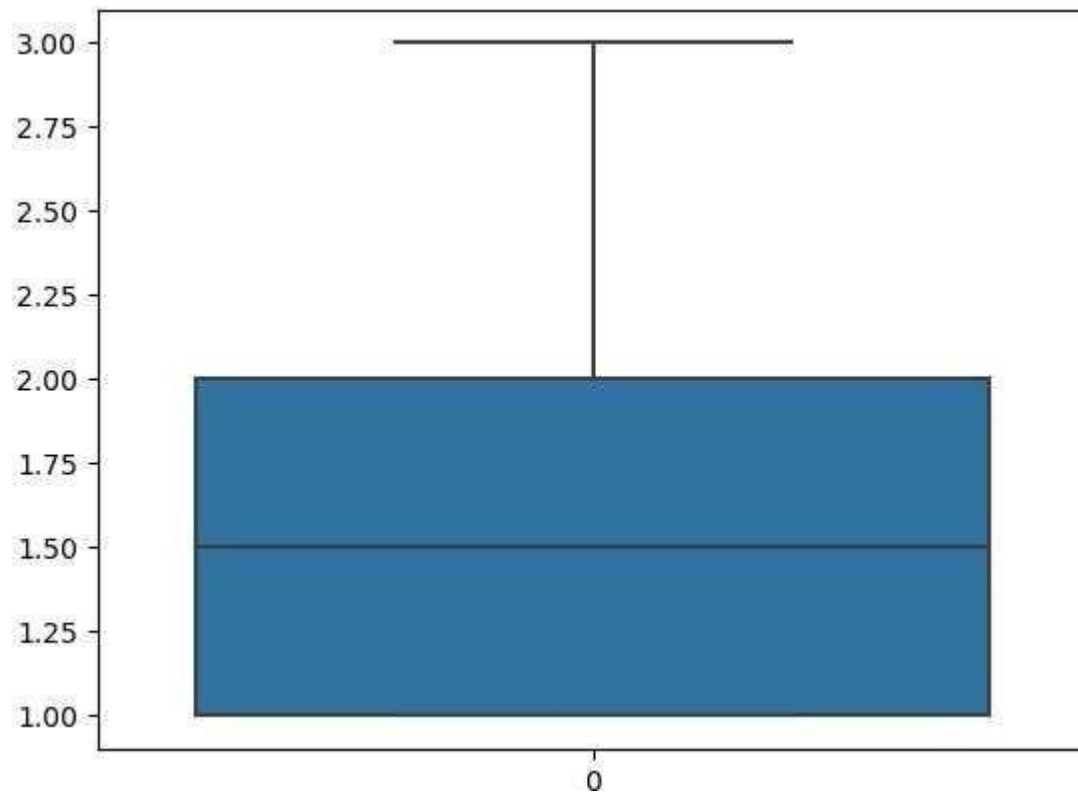
```
In [39]: len(np.where(z>3)[0])
```

```
Out[39]: 3
```

```
In [40]: df1=df1[(z<3)]
```

```
In [41]: sns.boxplot(df1['number of floors'])
```

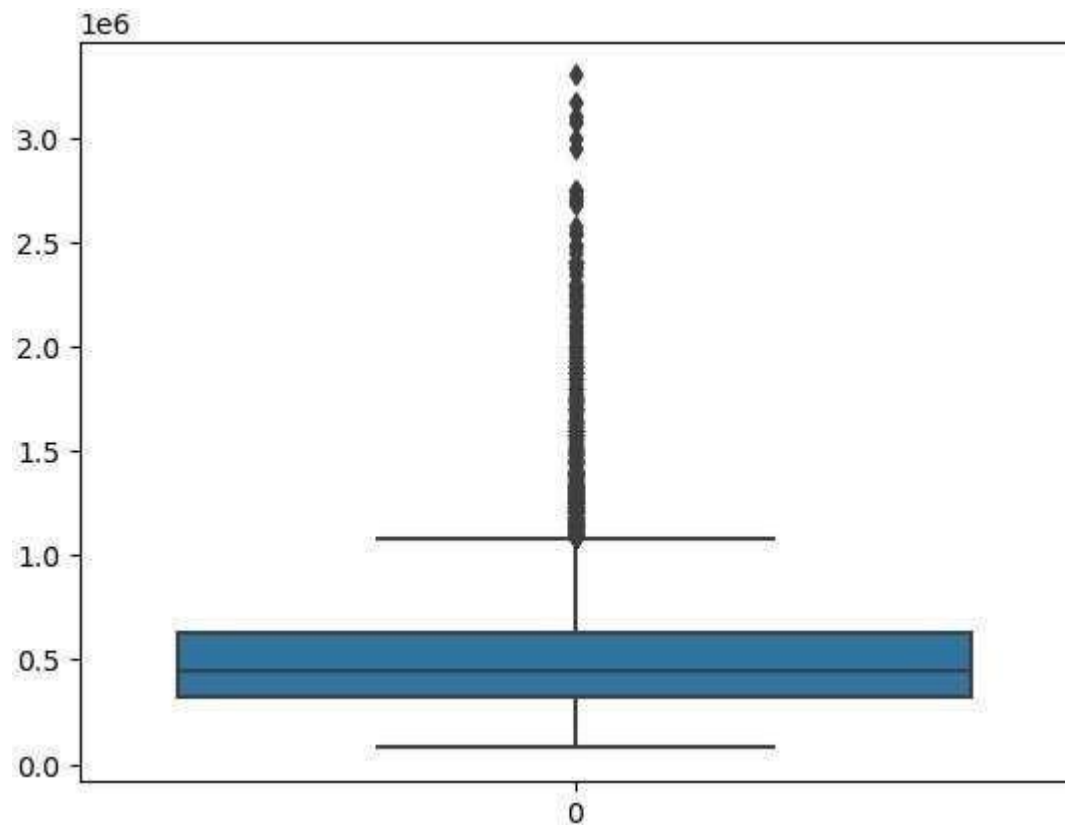
```
Out[41]: <AxesSubplot:>
```



**There are 3 outliers in number of floors**

```
In [42]: sns.boxplot(df1['Price'])
```

Out[42]: <AxesSubplot:>



```
In [43]: z=np.abs(stats.zscore(df1['Price']))
```

```
In [44]: len(np.where(z>3)[0])
```

```
Out[44]: 259
```

```
In [45]: df1=df1[(z<3)]
```

```
In [46]: df1
```

Out[46]:

	id	number of bedrooms	number of bathrooms	living area	lot area	number of floors	waterfront present	number of views	condition of the house	grade of the house	...	Built Year	Renovatio Yea
2	6762810998	5	2.75	2910	9480	1.5	0	0	3	8	...	1939	
3	6762812605	4	2.50	3310	42998	2.0	0	0	3	9	...	2001	
4	6762812919	3	2.00	2710	4500	1.5	0	0	4	8	...	1929	
5	6762813105	3	2.50	2600	4750	1.0	0	0	4	9	...	1951	
6	6762813157	5	3.25	3660	11995	2.0	0	2	3	10	...	2006	
...	...	...	...	...	...	...	...	...	...	...	...	...	...
14615	6762830250	2	1.50	1556	20000	1.0	0	0	4	7	...	1957	
14616	6762830339	3	2.00	1680	7000	1.5	0	0	4	7	...	1968	
14617	6762830618	2	1.00	1070	6120	1.0	0	0	3	6	...	1962	
14618	6762830709	4	1.00	1030	6621	1.0	0	0	4	6	...	1955	
14619	6762831463	3	1.00	900	4770	1.0	0	0	3	6	...	1969	200

13982 rows × 22 columns



```
In [47]: df1=df1.drop(['Renovation Year'],axis=1)
```

```
In [48]: df1
```

Out[48]:

	id	number of bedrooms	number of bathrooms	living area	lot area	number of floors	waterfront present	number of views	condition of the house	grade of the house	...	Area of the basement	Built Year
2	6762810998	5	2.75	2910	9480	1.5	0	0	3	8	...	0	1939
3	6762812605	4	2.50	3310	42998	2.0	0	0	3	9	...	0	2001
4	6762812919	3	2.00	2710	4500	1.5	0	0	4	8	...	830	1929
5	6762813105	3	2.50	2600	4750	1.0	0	0	4	9	...	900	1951
6	6762813157	5	3.25	3660	11995	2.0	0	2	3	10	...	0	2006
...	...	...	...	...	...	...	...	...	...	...	...	...	...
14615	6762830250	2	1.50	1556	20000	1.0	0	0	4	7	...	0	1957
14616	6762830339	3	2.00	1680	7000	1.5	0	0	4	7	...	0	1968
14617	6762830618	2	1.00	1070	6120	1.0	0	0	3	6	...	0	1962
14618	6762830709	4	1.00	1030	6621	1.0	0	0	4	6	...	0	1955
14619	6762831463	3	1.00	900	4770	1.0	0	0	3	6	...	0	1969

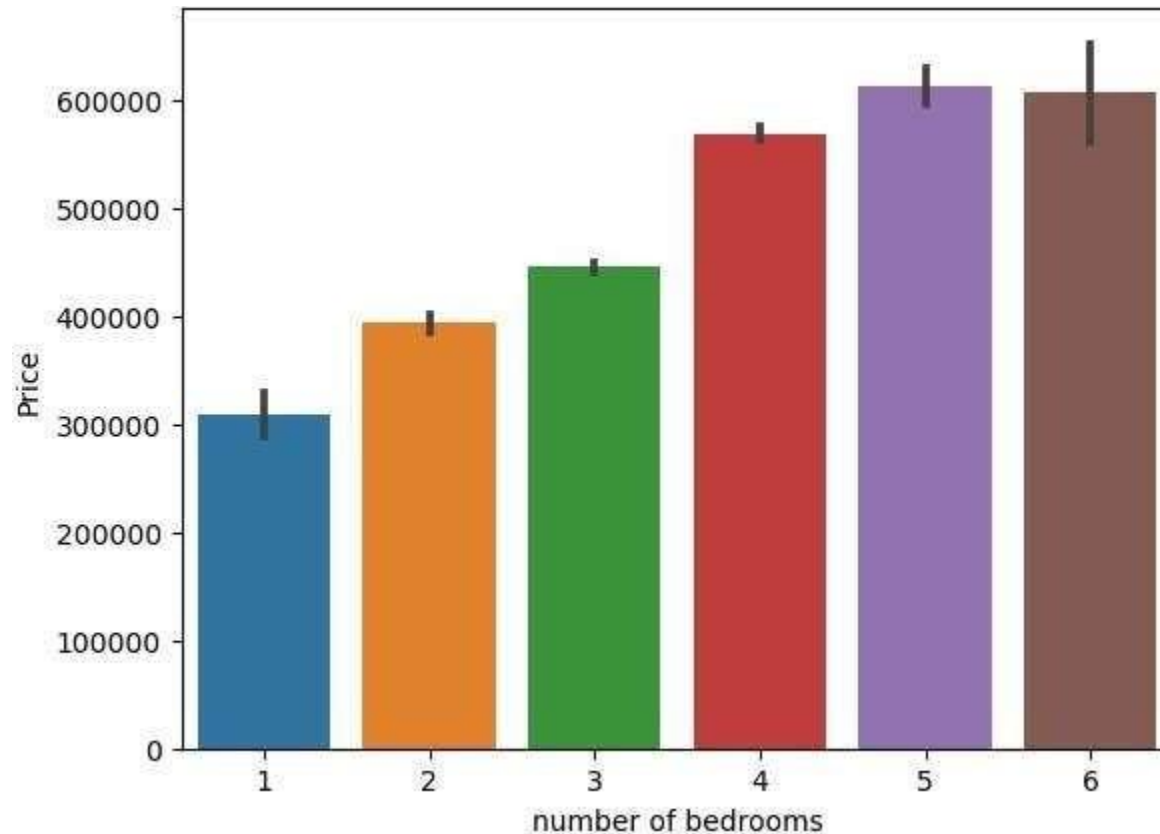
13982 rows × 21 columns

## BI - VARIATE ANALYSIS

**The column Renovation year have been removed. This is because most of the Renovation Year are 0 and proves to be of no use to the model**

```
In [49]: sns.barplot(data=df1,x='number of bedrooms',y='Price')
```

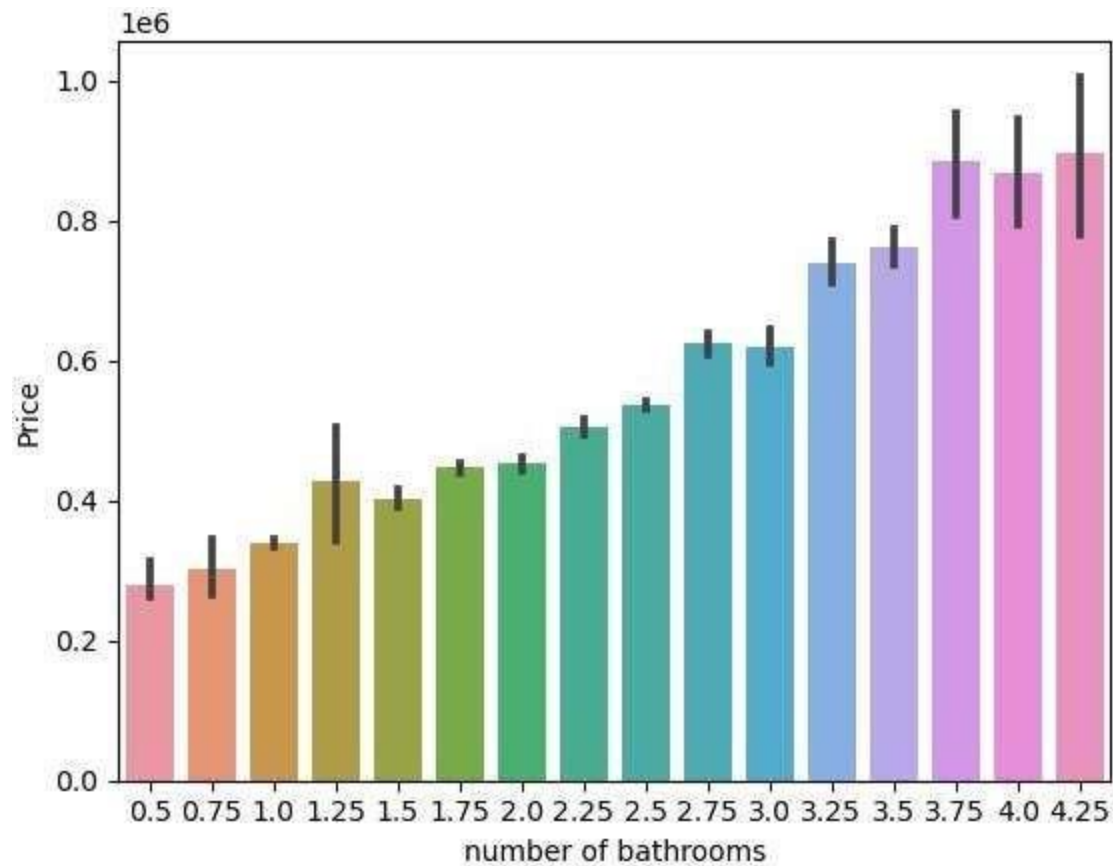
```
Out[49]: <AxesSubplot:xlabel='number of bedrooms', ylabel='Price'>
```



**Clear indication of Price increasing with number of bedrooms**

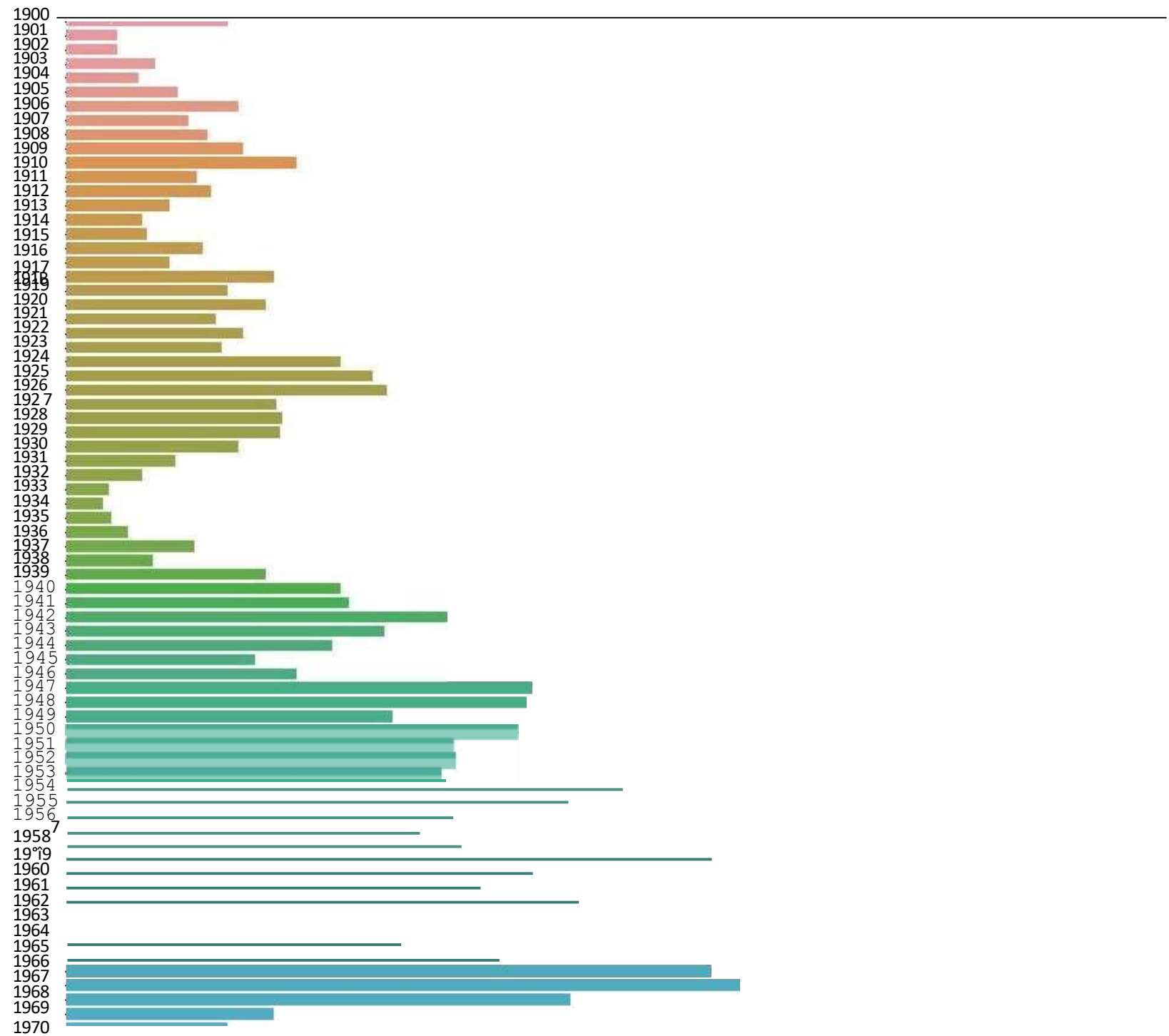
```
In [50]: sns.barplot(data=df1,x='number of bathrooms',y='Price')
```

```
Out[50]: <AxesSubplot:xlabel='number of bathrooms', ylabel='Price'>
```

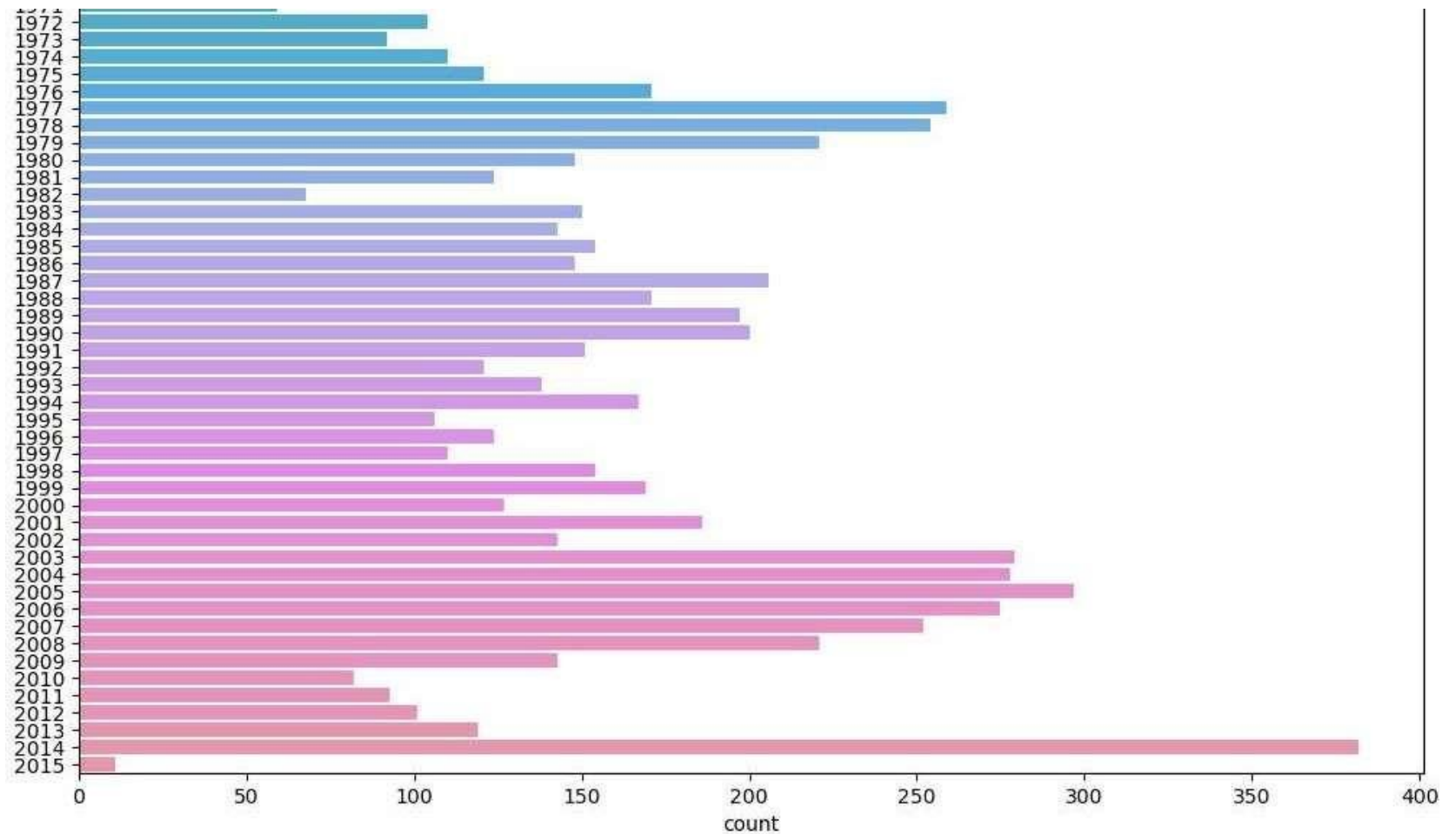


**Clear indication of Price increasing with number of bathrooms**

```
In [51]: plt.figure(figsize=(12,18))
sns.countplot(data=df1,y='Built Year')
plt.show()
```



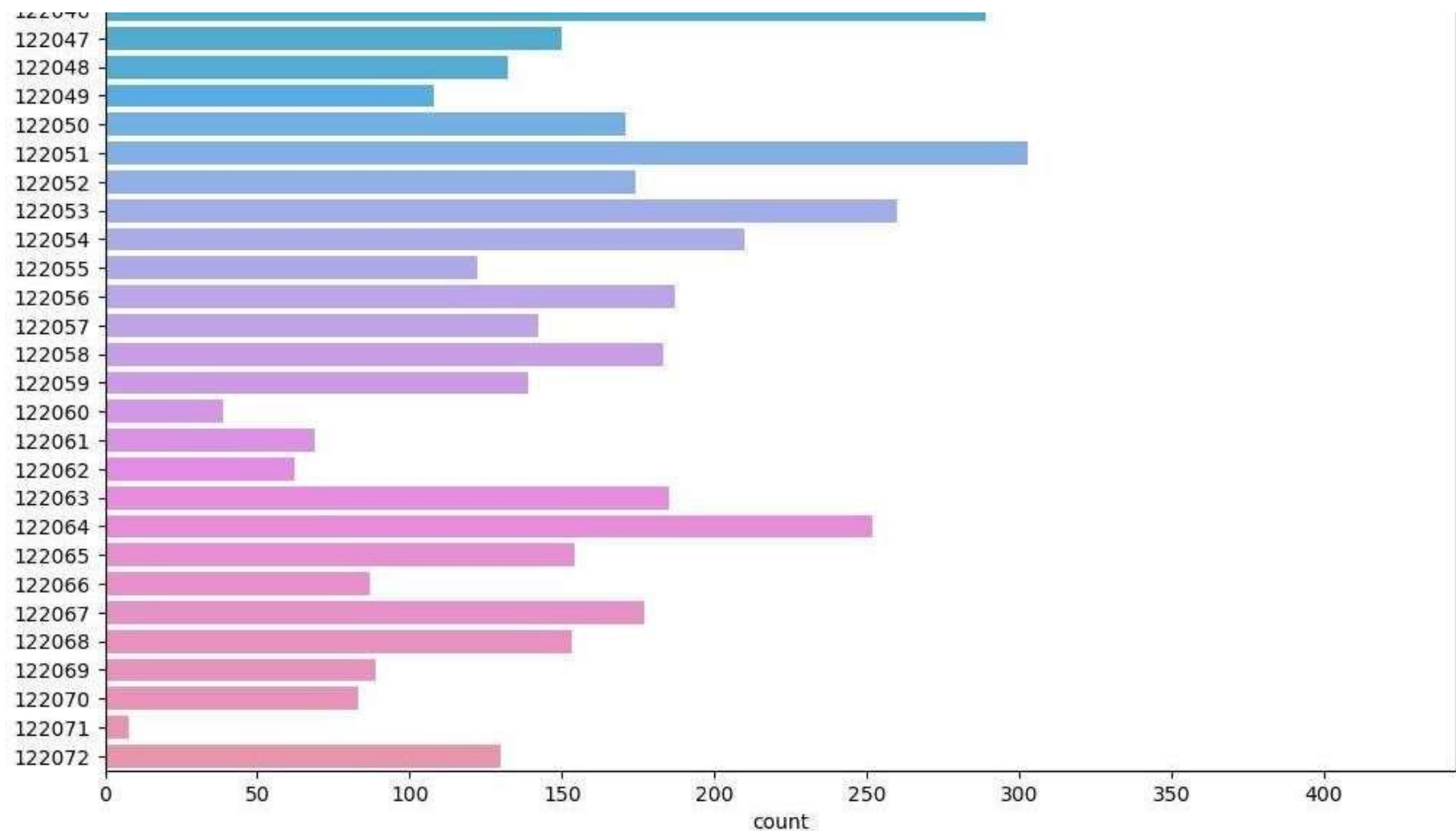




**Most of the houses were listed for sale in 2017**

```
In [52]: plt.figure(figsize=(12,18))
sns.countplot(data=df1,y='Postal Code')
plt.show()
```

12 200 3  
12 2004  
12 200 5  
12 2006  
12 200 7  
12 2008  
12 2009  
12 2010  
12 2011  
12 2012  
12 2013  
12 2014  
12 2015  
12 2016  
12 2017  
12 2018  
12 2019  
12 20 20  
12 2021  
12 20 22  
12 202 3  
12 20 24  
12 202 5  
12 20 26  
12 2027  
12 2028  
12 2029  
12 2030  
12 2031  
12 2032  
12 2033  
12 2034  
12 2035  
12 2036  
12 2037  
12 2038  
12 2039  
12 2040  
12 2041  
12 2042  
12 2043  
12 2044  
12 2045  
12 2046



**Most of the houses listed for sale are from the Pincode 122028**

```
In [53]: df1[df1['Built Year']==2014]['Latitude'].mean()
```

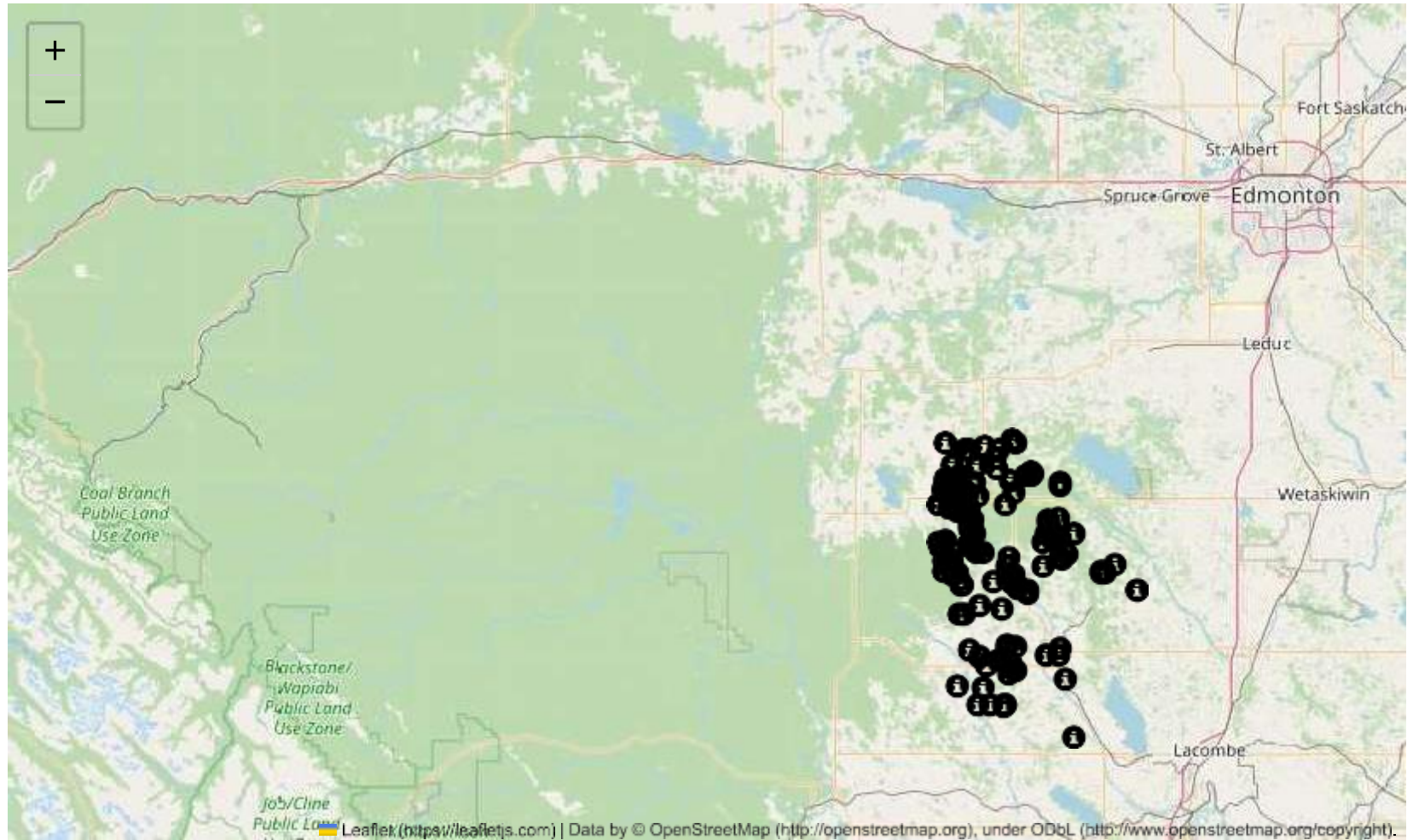
```
Out[53]: 52.77583376963351
```

```
In [54]: df1[df1['Built Year']==2014]['Longitude'].mean()
```

Out[54]: -114.38898952879582

```
In [55]: m = folium.Map(location = [52.77, -114.4], tiles = 'OpenStreetMap',  
    zoom_start=8)  
  
for index, location_info in df1[(df1['Built Year']==2014) & (df1['Distance from the airport']<=70)].iterrows():  
    folium.Marker([location_info["Latitude"], location_info["Longitude"]], popup=location_info["Price"],icon=folium.  
m
```

Out[55]:



```
In [56]: df1[df1['Built Year']>=2014]['Latitude'].mean()
```

Out[56]: 52.77850305343512

```
In [57]: df1[df1['Built Year']>=2014]['Longitude'].mean()
```

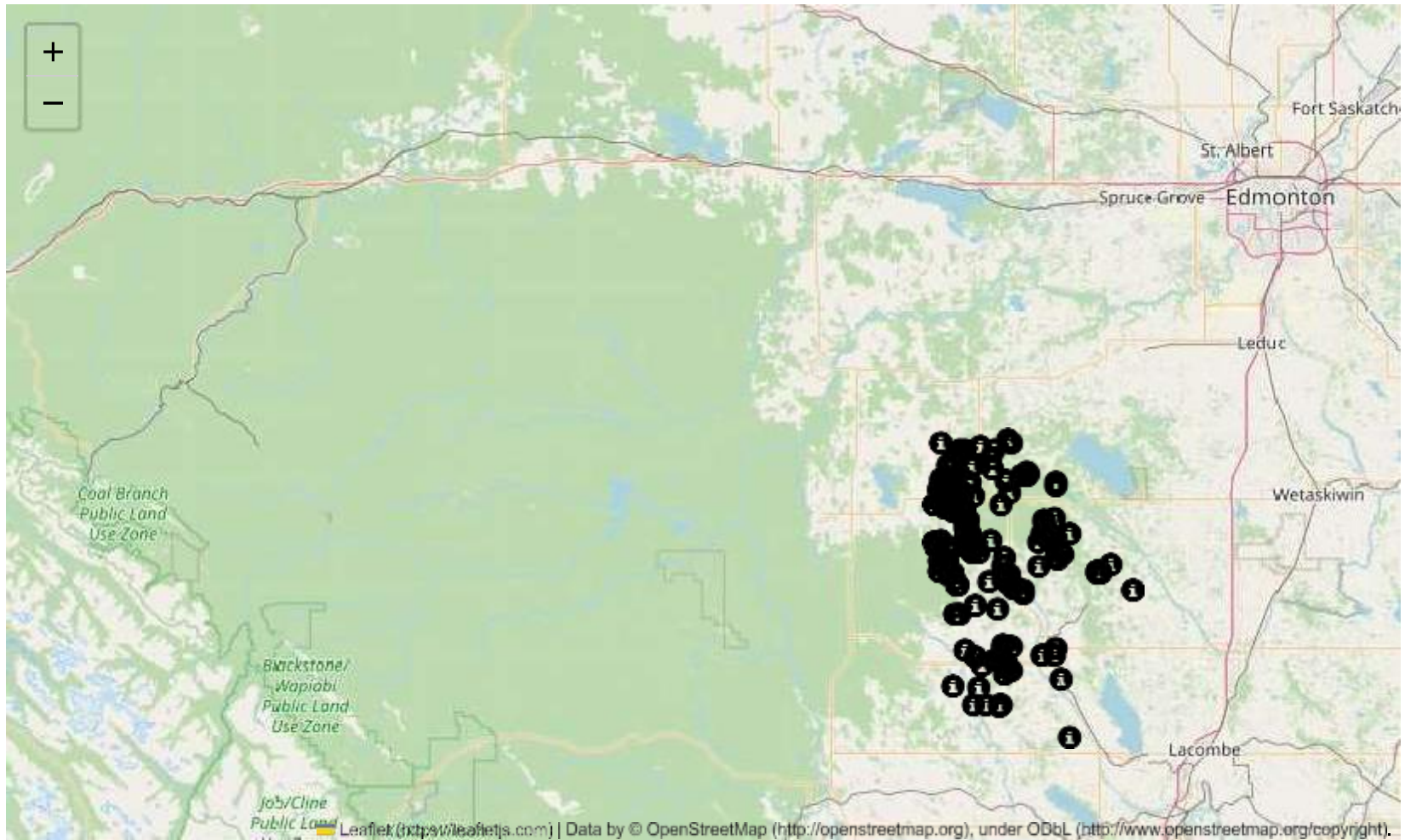
Out[57]: -114.39186768447837

```
In [58]: m = folium.Map(location = [52.77, -114.4], tiles = 'OpenStreetMap',
                        zoom_start=8)

for index, location_info in df1[(df1['Built Year']>=2014) & (df1['Distance from the airport']<=70)].iterrows():
    folium.Marker([location_info["Latitude"], location_info["Longitude"]], popup=location_info["Price"],icon=folium.
m
```



Out[58]:



**The houses listed for sale in this dataset are located in Alberta, Canada**

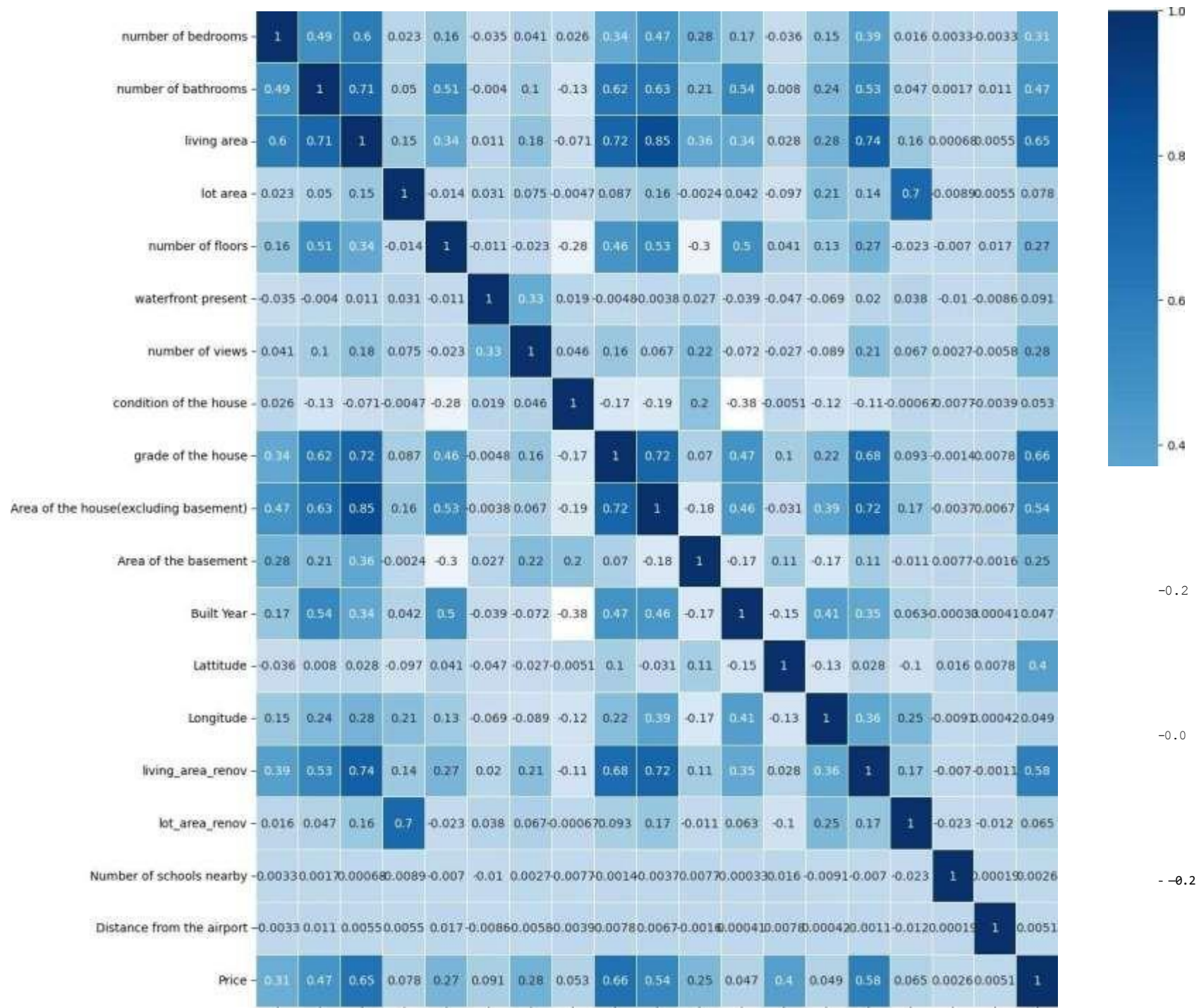
```
In [59]: df1=df1.drop(['id'],axis=1)
```

```
In [60]: df1=df1.drop(['Postal Code'],axis=1)
```

## MULTI - VARIATE ANALYSIS

**Columns ID and Postal Code have been dropped from df as an increase or decrease in Postal Code shall not directly impact the Price of the property**

```
In [61]: plt.figure(figsize=(15,15))  
sns.heatmap(df1.corr(),linewidths=0.5,annot=True,cmap='Blues')  
plt.show()
```



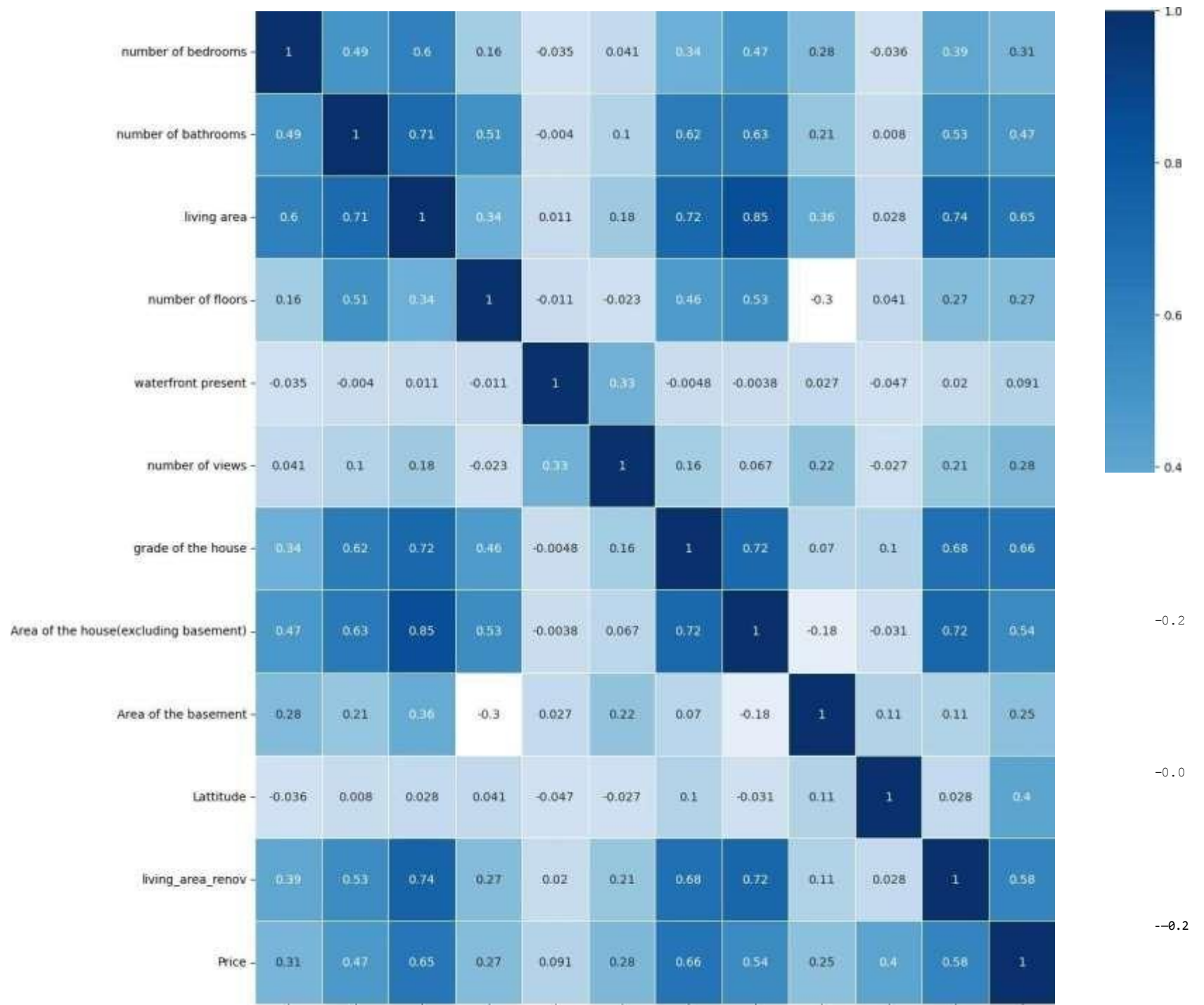


number of bedrooms
number of bathrooms
living area
lot area
number of floors
waterfront present
number of views
condition of the house
grade of the house
Area of the house(excluding basement)
Area of the basement
Built Year
Latitude
Longitude
living_area_renov
lot_area_renov
Number of schools nearby
Distance from the airport
Price

**Columns like 'lot area', 'condition of the house', 'Built Year', 'lot\_area\_renov', 'Number of schools nearby', 'Distance from the airport', 'Longitude' contribute minimal to Price which is the Target variable. Hence it is removed before training**

```
In [62]: df1=df1.drop(['lot area','condition of the house','Built Year','lot_area_renov','Number of schools nearby','Distance
```

```
In [63]: plt.figure(figsize=(15,15))
sns.heatmap(df1.corr(),linewidths=0.5,annot=True,cmap='Blues')
plt.show()
```



number of bedrooms	number of bathrooms	living area	number of floors	waterfront present	number of views	grade of the house	Area of the house(excluding basement)	Area of the basement	Latitude	living_area_renov	Price
--------------------	---------------------	-------------	------------------	--------------------	-----------------	--------------------	---------------------------------------	----------------------	----------	-------------------	-------

## Training of Model, Splitting of Dataset into Train and Test Set

```
In [64]: from sklearn.model_selection import train_test_split
```

```
In [65]: X=df1.drop(['Price'],axis =1)
```

```
In [66]: X.shape
```

```
Out[66]: (13982, 11)
```

```
In [67]: y=df1['Price']
```

```
In [68]: y.shape
```

```
Out[68]: (13982,)
```

```
In [69]: X_train,X_test,y_train,y_test= train_test_split(X,y,test_size=0.2,random_state=11)
```

```
In [70]: X_train.shape
```

```
Out[70]: (11185, 11)
```

```
In [71]: X_test.shape
```

Out[71]: (2797, 11)

```
In [72]: from sklearn.pipeline import make_pipeline
from sklearn.preprocessing import StandardScaler
from sklearn.linear_model import ElasticNet, Lasso, LinearRegression, RidgeCV
from catboost import CatBoostRegressor
from sklearn.ensemble import RandomForestRegressor, GradientBoostingRegressor
from xgboost import XGBRegressor
from sklearn.tree import DecisionTreeRegressor
from sklearn.ensemble import StackingRegressor
from sklearn.svm import SVR
```

```
In [73]: pipelines = {
    'en':make_pipeline(StandardScaler(), ElasticNet()),
    'lasso':make_pipeline(StandardScaler(), Lasso()),
    'Rcv':make_pipeline(StandardScaler(), RidgeCV()),
    'CatB':make_pipeline(StandardScaler(), CatBoostRegressor(eval_metric='RMSE',verbose=1000)),
    'lr':make_pipeline(StandardScaler(), LinearRegression()),
    'rf':make_pipeline(StandardScaler(), RandomForestRegressor()),
    'gb':make_pipeline(StandardScaler(), GradientBoostingRegressor()),
    'dtr':make_pipeline(StandardScaler(),DecisionTreeRegressor()),
    'xgb':make_pipeline(StandardScaler(),XGBRegressor())
}
```

```
In [74]: fit_models = {}
for algo, pipeline in pipelines.items():
    model = pipeline.fit(X_train, y_train)
    fit_models[algo] = model
```

/opt/conda/lib/python3.7/site-packages/sklearn/linear\_model/\_coordinate\_descent.py:648: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, check the scale of the features or consider increasing regularisation. Duality gap: 4.781e+12, tolerance: 5.929e+10

coef\_, l1\_reg, l2\_reg, X, y, max\_iter, tol, rng, random, positive

Learning rate set to 0.05996

0: learn: 221490.1496581 total: 61.4ms remaining: 1m 1s

999: learn: 77595.2298921 total: 2.85s remaining: 0us

```
In [75]: from sklearn.metrics import mean_absolute_error, mean_squared_error
maes=[]
al=[]
for algo, model in fit_models.items():
```

```

yhat = model.predict(X_test)
al.append(algo)
maes.append(mean_squared_error(y_test,yhat)**0.5)
print(algo,'MEAN ABSOLUTE ERROR', mean_absolute_error(y_test,yhat))
print(algo,'ROOT MEAN SQUARED ERROR',mean_squared_error(y_test,yhat)**0.5)

```

```

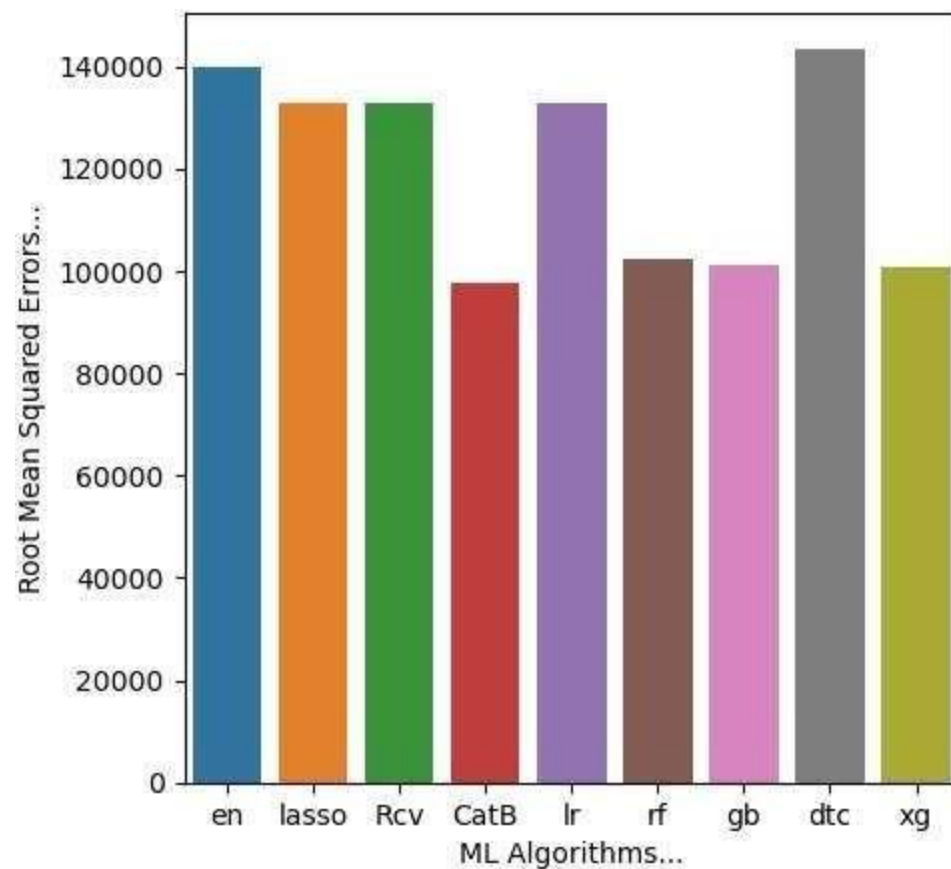
en MEAN ABSOLUTE ERROR 104444.32355671145
en ROOT MEAN SQUARED ERROR 140011.53917862213
lasso MEAN ABSOLUTE ERROR 97479.23118789196
lasso ROOT MEAN SQUARED ERROR 132916.1566456281
Rcv MEAN ABSOLUTE ERROR 97481.91673717603
Rcv ROOT MEAN SQUARED ERROR 132918.333682342
CatB MEAN ABSOLUTE ERROR 66637.30790160663
CatB ROOT MEAN SQUARED ERROR 97508.34029611414
lr MEAN ABSOLUTE ERROR 97574.48622571728
lr ROOT MEAN SQUARED ERROR 132952.7515959945
rf MEAN ABSOLUTE ERROR 69217.89879907611
rf ROOT MEAN SQUARED ERROR 102292.3632979867
gb MEAN ABSOLUTE ERROR 69874.84067217445
gb ROOT MEAN SQUARED ERROR 101056.41447857216
dtc MEAN ABSOLUTE ERROR 96944.72285782386
dtc ROOT MEAN SQUARED ERROR 143316.21683052482
xg MEAN ABSOLUTE ERROR 69035.05210660976
xg ROOT MEAN SQUARED ERROR 100694.41040458805

```

```

In [76]: plt.figure(figsize=(5,5))
plt.xlabel('ML Algorithms...')
plt.ylabel('Root Mean Squared Errors...')
ax=sns.barplot(x=al,y=maes)
plt.show()

```



```
In [ ]: CatB = CatBoostRegressor(verbose=1000,eval_metric='RMSE')
rf = RandomForestRegressor()
gb = GradientBoostingRegressor()
xg = XGBRegressor()
lr=LinearRegression()

stregr = StackingRegressor(estimators=[('catb',CatB),('xg', xg),('gb',gb)],
                           final_estimator=lr)

pipeline = make_pipeline(
    StandardScaler(),
    stregr
)
pipeline.fit(X_train, y_train)
```

```
# Generate predictions on the test set
y_pred = pipeline.predict(X_test)

# Evaluate the model
print("Root Mean Squared Error: %.4f" % mean_squared_error(y_test,y_pred)**0.5)
```

```
Learning rate set to 0.05996
0:      learn: 221490.1496581    total: 4.18ms    remaining: 4.18s
999:    learn: 77595.2298921    total: 2.81s    remaining: 0us
Learning rate set to 0.057883
0:      learn: 222091.4863333    total: 3.52ms    remaining: 3.51s
999:    learn: 76337.1933964    total: 2.52s    remaining: 0us
Learning rate set to 0.057883
0:      learn: 222546.8538661    total: 2.94ms    remaining: 2.94s
999:    learn: 75466.5961681    total: 2.51s    remaining: 0us
Learning rate set to 0.057883
0:      learn: 223455.5230951    total: 3.2ms     remaining: 3.2s
999:    learn: 75656.3661258    total: 2.52s    remaining: 0us
Learning rate set to 0.057883
0:      learn: 221606.9467960    total: 3.71ms    remaining: 3.7s
999:    learn: 75195.9699196    total: 2.46s    remaining: 0us
Learning rate set to 0.057883
0:      learn: 219316.0911020    total: 2.47ms    remaining: 2.47s
```

```
In [ ]: mean_squared_error(y_test,y_pred)**0.5
```

```
In [ ]: al.append('stacked model')
maes.append(mean_squared_error(y_test,y_pred)**0.5)
```

```
In [ ]: for i in range(10):
        print("The RMSE of",al[i], 'is',maes[i])
```

```
In [ ]: plt.figure(figsize=(9,5))
plt.xlabel('ML Algorithms...')
plt.ylabel('Root Mean Squared Errors...')
ax=sns.barplot(x=al,y=maes)
plt.show()
```