REAL ESTATE HOUSE PRICE PREDICTION

Objective

- Predict the price of houses from the given dataset by applying different regression based machine learning algorithms.
- Applying different performance boosting methods like feature selection, Hyper parameter tuning etc.
- Utilizing different EDA tools for visualization and data manipulation
- Comparing the performance of the different regression models

About the Dataset

1. title

> Shows the number of bedrooms if it is house. and the details of the location

2. price

> price of the house or the plot

3. size

> size of the house in square feet

4. price_per_sqft

> per square feet price for the house or plot

5. status

> whether the place is open for living or under construction

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

df=pd.read_excel('/content/raw_data.xlsx')
df.head()
```

	Unnamed: 0	title	price	size	price_per_sqft	status
0	0	3 BHK Apartment in CasaGrand Casagrand Meridian	1.18 Cr	2037	5,793 / sq ft	Under Construction
1	1	2 BHK Apartment in Shree Nandana Elite	57.56 L	1240	4,642 / sq ft	Under Construction
2	2	Residential Plot in Saroj Whispering Winds	32.3 L	2000	1,615 / sq ft	New
[illegible]	[illegible]	[illegible]	1.33	[illegible]	[illegible]	Under

```
df.sample(5)
```

	Unnamed: 0	title	price	size	price_per_sqft	status
56235	56234	\n Salarpuria Gold Summit\n3 BHK Flat\nHennur\n	165 Cr	1933 Sq.Ft.	NaN	NaN
41597	41597	2 BHK Apartment in Abhee nandana	61.9 L	1140	5,430 / sq ft	Ready to move
7161	7161	2 BHK Apartment in G Corp The Icon	1.2 Cr	1305	9,195 / sq ft	Ready to move

```
df.dtypes
```

```
Unnamed: 0         int64
title             object
price             object
size              object
price_per_sqft    object
status            object
dtype: object
```

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 74208 entries, 0 to 74207
Data columns (total 6 columns):
 #   Column          Non-Null Count  Dtype 
---  ------          --------------  ----- 
 0   Unnamed: 0      74208 non-null  int64 
 1   title           74208 non-null  object
 2   price           74208 non-null  object
 3   size            73612 non-null  object
 4   price_per_sqft  58445 non-null  object
 5   status          45372 non-null  object
dtypes: int64(1), object(5)
memory usage: 3.4+ MB
```

```
df.shape
```

```
(74208, 6)
```

```
df.drop_duplicates()
```

	Unnamed: 0	title	price	size	price_per_sqft	status
0	0	3 BHK Apartment in CasaGrand Casagrand Meridian	1.18 Cr	2037	5,793 / sq ft	Under Construction
1	1	2 BHK Apartment in Shree Nandana Elite	57.56 L	1240	4,642 / sq ft	Under Construction
2	2	Residential Plot in Saroj Whispering Winds	32.3 L	2000	1,615 / sq ft	New
3	3	3 BHK Apartment in Navami Landmaark	1.33 Cr	1641	8,133 / sq ft	Under Construction
4	4	2 BHK Apartment in V Venture EVA	55.32 L	957	5,787 / sq ft	Ready to move
...	...	...	...	...	...	...
74203	74202	5 Bedroom Built-up Area in Whitefield	23100000	3453	6689.834926	NaN
74204	74203	4 BHK Super built-up Area in Richards Town	40000000	3600	11111.111111	NaN
74205	74204	2 BHK Built-up Area in Raja Rajeshwari Nagar	6000000	1141	5258.545136	NaN
74206	74205	4 BHK Super built-up Area in Padmanabhanagar	48800000	4689	10407.336319	NaN
74207	74206	1 BHK Super built-up Area in Doddathoguru	1700000	550	3090.909091	NaN

74208 rows × 6 columns

Forming a new column and adding the number bedroom into it from the 'title' column

```
df['space']=df['title'].str.split().str[:2].str.join(' ')
df.head()
```

	Unnamed: 0	title	price	size	price_per_sqft	status	space
0	0	3 BHK Apartment in CasaGrand Casagrand Meridian	1.18 Cr	2037	5,793 / sq ft	Under Construction	3 BHK
1	1	2 BHK Apartment in Shree Nandana Elite	57.56 L	1240	4,642 / sq ft	Under Construction	2 BHK
2	2	Residential Plot in Saroj Whispering Winds	32.3 L	2000	1,615 / sq ft	New	Residential Plot
3	3	3 BHK Apartment in Navami Landmaark	1.33 Cr	1641	8,133 / sq ft	Under Construction	3 BHK
4	4	2 BHK Apartment in V Venture EVA	55.32 L	957	5,787 / sq ft	Ready to move	2 BHK

Drop unnecessary columns

```
df.drop(['Unnamed: 0','title','status'],inplace=True,axis=1)
```

Removing irrelevent characters and units from the features

```
df['price_per_sqft']=df['price_per_sqft'].str.replace('/ sq ft','')
df['price_per_sqft']=df['price_per_sqft'].str.replace(',','')       #5,751
df['price_per_sqft']=df['price_per_sqft'].str.replace('per sqft','')
df['price_per_sqft']=df['price_per_sqft'].str.replace('₹','')
df['size']=df['size'].str.replace('sqft','')
```

```
df['size']=df['size'].str.replace('sqm','')
df.head()
```

	price	size	price_per_sqft	space
0	1.18 Cr	2037	5793	3 BHK
1	57.56 L	1240	4642	2 BHK
2	32.3 L	2000	1615	Residential Plot
3	1.33 Cr	1641	8133	3 BHK
4	55.32 L	957	5787	2 BHK

```
df['space'].value_counts()
```

```
2 BHK                 18655
3 BHK                 18547
Residential Plot      11355
4 BHK                  4055
1 BHK                  1944
                      ...
Ganapathipura Plot        1
Bilekahalli 6+            1
Seegehalli 3              1
Nelamangala 2             1
18 Bedroom                1
Name: space, Length: 2059, dtype: int64
```

Replacing values in space column other than 'BHK' and 'Bedroom' into 'plot'

```
df['space']=df['space'].map(lambda x: x if 'BHK' in x or 'Bedroom' in x else 'plot'  )
df.head()

# def take(sp):
#   if 'BHK' in sp:
#     pass
#   elif 'Bedroom' in sp:
#     pass
#   else:
#     sp='plot'
#   return sp

# df['space']=df['space'].apply(take)
```

	price	size	price_per_sqft	space
0	1.18 Cr	2037	5793	3 BHK
1	57.56 L	1240	4642	2 BHK
2	32.3 L	2000	1615	plot
3	1.33 Cr	1641	8133	3 BHK
4	55.32 L	957	5787	2 BHK

```
df['space'].value_counts()
```

```
plot          27101
2 BHK         18655
3 BHK         18547
4 BHK          4055
1 BHK          1944
4 Bedroom       813
5 BHK           662
3 Bedroom       547
2 Bedroom       329
5 Bedroom       297
6 BHK           246
6 Bedroom       191
7 BHK           154
10 BHK          145
1 Bedroom       105
8 BHK            99
8 Bedroom        84
7 Bedroom        83
9 BHK            60
9 Bedroom        46
10 Bedroom       12
11 BHK            7
12 BHK            7
```

```
15 BHK           6
13 BHK           4
11 Bedroom       2
27 BHK           1
19 BHK           1
16 BHK           1
43 Bedroom       1
14 BHK           1
12 Bedroom       1
18 Bedroom       1
Name: space, dtype: int64
```

Removing rows having plot value in space column

```
df.drop(df[df['space'] == 'plot'].index, inplace=True)
df.reset_index(drop=True,inplace=True)
df.head()
```

	price	size	price_per_sqft	space
0	1.18 Cr	2037	5793	3 BHK
1	57.56 L	1240	4642	2 BHK
2	1.33 Cr	1641	8133	3 BHK
3	55.32 L	957	5787	2 BHK
4	83.47 L	1575	5300	3 BHK

Removing 'BHK' and 'Bedroom' from the space column

```
df['space']=df['space'].str.replace('Bedroom','')
df['space']=df['space'].str.replace('BHK','')
df.head()
```

	price	size	price_per_sqft	space
0	1.18 Cr	2037	5793	3
1	57.56 L	1240	4642	2
2	1.33 Cr	1641	8133	3
3	55.32 L	957	5787	2
4	83.47 L	1575	5300	3

```
df.shape
```

```
(47107, 4)
```

```
df['space'].value_counts()
```

```
3       19094
2       18984
4        4868
1        2049
5         959
6         437
7         237
8         183
10        157
9         106
11          9
12          8
15          6
13          4
27          1
19          1
16          1
43          1
14          1
18          1
Name: space, dtype: int64
```

```
df.isna().sum()
```

```
price                 0
size              13677
price_per_sqft    13205
space                 0
dtype: int64
```

```
df.dropna(subset=['price_per_sqft'],inplace=True)
```

```
df.isna().sum()
```

```
price               0
size              546
price_per_sqft      0
space               0
dtype: int64
```

```
df.dtypes
```

```
price             object
size              object
price_per_sqft    object
space             object
dtype: object
```

string replace

```
df['price']=df['price'].str.replace('₹','')
```

Converting price into numbers

```
def convert_prize(cash):
  if 'Cr' in cash:
    return float(cash.replace(' Cr',''))*10000000
  elif 'Lac' in cash:
    return float(cash.replace(' Lac',''))*100000
  elif 'L' in cash:
    return float(cash.replace(' L',''))*100000
  else:
    return float(cash)
```

```
df['price']=df['price'].apply(convert_prize)
```

```
df['price'].unique()
```

```
array([11800000.        ,  5756000.        , 13300000.        , ...,
       64400000.00000001,  9710000.        ,  9160000.        ])
```

Datatype changing

```
df['size']=df['size'].astype(float)
df['price_per_sqft']=df['price_per_sqft'].astype(float)
df['space']=df['space'].astype(int)
df['price']=df['price'].astype(int)
```

```
df.isna().sum()
```

```
price               0
size              546
price_per_sqft      0
space               0
dtype: int64
```

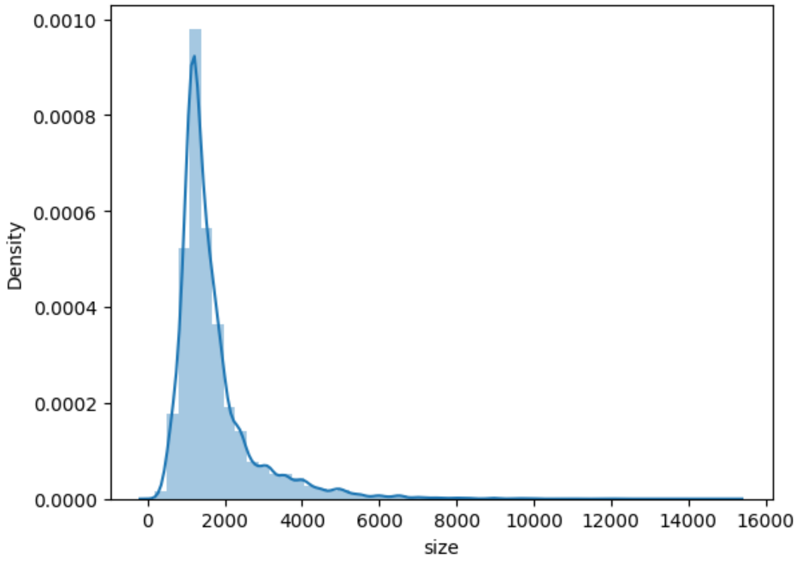
```
df.shape
```

```
(33902, 4)
```

Dealing missing values

```
sns.distplot(df['size'])
```

<Axes: xlabel='size', ylabel='Density'>




```
# distribution is not normal so median is used to fill the missing value
df['size']=df['size'].fillna(df['size'].median())
```

```
df.isna().sum()
```

```
price             0
size              0
price_per_sqft    0
space             0
dtype: int64
```

```
df.dtypes
```

```
price               int64
size              float64
price_per_sqft    float64
space               int64
dtype: object
```

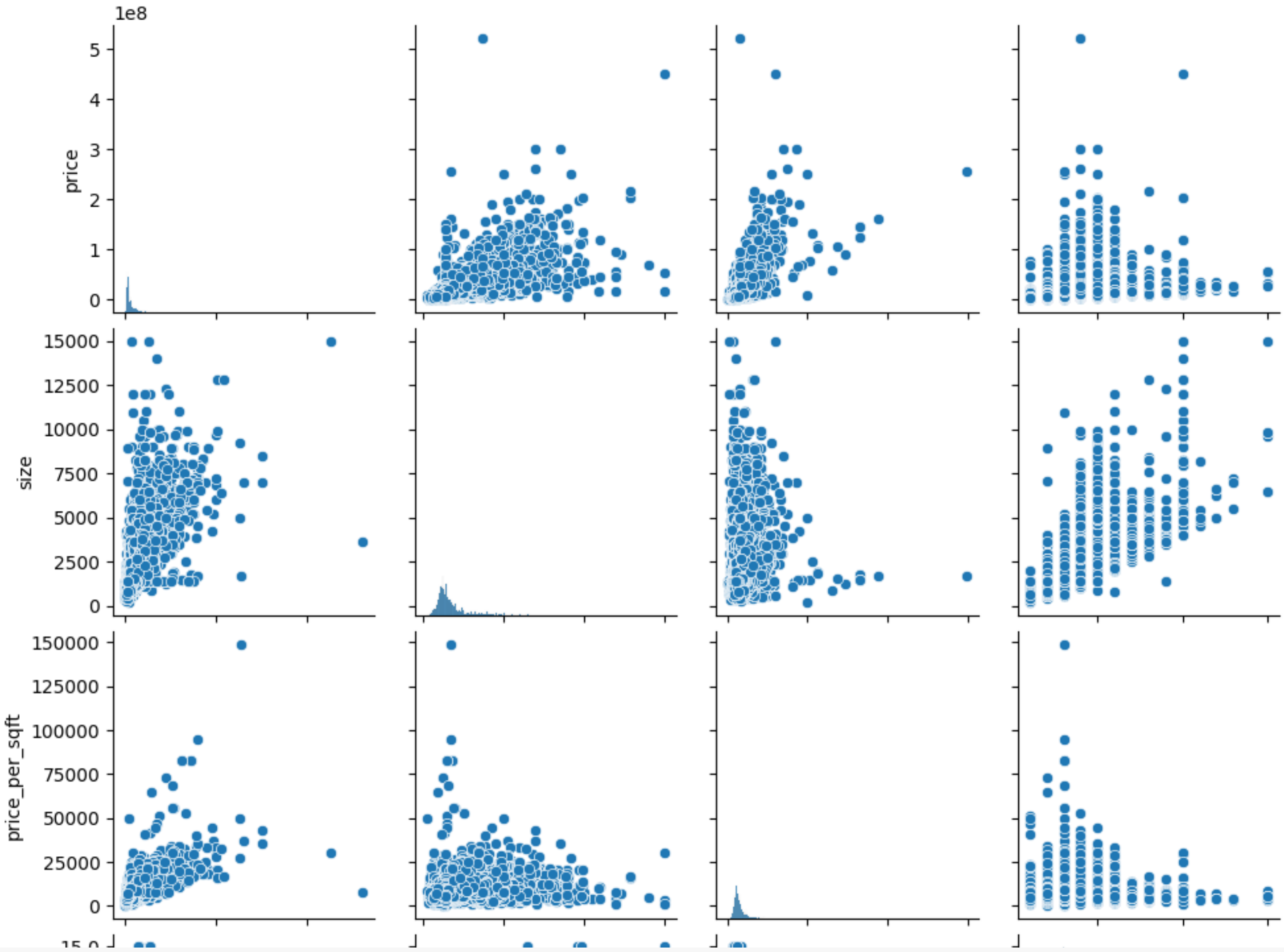
```
df.head()
```

	price	size	price_per_sqft	space
0	11800000	2037.0	5793.0	3
1	5756000	1240.0	4642.0	2
2	13300000	1641.0	8133.0	3
3	5532000	957.0	5787.0	2
4	8347000	1575.0	5300.0	3

Graphical representation of the Data

```
sns.pairplot(df)
```

<seaborn.axisgrid.PairGrid at 0x7c3c2dec4610>

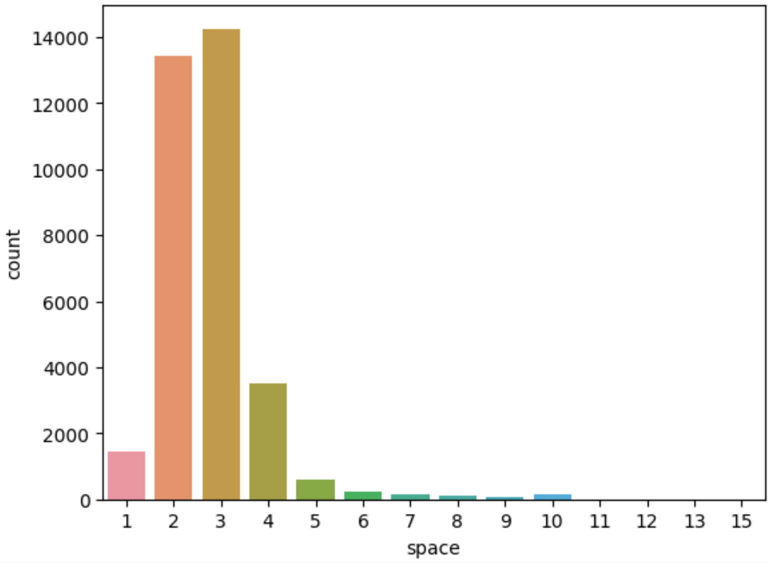



```
sns.heatmap(df.corr(),annot=True)
```

<Axes: >

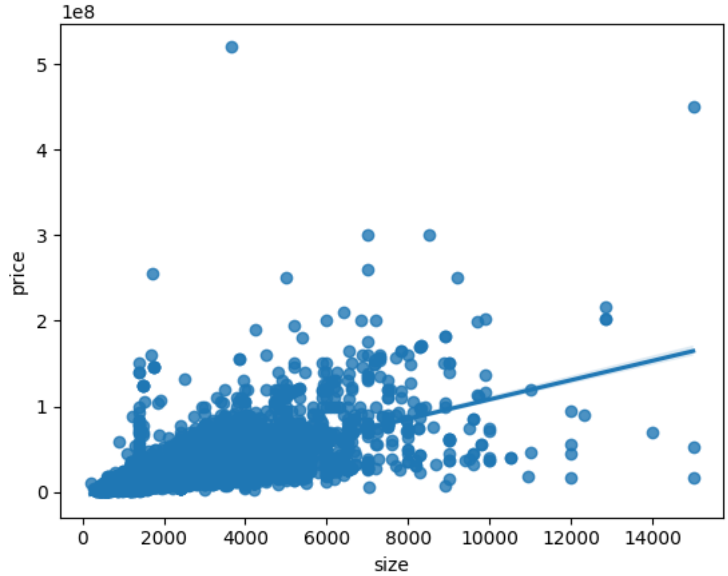

```
sns.countplot(x='space',data=df)
```

<Axes: xlabel='space', ylabel='count'>

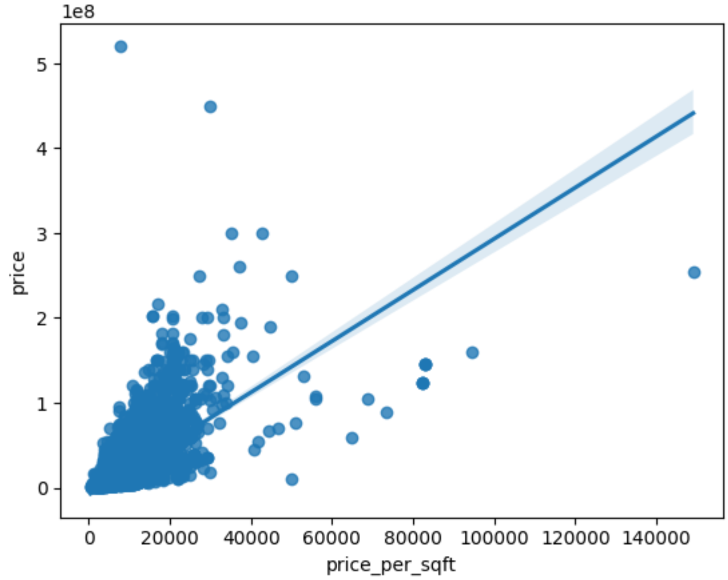



```
x_axis=['size', 'price_per_sqft', 'space']
y_axis=df['price']

for i in x_axis:
 print(sns.regplot(x=df[i],y=y_axis))
 plt.show()
```

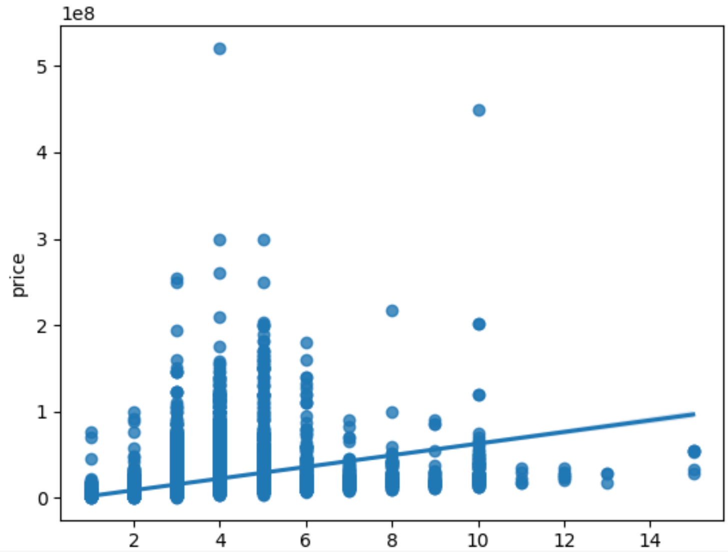
Axes(0.125,0.11;0.775x0.77)



Axes(0.125,0.11;0.775x0.77)

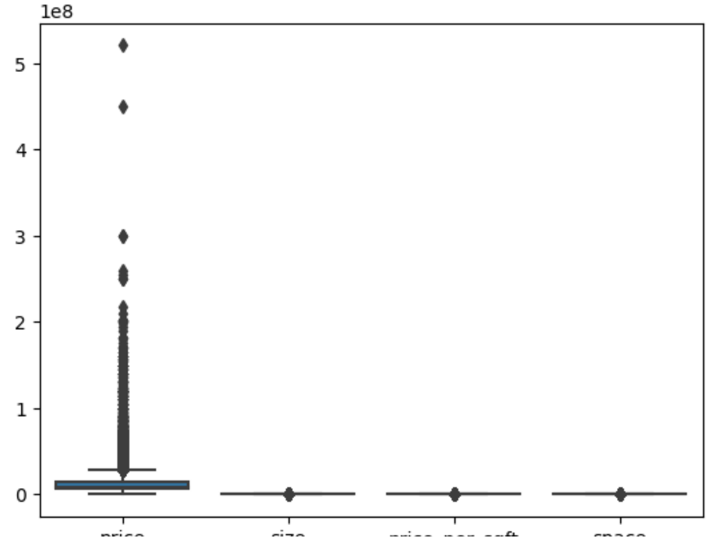


Axes(0.125,0.11;0.775x0.77)




```
sns.boxplot(df)
```

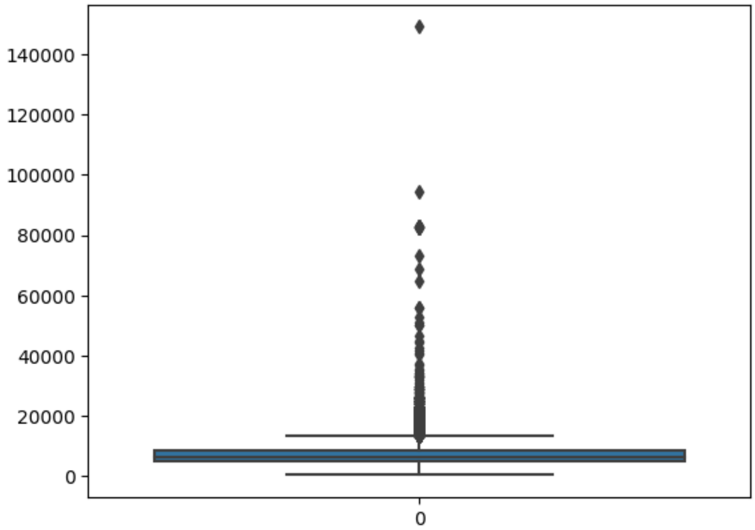
<Axes: >



*there is outliers in price column *

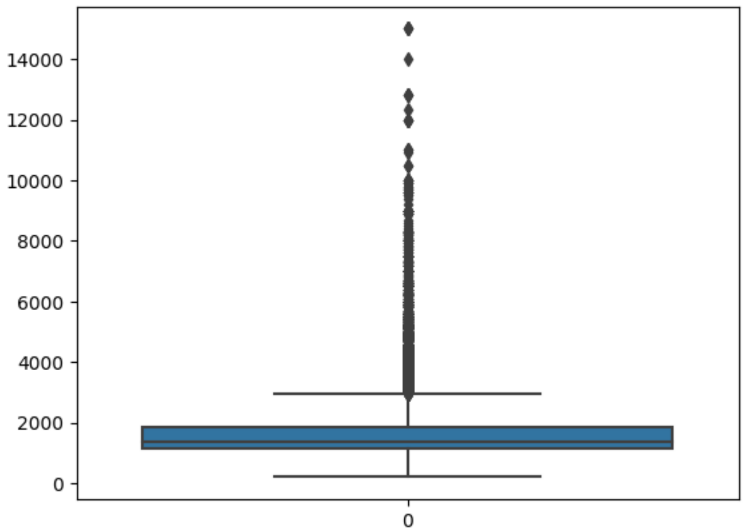
```
sns.boxplot(df['price_per_sqft'])
```

<Axes: >



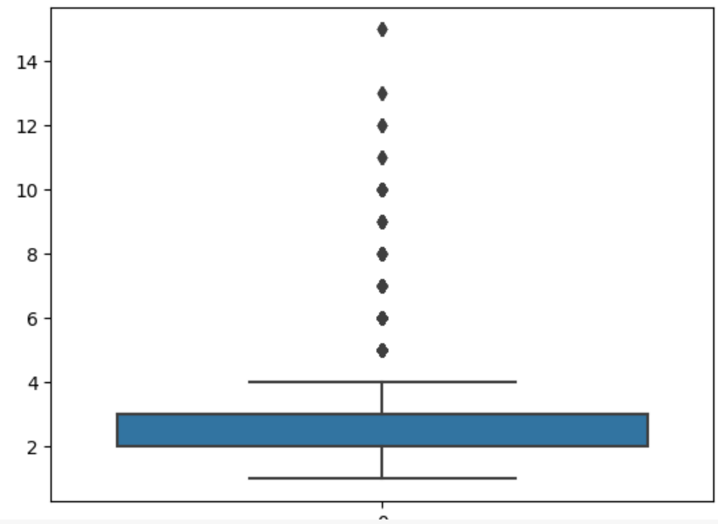

```
sns.boxplot(df['size'])
```

<Axes: >



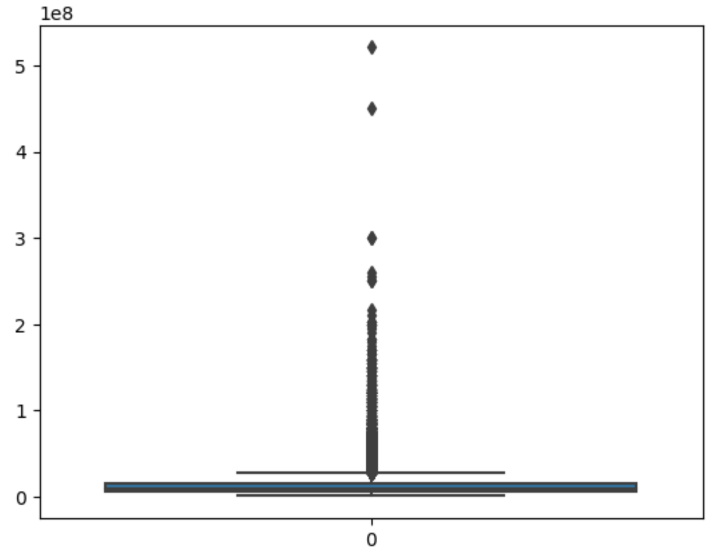

```
sns.boxplot(df['space'])
```

<Axes: >



```
# before removing outliers

sns.boxplot(df['price'])
```

<Axes: >

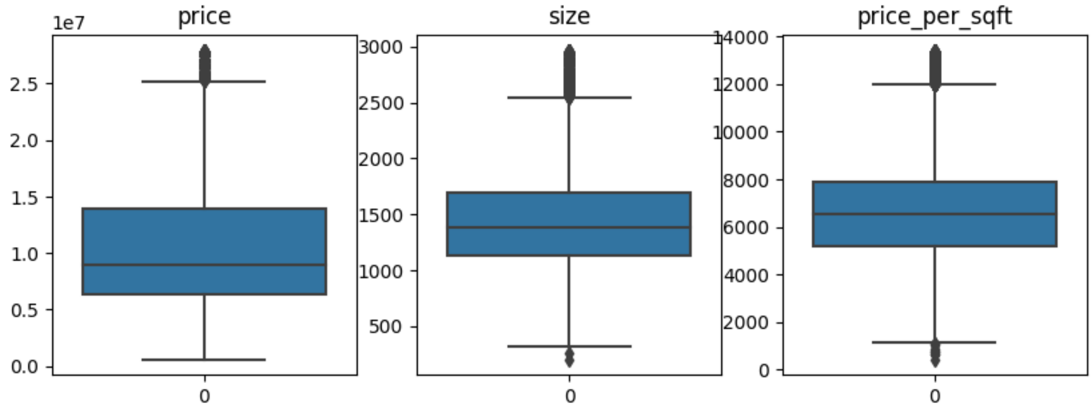


dealing outliers with mean **iqr - method**

```
# interquartile range
ds=['size', 'price_per_sqft','price']
for i in ds:
  q1=df[i].quantile(0.25)
  q3=df[i].quantile(0.75)
  iqr=q3-q1
  lower=q1-(iqr*1.5)
  upper=q3+(iqr*1.5)

  df[i] = df[i].apply(lambda x: x if lower <= x <= upper else df[i].mean())
```

```
# after dealing outliers
plt.figure(figsize=(10,3.3))

plt.subplot(1,3,1)
sns.boxplot(df['price'])
plt.title('price')

plt.subplot(1,3,2)
sns.boxplot(df['size'])
plt.title('size')

plt.subplot(1,3,3)
```

```
sns.boxplot(df['price_per_sqft'])
plt.title('price_per_sqft')
plt.show()
```




```
df.dtypes
```

```
price             float64
size              float64
price_per_sqft    float64
space               int64
dtype: object
```

```
x=df.drop(['price'],axis=1).astype(int)
y=df['price'].astype(int)
```

Feature selection using **chi_square test**

```
# from sklearn.feature_selection import SelectKBest,chi2

# chi=SelectKBest(chi2,k=3)
# best=chi.fit_transform(x,y)
#print(best.shape)
# x_indes=chi.get_support(indices=True)
# print(df.columns[x_indes])

# x_chi=df.drop(['space','price'],axis=1)
# x_chi.dtypes
```

```
from sklearn.model_selection import train_test_split
xtr,xts,ytr,yts=train_test_split(x,y,random_state=42,test_size=0.30)
```

```
from sklearn.preprocessing import StandardScaler
std=StandardScaler()
std.fit(xtr)
xtr=std.transform(xtr)
xts=std.transform(xts)
```

Model creation

```
from sklearn.linear_model import LinearRegression
model=LinearRegression()
```

Hyperparmeter tuning for linear Regression

```
# to get the default values for the parameters
model.get_params()
```

```
{'copy_X': True, 'fit_intercept': True, 'n_jobs': None, 'positive': False}
```

```
from sklearn.model_selection import GridSearchCV

parameter={'copy_X': [True,False], 'fit_intercept': [True,False], 'n_jobs': [None,1,5,7,6], 'positive':[True, False]}
gsv=GridSearchCV(model,parameter,cv=10,scoring='accuracy')
gsv.fit(xtr,ytr)
```

```
GridSearchCV
estimator: LinearRegression
  LinearRegression
```

```
gsv.best_params_
```

```
{'copy_X': True, 'fit_intercept': True, 'n_jobs': None, 'positive': True}
```

Multiple linear regression model creation

```
from sklearn.linear_model import LinearRegression
model1=LinearRegression(positive=True)
model1.fit(xtr,ytr)
ypr=model1.predict(xts)
```

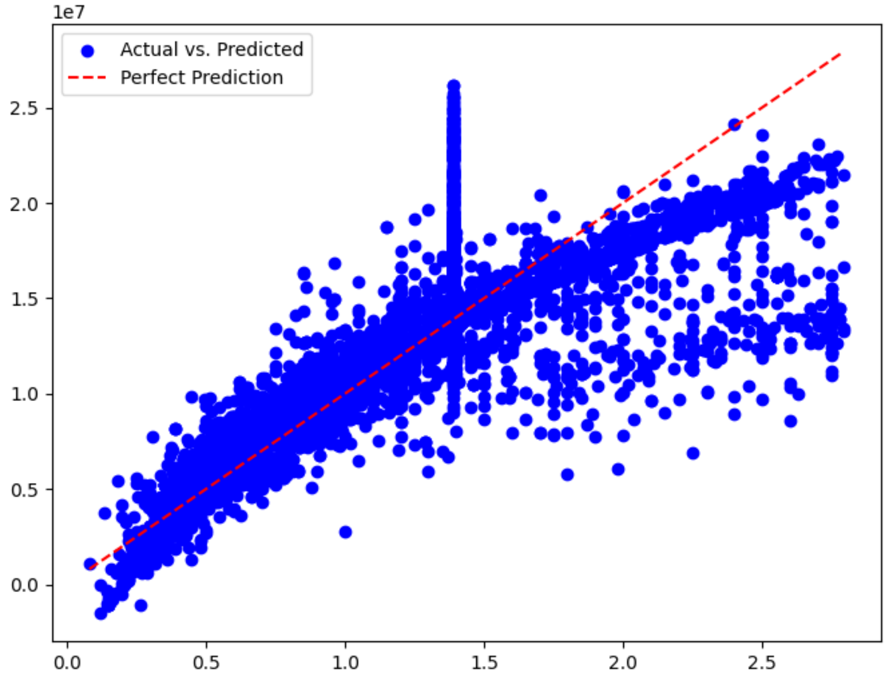
```
df1=pd.DataFrame({'actual':yts,'predicted':ypr,'differance':yts-ypr})
df1
```

	actual	predicted	differance
18397	13895895	1.369176e+07	2.041323e+05
24636	13895895	2.244445e+07	-8.548554e+06
5749	13895895	1.557182e+07	-1.675923e+06
21115	13895895	2.003561e+07	-6.139714e+06
1402	6400000	6.553946e+06	-1.539456e+05
...	...	...	...
19495	12500000	1.329248e+07	-7.924791e+05
25818	16500000	1.560057e+07	8.994319e+05
10202	2610000	1.686807e+06	9.231928e+05
2984	11500000	1.274146e+07	-1.241461e+06
8739	8769000	9.790120e+06	-1.021120e+06

10171 rows × 3 columns

```
plt.figure(figsize=(8, 6))
plt.scatter(df1['actual'], df1['predicted'], marker='o', color='blue', label='Actual vs. Predicted')
plt.plot([min(df1['actual']), max(df1['actual'])], [min(df1['actual']), max(df1['actual'])], linestyle='--', color='red', label='Perfect
plt.legend()
```

```
<matplotlib.legend.Legend at 0x7c3c276c7df0>
```




```
print('slope is ')
print(list(zip(x,model1.coef_)))
print('constant is ',model1.intercept_)
```

```
slope is
[('size', 2381157.806194569), ('price_per_sqft', 2703215.8259997703), ('space', 1207912.0173615823)]
constant is  10436601.962454174
```

```
from sklearn.metrics import r2_score,mean_absolute_percentage_error,mean_squared_error

r0=r2_score(yts,ypr)
print('r2 score',r2_score(yts,ypr))
print('maep ',mean_absolute_percentage_error(ypr,yts))
```

```
r2 score 0.7565905904339756
maep  0.16570523266452494
```

Polynomial Regression

```
from sklearn.preprocessing import PolynomialFeatures
poly=PolynomialFeatures(degree=3)
poly.fit(x,y)
xply=poly.fit_transform(x)

xtrp,xtsp,ytrp,ytsp=train_test_split(xply,y,random_state=42,test_size=0.30)

model2=LinearRegression()
model2.fit(xtrp,ytrp)
yp=model2.predict(xtsp)
```

```
xply.shape
```

```
(33902, 20)
```

```
r1=r2_score(ytsp,yp)
print('r2 score',r1)
print('maep ',mean_absolute_percentage_error(yp,ytsp))
```

```
r2 score 0.8134061502988745
maep  0.11769392929248679
```

Decision tree algorithm

```
from sklearn.tree import DecisionTreeRegressor
dec=DecisionTreeRegressor()
dec.fit(xtr,ytr)
ypr1=dec.predict(xts)

r2=r2_score(yts,ypr1)
print('r2 score',r2)
print('maep ',mean_absolute_percentage_error(ypr1,yts))
```

```
r2 score 0.9223807263497109
maep  0.03143447676581806
```

Random forest algorithm

```
from sklearn.ensemble import RandomForestRegressor
random=RandomForestRegressor()
random.fit(xtr,ytr)
ypr2=random.predict(xts)

r3=r2_score(yts,ypr2)
print('r2 score',r3)
print('maep ',mean_absolute_percentage_error(ypr2,yts))
```

```
r2 score 0.9412874225012221
maep  0.03316465026566907
```

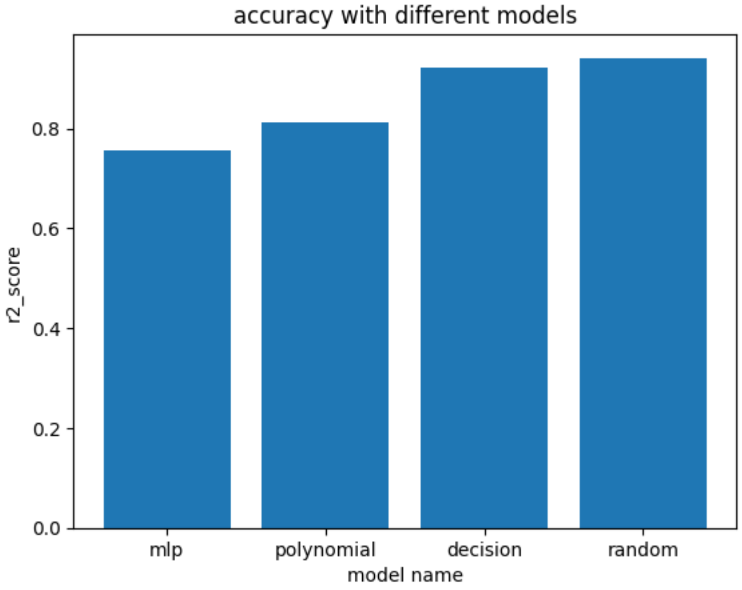
Ridge Regression

```
from sklearn.linear_model import Ridge
rdg=Ridge(alpha=2)
rdg.fit(xtr,ytr)
yr=rdg.predict(xts)

r4=r2_score(yts,yr)
print('r2 score',r4)
print('maep ',mean_absolute_percentage_error(yr,yts))
```

```
r2 score 0.75659235954779
maep  0.16659618732812337
```

```
al=['mlp','polynomial','decision','random']
result=[r0,r1,r2,r3]

plt.bar(al,result)
plt.xlabel('model name')
plt.ylabel('r2_score')
plt.title('accuracy with different models')
```

Text(0.5, 1.0, 'accuracy with different models')



Pickling

```
import pickle

with open('random_forest.pickle', 'wb') as dump_var:
    pickle.dump(random, dump_var)

pickle_in = open('random_forest.pickle', 'rb')
pickle_clf = pickle.load(pickle_in)

accuracy_pkl = pickle_clf.score(xts,yts)
accuracy_pkl
```

0.9412874225012221