Regression model to predict the housing prices Data set

In [1]:
```
#importing required libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn import linear_model

%matplotlib inline
```

In [2]:
```
HPdf = pd.read_csv('HousingPrices.csv.txt')
#reading the data from csv file
#data frame is taken as 'HPdf'
```

In [3]:
```
HPdf.head()
#head() will show the first five rows with data from csv file.
```

Out[3]:

	id	date	price	bedrooms	bathrooms	sqft_living	sqft_lot	floors	waterfro
0	7129300520	20141013T000000	221900.0	3	1.00	1180	5650	1.0	
1	6414100192	20141209T000000	538000.0	3	2.25	2570	7242	2.0	
2	5631500400	20150225T000000	180000.0	2	1.00	770	10000	1.0	
3	2487200875	20141209T000000	604000.0	4	3.00	1960	5000	1.0	
4	1954400510	20150218T000000	510000.0	3	2.00	1680	8080	1.0	

5 rows × 21 columns

In [4]:
```
HPdf.shape
```

Out[4]:
```
(21613, 21)
```

In [5]:
```
HPdf_train = HPdf.copy()
HPdf_train.drop('id', axis=1, inplace=True)
HPdf.head()
#here 'id' is dropped as it has no impact in comparisons and 'date' also dropped in lat
```

Out[5]:

	id	date	price	bedrooms	bathrooms	sqft_living	sqft_lot	floors	waterfro
0	7129300520	20141013T000000	221900.0	3	1.00	1180	5650	1.0	
1	6414100192	20141209T000000	538000.0	3	2.25	2570	7242	2.0	
2	5631500400	20150225T000000	180000.0	2	1.00	770	10000	1.0	

	id	date	price	bedrooms	bathrooms	sqft_living	sqft_lot	floors	waterfro
3	2487200875	20141209T000000	604000.0	4	3.00	1960	5000	1.0	
4	1954400510	20150218T000000	510000.0	3	2.00	1680	8080	1.0	

5 rows × 21 columns

In [6]:
```
HPdf_train.info()
#To find the data type of respected columns.
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 21613 entries, 0 to 21612
Data columns (total 20 columns):
 #   Column         Non-Null Count  Dtype  
---  ------         --------------  -----  
 0   date           21613 non-null  object 
 1   price          21613 non-null  float64
 2   bedrooms       21613 non-null  int64  
 3   bathrooms      21613 non-null  float64
 4   sqft_living    21613 non-null  int64  
 5   sqft_lot       21613 non-null  int64  
 6   floors         21613 non-null  float64
 7   waterfront     21613 non-null  int64  
 8   view           21613 non-null  int64  
 9   condition      21613 non-null  int64  
 10  grade          21613 non-null  int64  
 11  sqft_above     21613 non-null  int64  
 12  sqft_basement  21613 non-null  int64  
 13  yr_built       21613 non-null  int64  
 14  yr_renovated   21613 non-null  int64  
 15  zipcode        21613 non-null  int64  
 16  lat            21613 non-null  float64
 17  long           21613 non-null  float64
 18  sqft_living15  21613 non-null  int64  
 19  sqft_lot15     21613 non-null  int64  
dtypes: float64(5), int64(14), object(1)
memory usage: 3.3+ MB
```

In [7]:
```
HPdf_train.shape
```

Out[7]: (21613, 20)

In [8]:
```
HPdf_train.describe()
```

Out[8]:

	price	bedrooms	bathrooms	sqft_living	sqft_lot	floors	waterfro
count	2.161300e+04	21613.000000	21613.000000	21613.000000	2.161300e+04	21613.000000	21613.0000
mean	5.400881e+05	3.370842	2.114757	2079.899736	1.510697e+04	1.494309	0.0075
std	3.671272e+05	0.930062	0.770163	918.440897	4.142051e+04	0.539989	0.0865
min	7.500000e+04	0.000000	0.000000	290.000000	5.200000e+02	1.000000	0.0000
25%	3.219500e+05	3.000000	1.750000	1427.000000	5.040000e+03	1.000000	0.0000
50%	4.500000e+05	3.000000	2.250000	1910.000000	7.618000e+03	1.500000	0.0000

	price	bedrooms	bathrooms	sqft_living	sqft_lot	floors	waterfro
75%	6.450000e+05	4.000000	2.500000	2550.000000	1.068800e+04	2.000000	0.0000
max	7.700000e+06	33.000000	8.000000	13540.000000	1.651359e+06	3.500000	1.0000

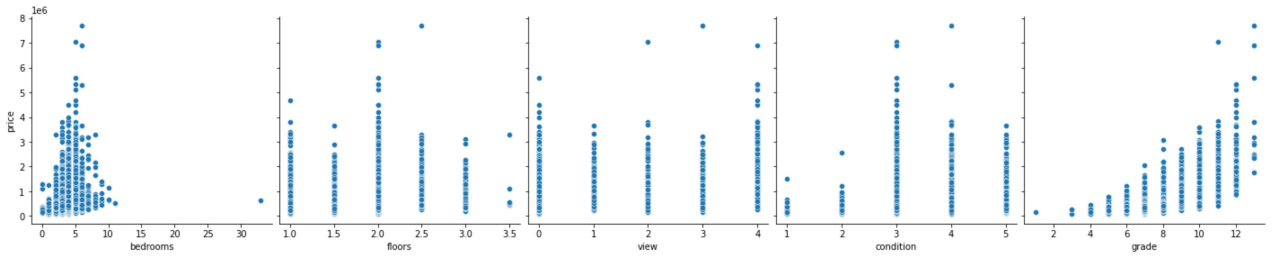
In [9]:
```
# Checking Null values
HPdf_train.isnull().sum()*100/HPdf_train.shape[0]
# There are no NULL values in the dataset, hence it is clean.
```

Out[9]:
```
date             0.0
price            0.0
bedrooms         0.0
bathrooms        0.0
sqft_living      0.0
sqft_lot         0.0
floors           0.0
waterfront       0.0
view             0.0
condition        0.0
grade            0.0
sqft_above       0.0
sqft_basement    0.0
yr_built         0.0
yr_renovated     0.0
zipcode          0.0
lat              0.0
long             0.0
sqft_living15    0.0
sqft_lot15       0.0
dtype: float64
```

Exploratory data analysis

In [10]:
```
sns.pairplot(HPdf, x_vars =['bedrooms', 'floors','view','condition','grade'],
             y_vars ='price',height=4, kind='scatter')
#it is used to show the relations between the two factors.
```

Out[10]:
```
<seaborn.axisgrid.PairGrid at 0x2210bf24280>
```

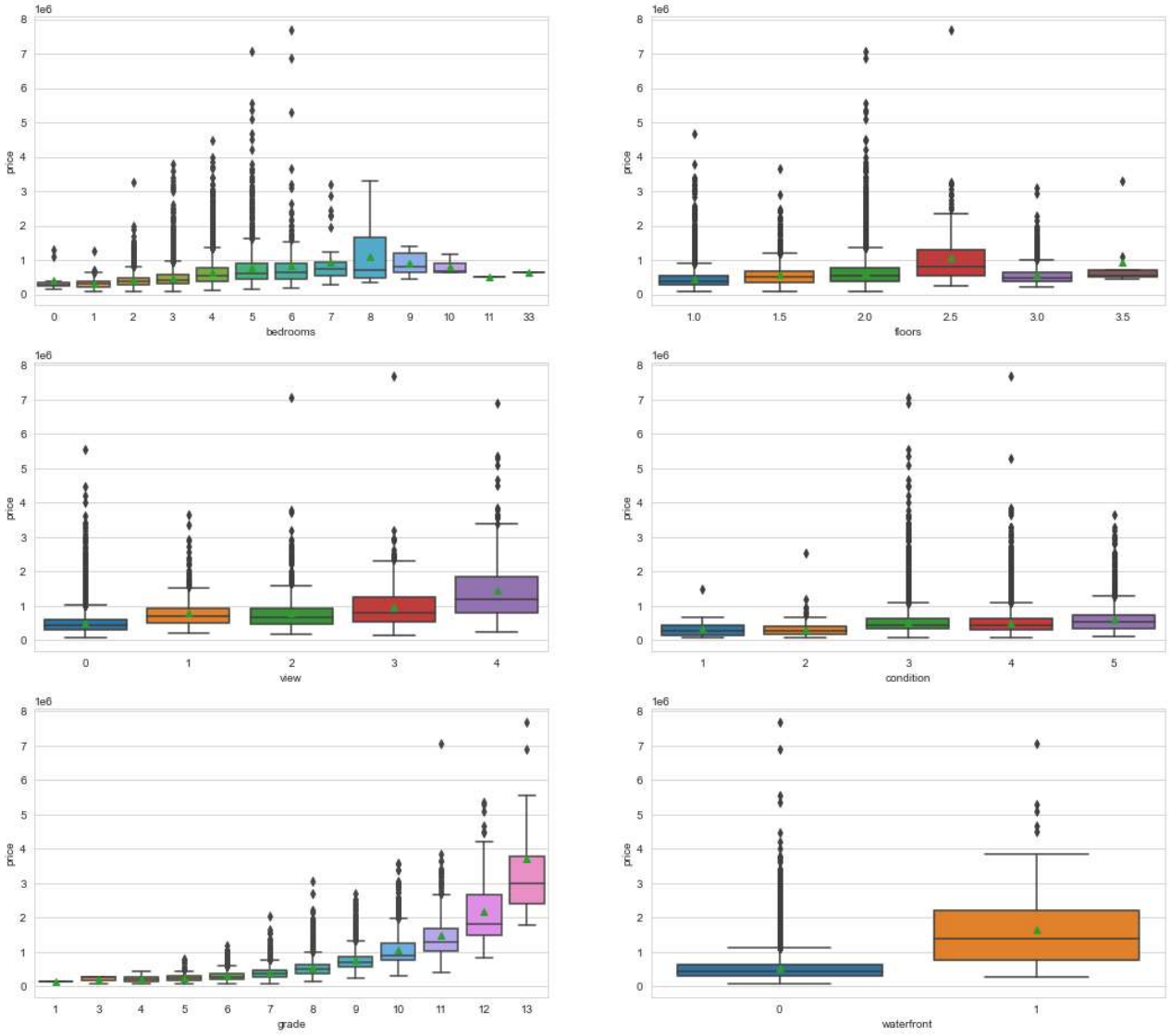


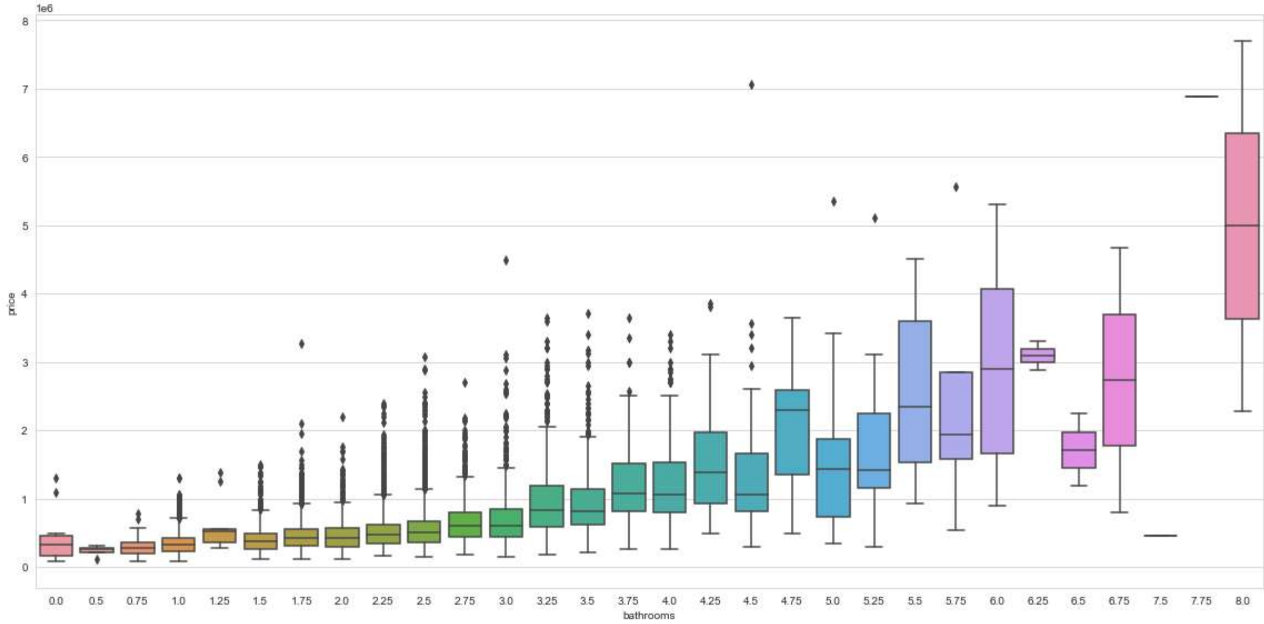
In [11]:
```
sns.set_style('whitegrid')
fig, ax = plt.subplots(3, 2, figsize=(18,16))
sns.boxplot(x = 'bedrooms', y = 'price', data = HPdf_train, orient = 'v', showmeans = T
sns.boxplot(x = 'floors', y = 'price', data = HPdf_train, orient = 'v', showmeans = Tru
sns.boxplot(x = 'view', y = 'price', data = HPdf_train, orient = 'v', showmeans = True,
sns.boxplot(x = 'condition', y = 'price', data = HPdf_train, orient = 'v', showmeans =
sns.boxplot(x = 'grade', y = 'price', data = HPdf_train, orient = 'v', showmeans = True
```

```
sns.boxplot(x= 'waterfront', y= 'price', data= HPdf_train, orient='v', showmeans = True

fig = plt.figure(figsize=(16, 8))
sns.boxplot('bathrooms', 'price', data=HPdf_train)
plt.tight_layout()
plt.tight_layout()
plt.show()
#here boxplot is used to show the data size occupied and to represent more clearly.
```

```
C:\Users\Sidhvi\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pa
ss the following variables as keyword args: x, y. From version 0.12, the only valid posi
tional argument will be `data`, and passing other arguments without an explicit keyword
will result in an error or misinterpretation.
  warnings.warn(
```





In [12]:

```
features_cont = ['sqft_living', 'sqft_lot', 'sqft_above','sqft_basement',
                 'sqft_living15', 'sqft_lot15']

fig, axes = plt.subplots(3,2, figsize=(14,14))

for xcol, ax in zip(features_cont, axes.flatten()):
    sns.regplot(xcol, 'price', data=HPdf_train, ax=ax)

plt.tight_layout()
#taken most effected columns with price and plotted scatter plot.
```

```
C:\Users\Sidhvi\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pa
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  warnings.warn(
```
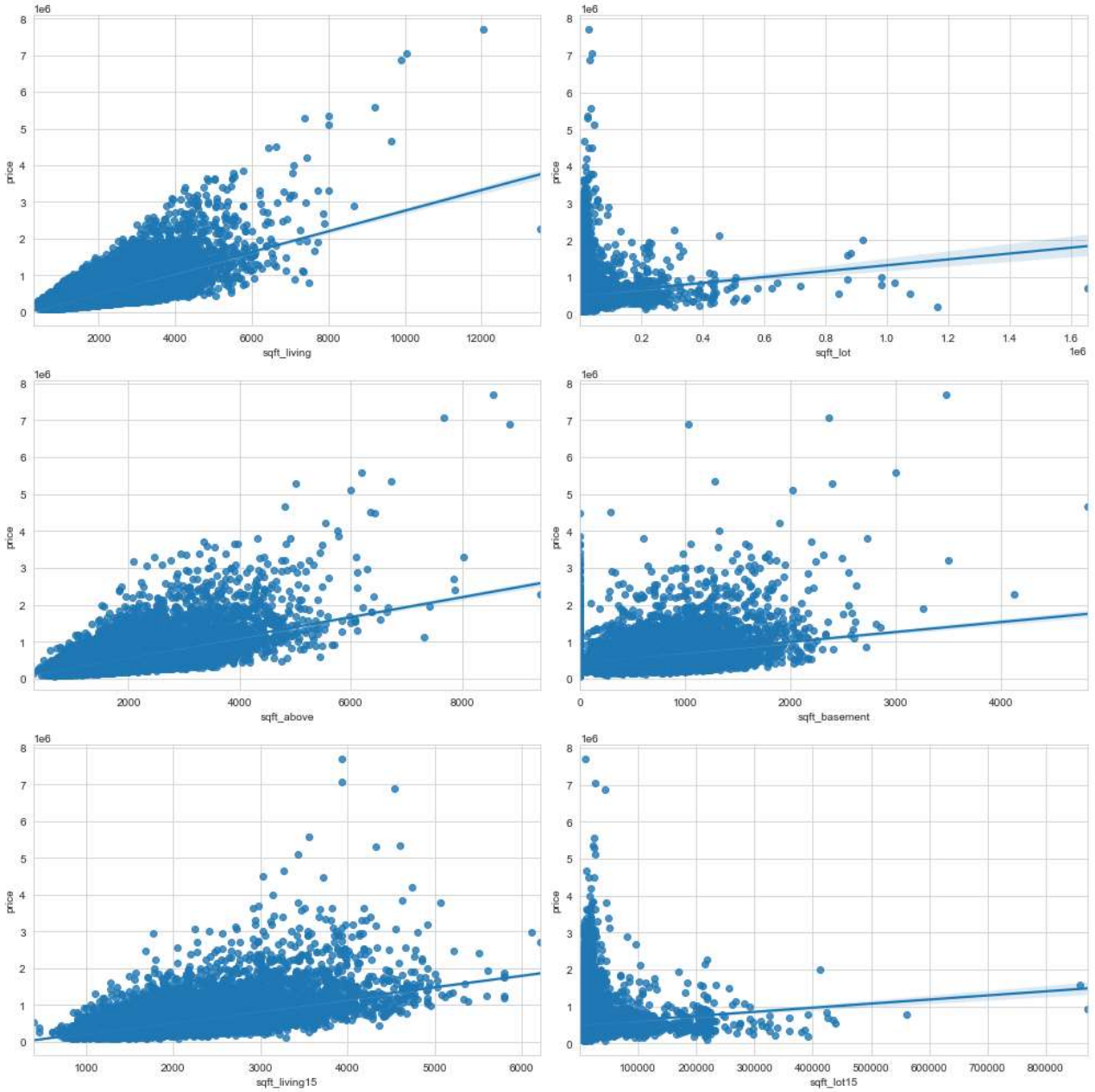
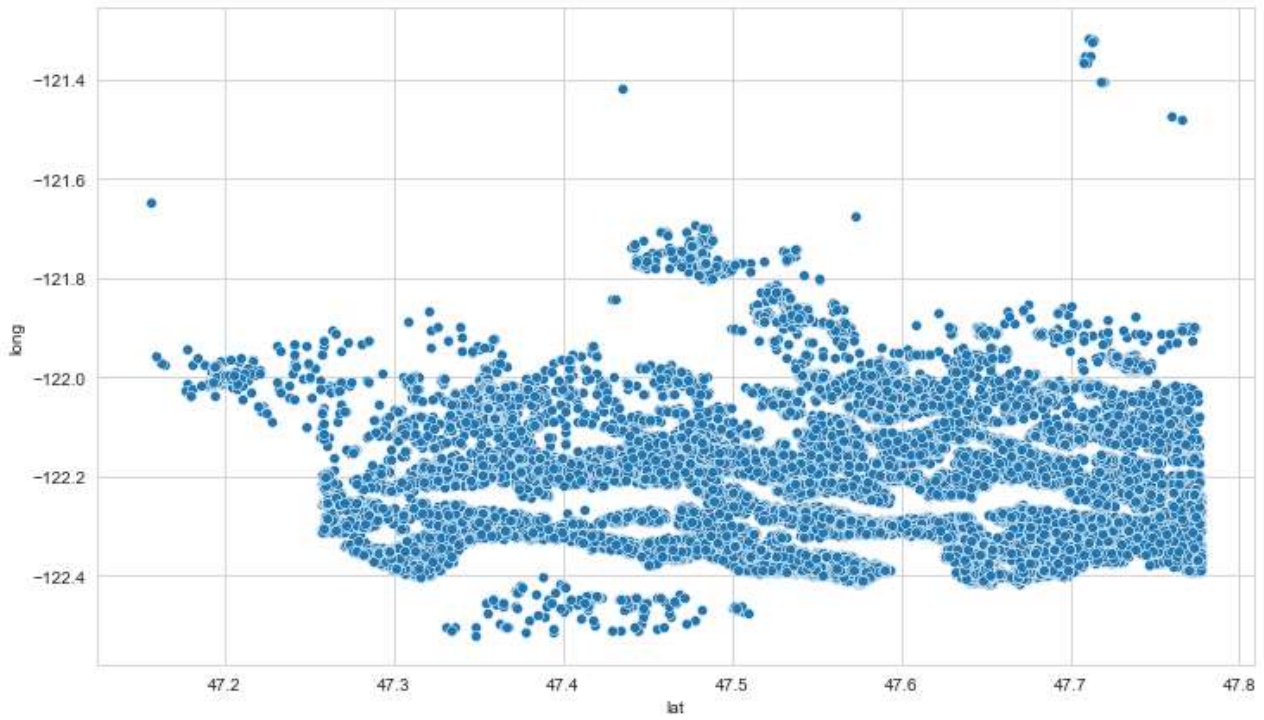



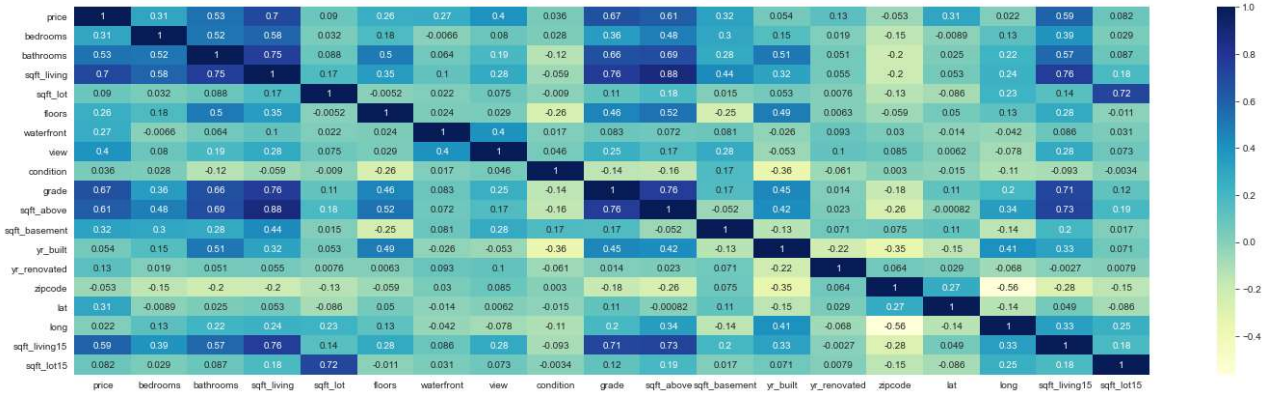
In [13]:
```
fig = plt.figure(figsize = (12,7))
sns.scatterplot(data=HPdf, x="lat", y="long")
#plotting to find where houses are located using latittude and longitude.
```

Out[13]: <AxesSubplot:xlabel='lat', ylabel='long'>



In [14]:
```
correlation = HPdf_train.corr()
correlation1 = correlation.abs().unstack()
correlation1.sort_values(ascending=False)
plt.subplots(figsize=(25,7))
sns.heatmap(correlation,annot=True,cmap="YlGnBu")
#heatmap shows the corelation between each factor and indicated according to the scale
```

Out[14]: <AxesSubplot:>



Creating the train, test Split

In [15]:
```
from sklearn.linear_model import LinearRegression
from sklearn.model_selection import train_test_split
#importing some required functions to split and train data and to implement linear regr
```

In [16]:
```
#test data is taken as 30% and training data as 70%.
X = HPdf.drop(['price','date'], axis=1)
Y = HPdf['price']
```

```
X_train, X_test, Y_train, Y_test = train_test_split(X,Y,test_size=0.3,random_state=230)
#as mentioned above date is dropped as it has no effect.
```

Implementing linear regression model

In [17]:
```
#fitting the data
lm = LinearRegression()
lm.fit(X_train, Y_train)
```

Out[17]:
```
LinearRegression()
```

In [18]:
```
#using recursive feature elimination.
from sklearn.feature_selection import RFE
rfe = RFE(lm, 6)
rfe = rfe.fit(X_train, Y_train)
#here i'm taking 6 feature from feature selection.
```

```
C:\Users\Sidhvi\anaconda3\lib\site-packages\sklearn\utils\validation.py:70: FutureWarnin
g: Pass n_features_to_select=6 as keyword args. From version 1.0 (renaming of 0.25) pass
ing these as positional arguments will result in an error
  warnings.warn(f"Pass {args_msg} as keyword args. From version "
```

In [19]:
```
col = X_train.columns[rfe.support_]
col
#output shows the columns used
```

Out[19]:
```
Index(['waterfront', 'view', 'condition', 'grade', 'lat', 'long'], dtype='object')
```

In [20]:
```
X_train_rfe = X_train[col]
```

In [22]:
```
import statsmodels.api as sm
X_train_rfe = sm.add_constant(X_train_rfe)
```

In [23]:
```
import statsmodels.api as sm
lm = sm.OLS(Y_train,X_train_rfe).fit()
print(lm.summary())
#shows the results of OLS regression.
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:                  price   R-squared:                       0.605
Model:                            OLS   Adj. R-squared:                  0.605
Method:                 Least Squares   F-statistic:                     3863.
Date:                Sun, 19 Dec 2021   Prob (F-statistic):               0.00
Time:                        22:38:47   Log-Likelihood:            -2.0791e+05
No. Observations:               15129   AIC:                         4.158e+05
Df Residuals:                   15122   BIC:                         4.159e+05
Df Model:                           6
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
```

```
const       -4.11e+07   1.68e+06    -24.461      0.000   -4.44e+07   -3.78e+07
waterfront   5.759e+05   2.22e+04     25.909      0.000    5.32e+05    6.19e+05
view         8.294e+04   2688.678     30.849      0.000    7.77e+04    8.82e+04
condition    6.531e+04   2846.738     22.942      0.000    5.97e+04    7.09e+04
grade        1.856e+05   1683.710    110.209      0.000    1.82e+05    1.89e+05
lat          6.261e+05   1.36e+04     46.204      0.000       6e+05    6.53e+05
long        -8.34e+04   1.36e+04     -6.144      0.000   -1.1e+05   -5.68e+04
==============================================================================
Omnibus:                    11245.210   Durbin-Watson:                   1.996
Prob(Omnibus):                  0.000   Jarque-Bera (JB):           486127.937
Skew:                           3.131   Prob(JB):                         0.00
Kurtosis:                      30.055   Cond. No.                     1.21e+05
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specifi
ed.
[2] The condition number is large, 1.21e+05. This might indicate that there are
strong multicollinearity or other numerical problems.
```

In [24]:

```
# trained vs predicted.
Y_train_price = lm.predict(X_train_rfe)
res = (Y_train_price - Y_train)
```

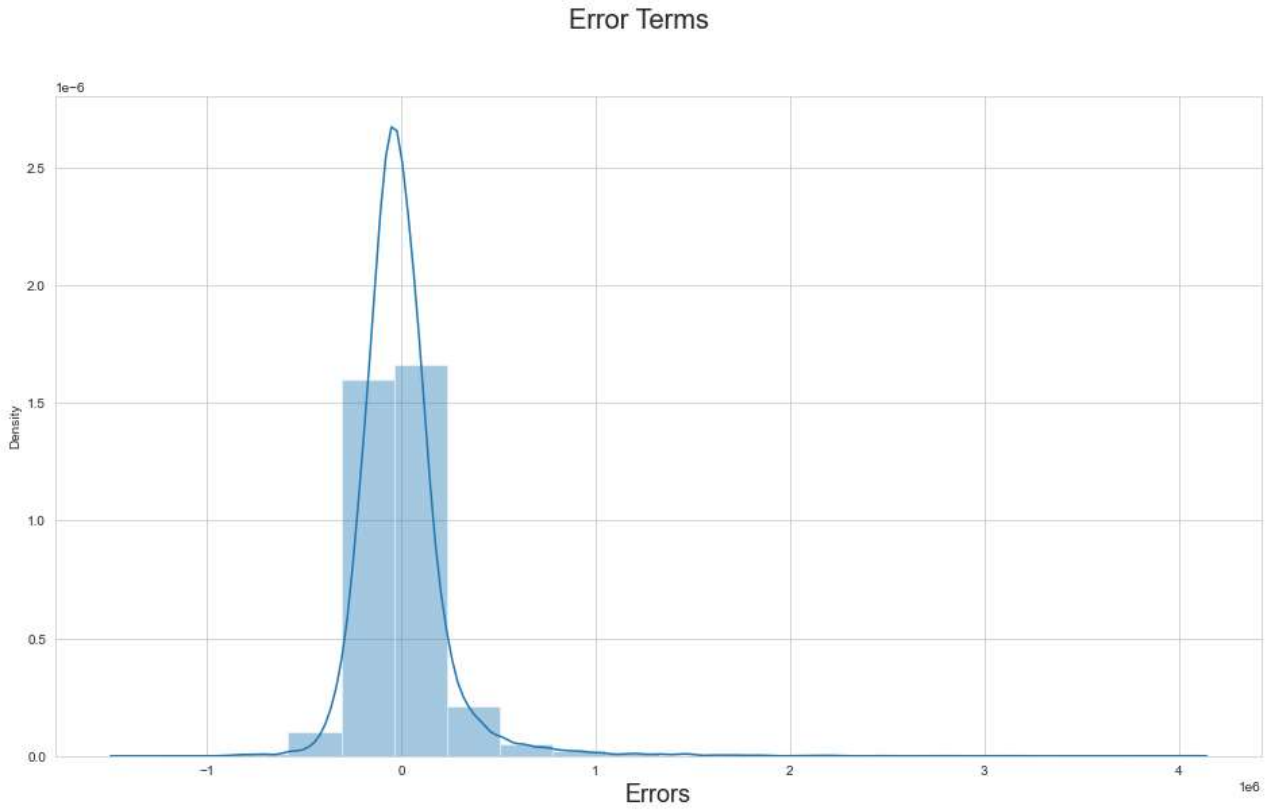
Residual analysis

In [25]:

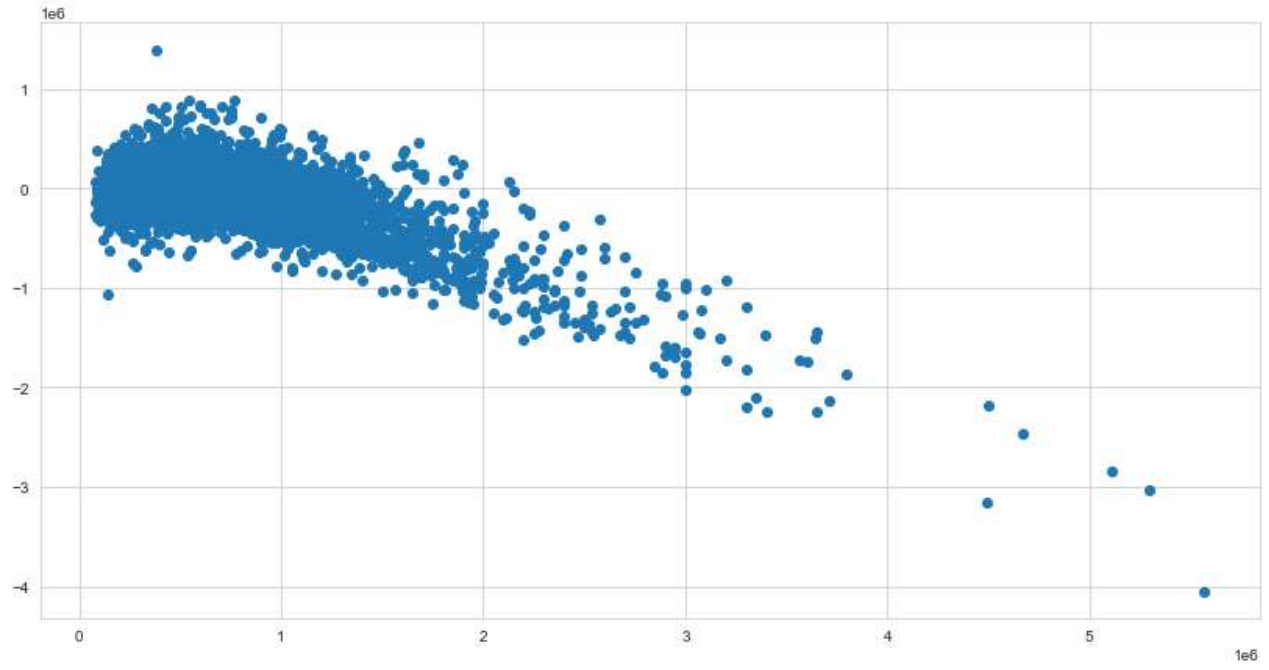
```
#plotting the error terms.
fig = plt.figure(figsize = (16,9))
sns.distplot((Y_train - Y_train_price), bins = 20)
fig.suptitle('Error Terms', fontsize = 20)
plt.xlabel('Errors', fontsize = 18)
```

```
C:\Users\Sidhvi\anaconda3\lib\site-packages\seaborn\distributions.py:2557: FutureWarnin
g: `distplot` is a deprecated function and will be removed in a future version. Please a
dapt your code to use either `displot` (a figure-level function with similar flexibilit
y) or `histplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```

Out[25]: Text(0.5, 0, 'Errors')



In [26]:
```
fig = plt.figure(figsize = (14,7))
plt.scatter(Y_train,res)
plt.show()
```



In [27]:
```
Y_test = HPdf.pop('price')
X_test = HPdf
```

In [28]:
```
X_test = sm.add_constant(X_test)
```

In [29]:
```
X_test_rfe = X_test[X_train_rfe.columns]
```

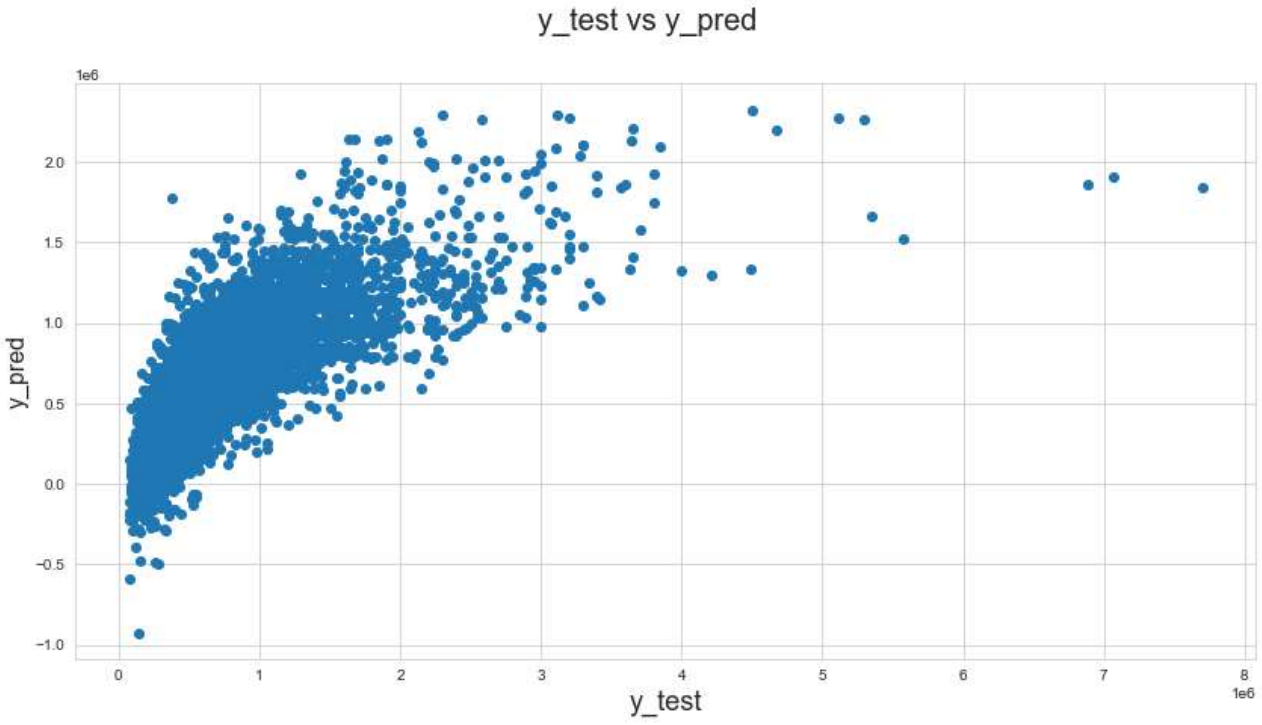
In [30]:
```
Y_pred = lm.predict(X_test_rfe)
```

In [31]:
```
#to find the r2 score from predicted vs tested.
from sklearn.metrics import r2_score
r2_score(Y_test, Y_pred)
```

Out[31]: 0.5896702100120661

In [32]:
```
# plotting the data from tested and predicted data.
fig = plt.figure(figsize = (14,7))
plt.scatter(Y_test,Y_pred)
fig.suptitle('y_test vs y_pred', fontsize=20)
plt.xlabel('y_test', fontsize=18)
plt.ylabel('y_pred', fontsize=16)
```

Out[32]: Text(0, 0.5, 'y_pred')



Conclusion

An R squared error of 0.605 indicates the accuracy of the model is fairly good. Further,this model can be improved by following some more steps like using Gradient boosting and Random Forest Regression makes the model to find optimal parameter.