Predicting King County House Prices

This dataset includes the price of homes in King County, Washington from sales between May 2014 and May 2015. It also contains information on 18 features of the homes, the date of sale, and the ID of the home being sold. id - Unique ID for each home sold.

In this project, we are trying to understand the relationship between house features and how these variables are used to predict house price.

In [1]:
```
# import packages
import pandas as pd
import numpy as np
import seaborn as sns

import matplotlib.pyplot as plt
import matplotlib.mlab as mlab
import matplotlib
from matplotlib.pyplot import figure

%matplotlib inline
```

In [2]:
```
plt.style.use('ggplot')

matplotlib.rcParams['figure.figsize'] = (12,8)

pd.options.mode.chained_assignment = None
```

In [3]:
```
#Loading data
df = pd.read_csv('kc_house_data.csv')
```

Exploratory Data Analysis

In [4]:
```
df.head()
```

Out[4]:

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

5 rows × 21 columns

In [5]:
```
df.info()
df.describe()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 21613 entries, 0 to 21612
Data columns (total 21 columns):
```

```
 #   Column         Non-Null Count  Dtype  
---  ------         --------------  -----  
 0   id             21613 non-null  int64  
 1   date           21613 non-null  object 
 2   price          21613 non-null  float64
 3   bedrooms       21613 non-null  int64  
 4   bathrooms      21613 non-null  float64
 5   sqft_living    21613 non-null  int64  
 6   sqft_lot       21613 non-null  int64  
 7   floors         21613 non-null  float64
 8   waterfront     21613 non-null  int64  
 9   view           21613 non-null  int64  
 10  condition      21613 non-null  int64  
 11  grade          21613 non-null  int64  
 12  sqft_above     21613 non-null  int64  
 13  sqft_basement  21613 non-null  int64  
 14  yr_built       21613 non-null  int64  
 15  yr_renovated   21613 non-null  int64  
 16  zipcode        21613 non-null  int64  
 17  lat            21613 non-null  float64
 18  long           21613 non-null  float64
 19  sqft_living15  21613 non-null  int64  
 20  sqft_lot15     21613 non-null  int64  
dtypes: float64(5), int64(15), object(1)
memory usage: 3.5+ MB
```

Out[5]:

	id	price	bedrooms	bathrooms	sqft_living	sqft_lot	floors	waterf
count	2.161300e+04	2.161300e+04	21613.000000	21613.000000	21613.000000	2.161300e+04	21613.000000	21613.000
mean	4.580302e+09	5.400881e+05	3.370842	2.114757	2079.899736	1.510697e+04	1.494309	0.007
std	2.876566e+09	3.671272e+05	0.930062	0.770163	918.440897	4.142051e+04	0.539989	0.086
min	1.000102e+06	7.500000e+04	0.000000	0.000000	290.000000	5.200000e+02	1.000000	0.000
25%	2.123049e+09	3.219500e+05	3.000000	1.750000	1427.000000	5.040000e+03	1.000000	0.000
50%	3.904930e+09	4.500000e+05	3.000000	2.250000	1910.000000	7.618000e+03	1.500000	0.000
75%	7.308900e+09	6.450000e+05	4.000000	2.500000	2550.000000	1.068800e+04	2.000000	0.000
max	9.900000e+09	7.700000e+06	33.000000	8.000000	13540.000000	1.651359e+06	3.500000	1.000

Data Cleaning

In [6]:
```
# let's drop unnecessory featurs
df= df.drop('id',axis=1)
df = df.drop('zipcode',axis=1)
```

In [7]:
```
#check the null value
#df.isnull()
#df.isnull().sum()
df.isnull().sum().sum()
```

Out[7]:
```
0
```

In [8]:
```
#check duplicate rows
df.duplicated()
```

Out[8]:
```
0        False
1        False
```

```
2         False
3         False
4         False
          ...
21608     False
21609     False
21610     False
21611     False
21612     False
Length: 21613, dtype: bool
```

In [9]:
```
#drop the duplicate rows
df.drop_duplicates(subset=None, keep='first', inplace=False, ignore_index =False)
```

Out[9]:

	date	price	bedrooms	bathrooms	sqft_living	sqft_lot	floors	waterfront	view	condition
0	20141013T000000	221900.0	3	1.00	1180	5650	1.0	0	0	3
1	20141209T000000	538000.0	3	2.25	2570	7242	2.0	0	0	3
2	20150225T000000	180000.0	2	1.00	770	10000	1.0	0	0	3
3	20141209T000000	604000.0	4	3.00	1960	5000	1.0	0	0	5
4	20150218T000000	510000.0	3	2.00	1680	8080	1.0	0	0	3
...	...	...	...	...	...	...	...	...	...	...
21608	20140521T000000	360000.0	3	2.50	1530	1131	3.0	0	0	3
21609	20150223T000000	400000.0	4	2.50	2310	5813	2.0	0	0	3
21610	20140623T000000	402101.0	2	0.75	1020	1350	2.0	0	0	3
21611	20150116T000000	400000.0	3	2.50	1600	2388	2.0	0	0	3
21612	20141015T000000	325000.0	2	0.75	1020	1076	2.0	0	0	3

21613 rows × 19 columns

In [10]:
```
#convert the type of  date column
df['date'] = pd.to_datetime(df['date'])
```

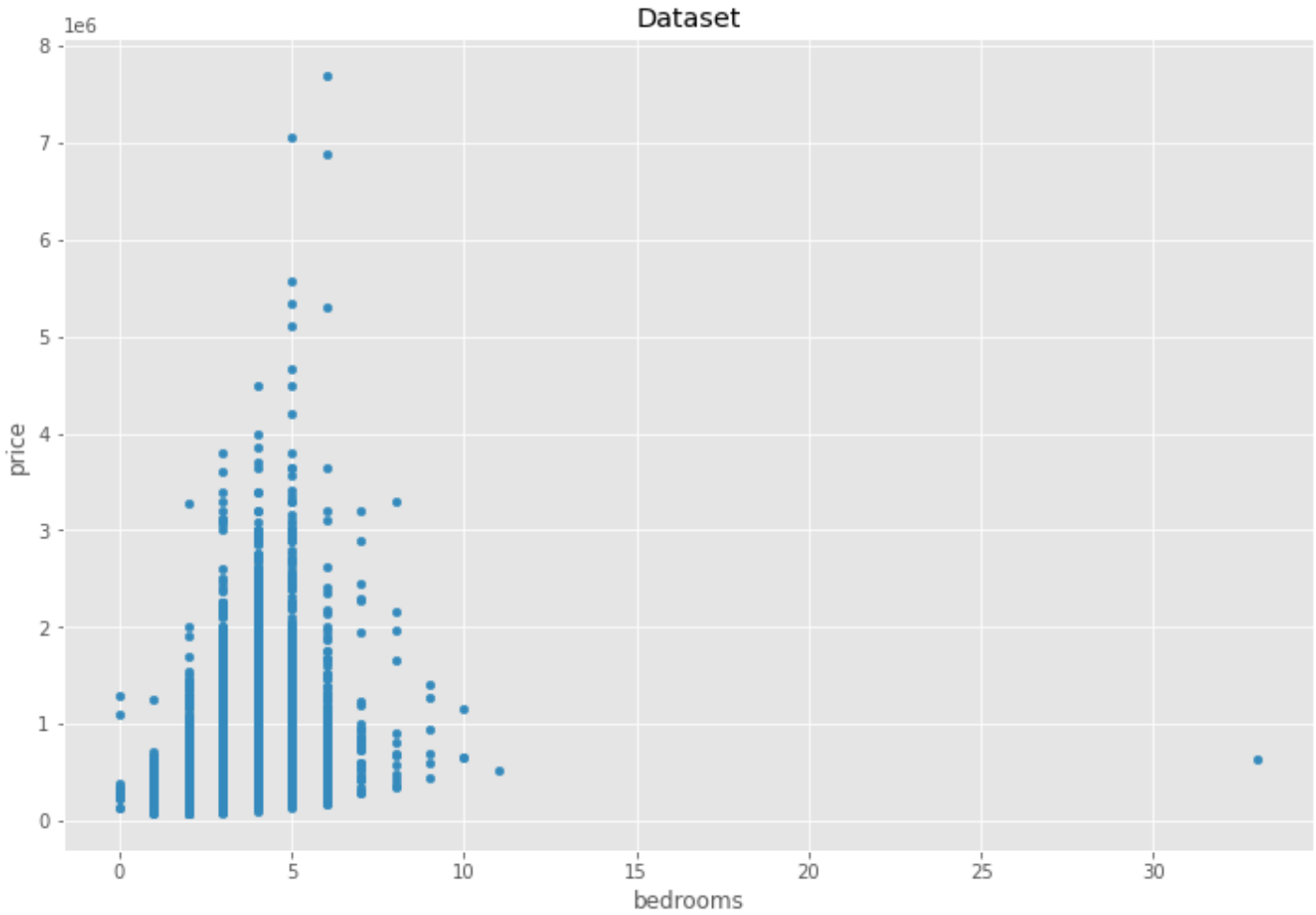
In [11]:
```
df['date']
```

Out[11]:
```
0       2014-10-13
1       2014-12-09
2       2015-02-25
3       2014-12-09
4       2015-02-18
           ...
21608   2014-05-21
21609   2015-02-23
21610   2014-06-23
21611   2015-01-16
21612   2014-10-15
Name: date, Length: 21613, dtype: datetime64[ns]
```

Data Visualization

In [12]:
```
df.plot.scatter(x='bedrooms', y='price', title='Dataset')
```

Out[12]: <AxesSubplot:title={'center':'Dataset'}, xlabel='bedrooms', ylabel='price'>



The outliers in the bedroom column are obvious so need to be handle. maximum value of bedroom is 33!

In [13]:
```
sort=df.sort_values(by='bedrooms', ascending=False)
sort.head()
```

Out[13]:

	date	price	bedrooms	bathrooms	sqft_living	sqft_lot	floors	waterfront	view	condition	grade	sc
15870	2014-06-25	640000.0	33	1.75	1620	6000	1.0	0	0	5	7	
8757	2014-08-21	520000.0	11	3.00	3000	4960	2.0	0	0	3	7	
15161	2014-10-29	650000.0	10	2.00	3610	11914	2.0	0	0	4	7	
13314	2014-08-14	1148000.0	10	5.25	4590	10920	1.0	0	2	3	9	
19254	2014-12-29	660000.0	10	3.00	2920	3745	2.0	0	0	4	7	

We can notice in the first row in the previous table that the value of 33 was assigned to the number of bedrooms by mistake, so that it is not reasonable that the number of bedrooms and the number of toilets is 1.75 in the same house.

In [14]:
```
df['bedrooms'] = np.where(df['bedrooms'] == 33, 3, df['bedrooms'])
```

In [15]:

```
df.iloc[15870]
```

Out[15]:

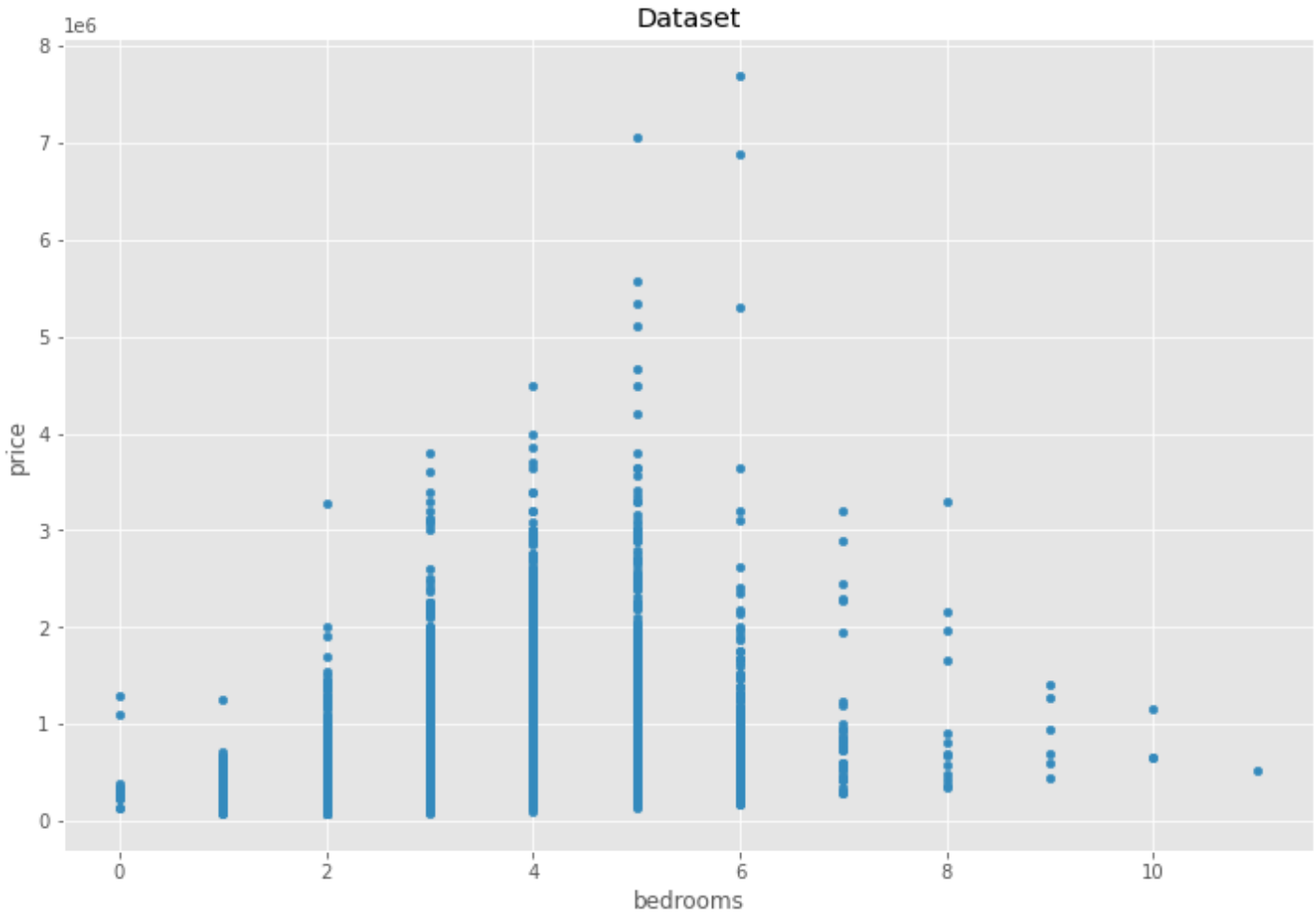
```
date             2014-06-25 00:00:00
price                       640000.0
bedrooms                           3
bathrooms                       1.75
sqft_living                     1620
sqft_lot                        6000
floors                           1.0
waterfront                         0
view                               0
condition                          5
grade                              7
sqft_above                      1040
sqft_basement                    580
yr_built                        1947
yr_renovated                       0
lat                          47.6878
long                        -122.331
sqft_living15                   1330
sqft_lot15                      4700
Name: 15870, dtype: object
```

In [16]:

```
df.plot.scatter(x='bedrooms', y='price', title='Dataset')
```

Out[16]:

```
<AxesSubplot:title={'center':'Dataset'}, xlabel='bedrooms', ylabel='price'>
```



In [17]:

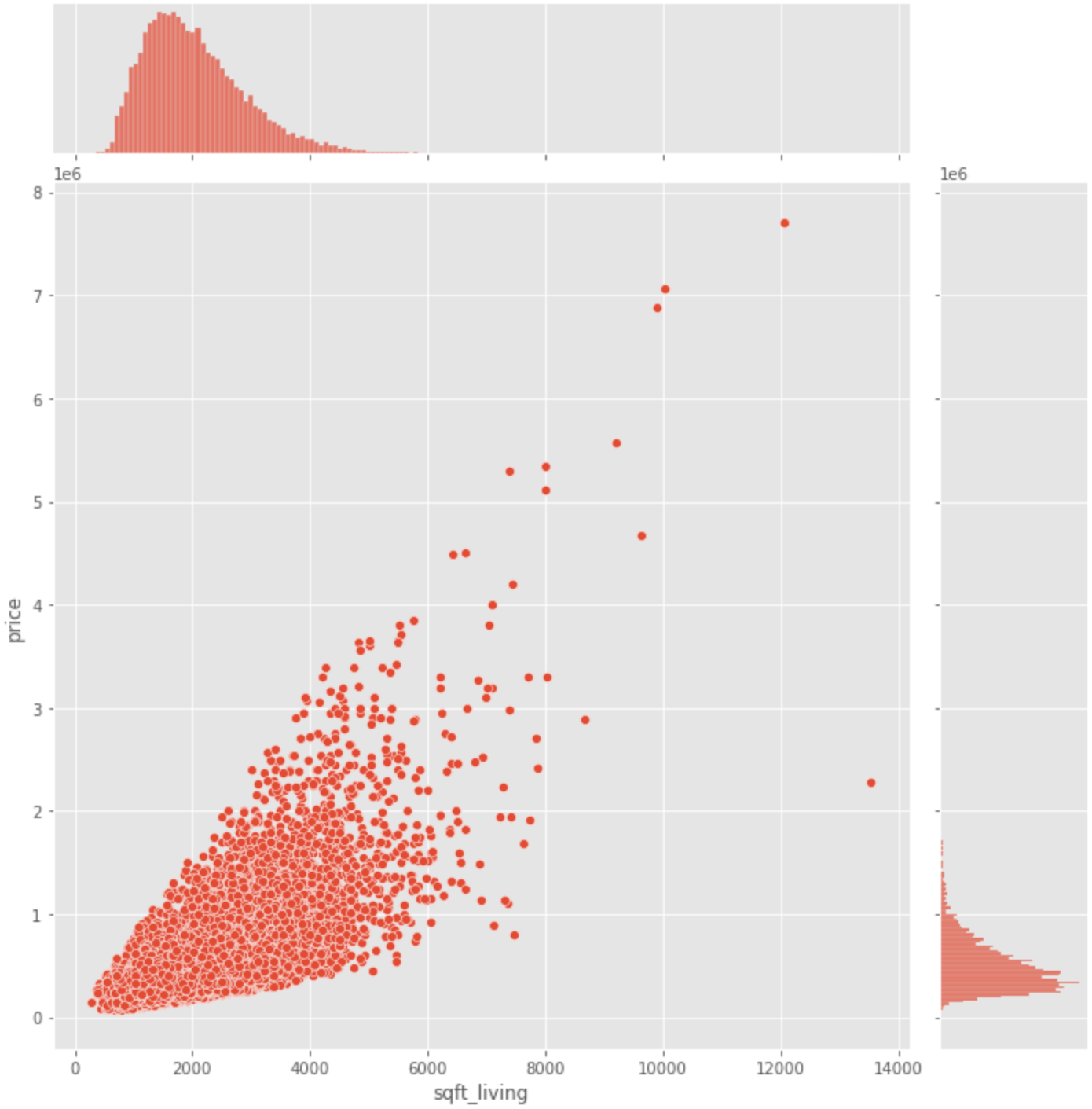
```
sns.jointplot(x="sqft_living", y="price", data=df, size=10)
```

```
C:\Users\User\anaconda3\lib\site-packages\seaborn\axisgrid.py:2182: UserWarning: The `size
` parameter has been renamed to `height`; please update your code.
```

```
  warnings.warn(msg, UserWarning)
```

Out[17]:

```
<seaborn.axisgrid.JointGrid at 0x1c2ee9f53a0>
```

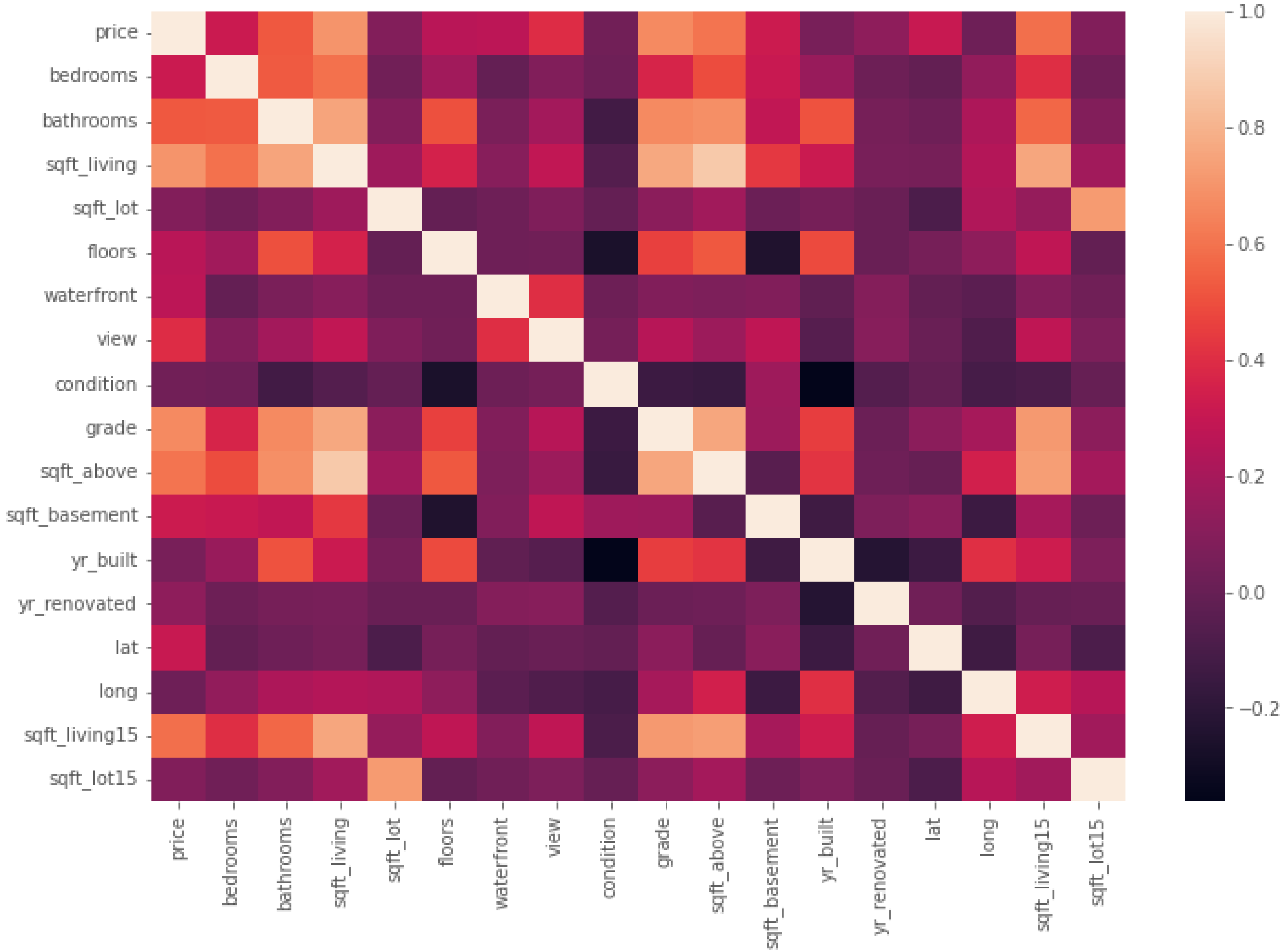


In [18]:

```
# check for any correlations between variables
corr = df.corr()
sns.heatmap(corr)
# sqft_living, grade, sqft_above and sqft_living15 seem to have a
# high influence in price
```

Out[18]:

```
<AxesSubplot:>
```



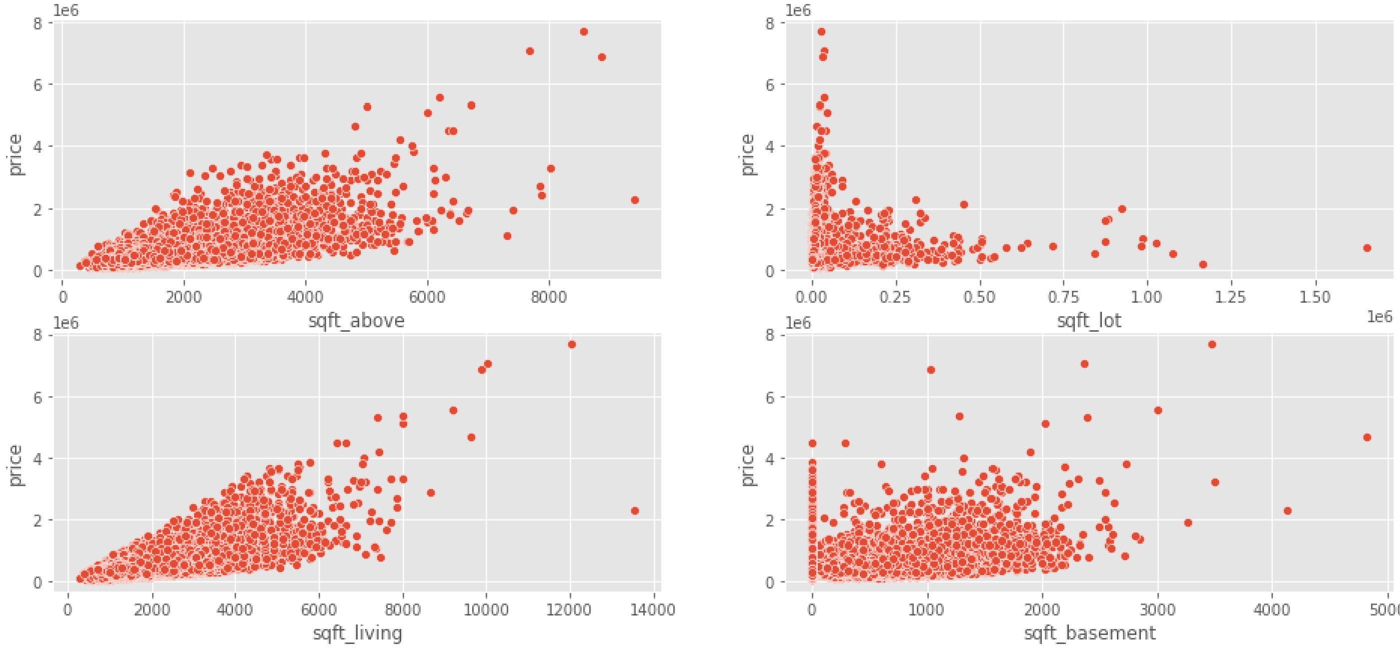
In [19]:

```
#visualizing square footage of (home,lot,above and basement)
fig = plt.figure(figsize=(16,7))
fig.add_subplot(2,2,1)
sns.scatterplot(df['sqft_above'], df['price'])
fig.add_subplot(2,2,2)
sns.scatterplot(df['sqft_lot'],df['price'])
fig.add_subplot(2,2,3)
sns.scatterplot(df['sqft_living'],df['price'])
fig.add_subplot(2,2,4)
sns.scatterplot(df['sqft_basement'],df['price'])
```

```
C:\Users\User\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass t
he following variables as keyword args: x, y. From version 0.12, the only valid positional
argument will be `data`, and passing other arguments without an explicit keyword will resu
lt in an error or misinterpretation.
  warnings.warn(
C:\Users\User\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass t
he following variables as keyword args: x, y. From version 0.12, the only valid positional
argument will be `data`, and passing other arguments without an explicit keyword will resu
lt in an error or misinterpretation.
  warnings.warn(
C:\Users\User\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass t
he following variables as keyword args: x, y. From version 0.12, the only valid positional
argument will be `data`, and passing other arguments without an explicit keyword will resu
lt in an error or misinterpretation.
  warnings.warn(
C:\Users\User\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass t
he following variables as keyword args: x, y. From version 0.12, the only valid positional
argument will be `data`, and passing other arguments without an explicit keyword will resu
```

lt in an error or misinterpretation.
  warnings.warn(

Out[19]:
<AxesSubplot:xlabel='sqft_basement', ylabel='price'>

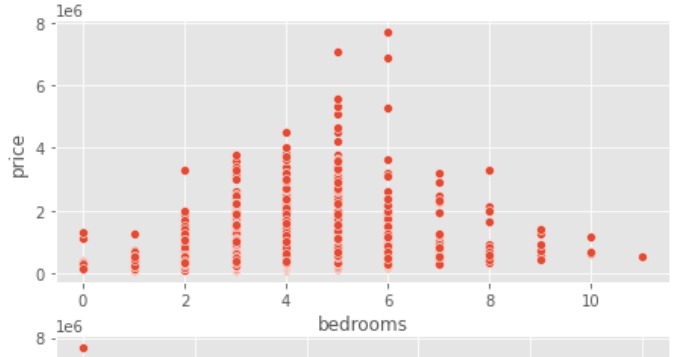


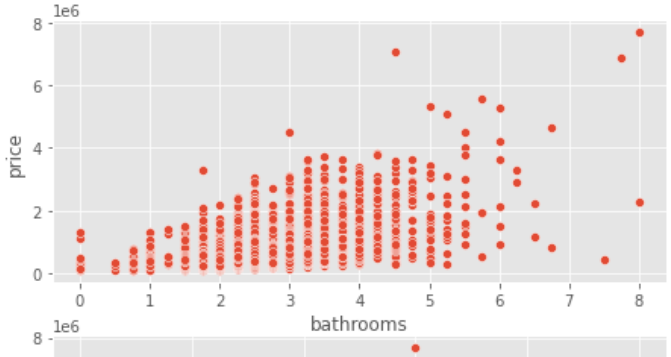
In [20]:

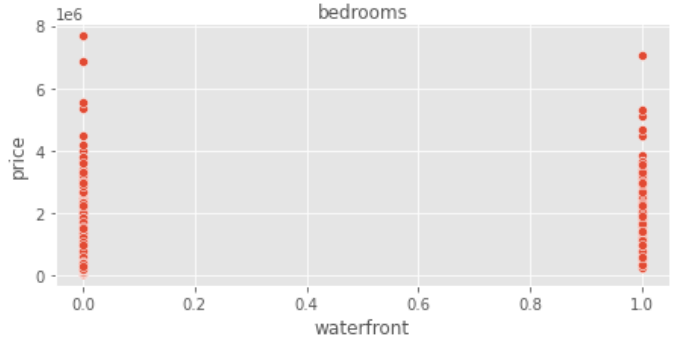
```
fig = plt.figure(figsize=(16,7))
fig.add_subplot(2,2,1)
sns.scatterplot(df['bedrooms'], df['price'])
fig.add_subplot(2,2,2)
sns.scatterplot(df['bathrooms'],df['price'])
fig.add_subplot(2,2,3)
sns.scatterplot(df['waterfront'],df['price'])
fig.add_subplot(2,2,4)
sns.scatterplot(df['floors'],df['price'])
```

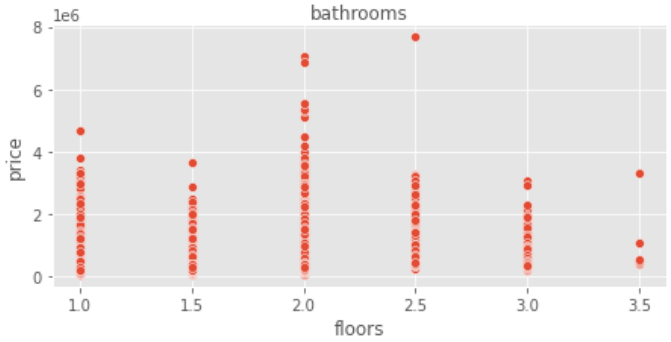
```
C:\Users\User\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass t
he following variables as keyword args: x, y. From version 0.12, the only valid positional
argument will be `data`, and passing other arguments without an explicit keyword will resu
lt in an error or misinterpretation.
  warnings.warn(
C:\Users\User\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass t
he following variables as keyword args: x, y. From version 0.12, the only valid positional
argument will be `data`, and passing other arguments without an explicit keyword will resu
lt in an error or misinterpretation.
  warnings.warn(
C:\Users\User\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass t
he following variables as keyword args: x, y. From version 0.12, the only valid positional
argument will be `data`, and passing other arguments without an explicit keyword will resu
lt in an error or misinterpretation.
  warnings.warn(
C:\Users\User\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass t
he following variables as keyword args: x, y. From version 0.12, the only valid positional
argument will be `data`, and passing other arguments without an explicit keyword will resu
lt in an error or misinterpretation.
  warnings.warn(
```

Out[20]:
<AxesSubplot:xlabel='floors', ylabel='price'>









Creating Linear Regression Model

In [21]:
```
#define the x and y
X= df.drop(['price','date'],axis=1).values
y = df['price'].values
```

In [22]:
```
# Splitting the dataset into the Training set and Test set
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=1/3, random_state=0)
```

In [23]:
```
# Fitting Simple Linear Regression to the Training set
from sklearn.linear_model import LinearRegression
regressor = LinearRegression()
regressor.fit(X_train, y_train)
```

Out[23]:
```
LinearRegression()
```

In [24]:
```
y_pred = regressor.predict(X_test)

y_pred
```

Out[24]:
```
array([ 392052.30936598, 1499728.59924349,  527752.72808461, ...,
        535623.08393385,  334899.35828061,  417778.28135134])
```

In [25]:
```
y_pred
```

Out[25]:
```
array([ 392052.30936598, 1499728.59924349,  527752.72808461, ...,
        535623.08393385,  334899.35828061,  417778.28135134])
```

In [26]:
```
from sklearn.metrics import mean_squared_error,r2_score
r2_score(y_test,y_pred)
```

Out[26]:
```
0.6803199085266312
```

In [27]:

```
print(y_pred)
```

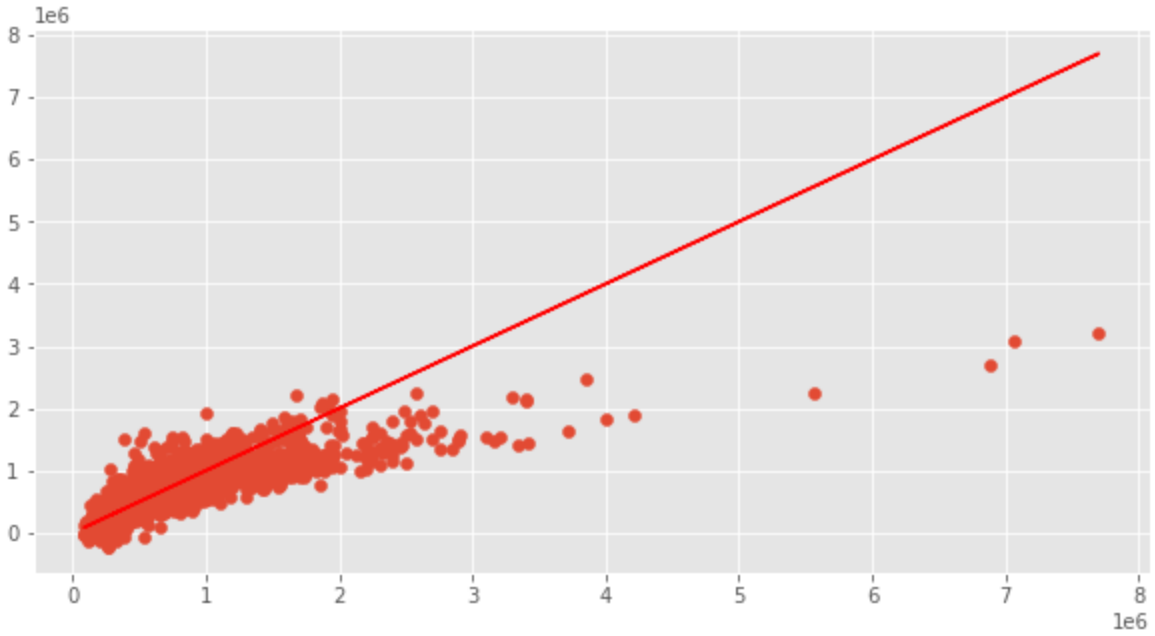
```
[ 392052.30936598 1499728.59924349  527752.72808461 ...  535623.08393385
  334899.35828061  417778.28135134]
```

In [28]:

```
# Our predictions
plt.figure(figsize=(10,5))
plt.scatter(y_test,y_pred)
plt.savefig('fig_par.jpg')
# Perfect predictions
plt.plot(y_test,y_test,'r')
```

Out[28]:

```
[<matplotlib.lines.Line2D at 0x1c2f23fc310>]
```



In [29]:

```
pred_y_df=pd.DataFrame({'Actual Value':y_test,'Predicted Value':y_pred,'Diffrance':y_test-
pred_y_df[1:10]
```

Out[29]:

	Actual Value	Predicted Value	Diffrance
1	1578000.0	1.499729e+06	78271.400757
2	562100.0	5.277527e+05	34347.271915
3	631500.0	5.838389e+05	47661.069201
4	780000.0	9.928467e+05	-212846.697397
5	485000.0	3.739064e+05	111093.619754
6	340000.0	4.059534e+05	-65953.350167
7	335606.0	4.051736e+05	-69567.646177
8	425000.0	5.754226e+05	-150422.621559
9	490000.0	1.186921e+06	-696921.134941

Evaluation on Test Data

In [30]:

```
from sklearn.tree import DecisionTreeRegressor
df_model= DecisionTreeRegressor(max_depth=5).fit(X_train,y_train)
```

```
y_pred1 = df_model.predict(X_test)
```

In [31]:
```
 #evaluation metrics
# explained variance score: best possible score is 1 and lower values are worse
from sklearn import metrics

print('Mean Absolute Error: {:.2f}'.format(metrics.mean_absolute_error(y_test, y_pred1)))
print('Mean Squared Error: {:.2f}'.format(metrics.mean_squared_error(y_test, y_pred1)))
print('Root Mean Squared Error: {:.2f}'.format(np.sqrt(metrics.mean_squared_error(y_test,
print('Variance score is: {:.2f}'.format(metrics.explained_variance_score(y_test,y_pred1))
```

```
Mean Absolute Error: 111645.83
Mean Squared Error: 40230132971.79
Root Mean Squared Error: 200574.51
Variance score is: 0.72
```

In [32]:
```
# we are off about 20% (comparing mean absolut error and mean of price)
df['price'].mean()
```

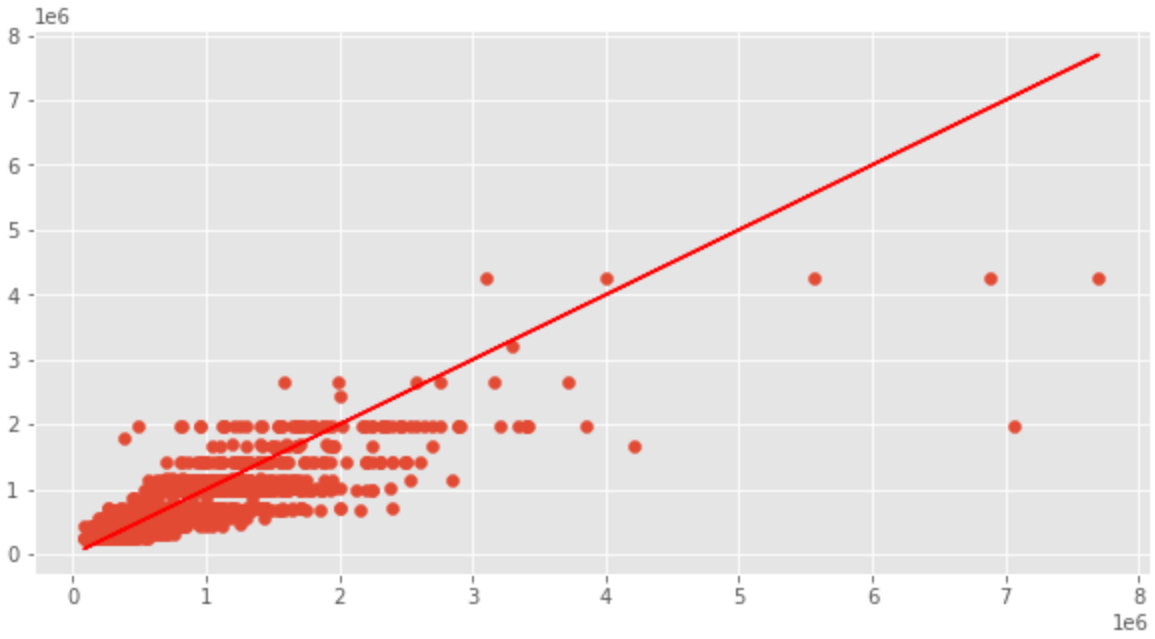
Out[32]:
```
540088.1417665294
```

In [33]:
```
r2_score(y_test,y_pred1)
```

Out[33]:
```
0.7212822895941178
```

In [34]:
```
# Our predictions
fig = plt.figure(figsize=(10,5))
plt.scatter(y_test,y_pred1)
# Perfect predictions
plt.plot(y_test,y_test,'r')
```

Out[34]:
```
[<matplotlib.lines.Line2D at 0x1c2f25ebfa0>]
```



In [35]:
```
print('Linear Regression Model:')
print("Train Score {:.2f}".format(regressor.score(X_train,y_train)))
print("Test Score {:.2f}".format(regressor.score(X_test, y_test)))
```

```
Linear Regression Model:
```

```
Train Score 0.70
Test Score 0.68
```

In [ ]: