

# King County, Data Analysis

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- Scheduled project review date/time:
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- Blog post URL: <https://medium.com/@nataliagoncharov/data-analysis-real-estate-in-king-county-washington-6c74cad2e79>

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## Data Description

- id - Unique identifier for a house
- date - Date house was sold
- price - Sale price (prediction target)
- bedrooms - Number of bedrooms
- bathrooms - Number of bathrooms
- sqft\_living - Square footage of living space in the home
- sqft\_lot - Square footage of the lot
- floors - Number of floors (levels) in house
- waterfront - Whether the house is on a waterfront
  - Includes Duwamish, Elliott Bay, Puget Sound, Lake Union, Ship Canal, Lake Washington, Lake Sammamish, other lake, and river/slough waterfronts
- view - Quality of view from house
  - Includes views of Mt. Rainier, Olympics, Cascades, Territorial, Seattle Skyline, Puget Sound, Lake Washington, Lake Sammamish, small lake / river / creek, and other
- condition - How good the overall condition of the house is. Related to maintenance of house.
  - See the [King County Assessor Website](#) for further explanation of each condition code
- grade - Overall grade of the house. Related to the construction and design of the house.
  - See the [King County Assessor Website](#) for further explanation of each building grade code
- sqft\_above - Square footage of house apart from basement
- sqft\_basement - Square footage of the basement
- yr\_built - Year when house was built
- yr\_renovated - Year when house was renovated
- zipcode - ZIP Code used by the United States Postal Service
- lat - Latitude coordinate
- long - Longitude coordinate

- sqft\_living15 - The square footage of interior housing living space for the nearest 15 neighbors
- sqft\_lot15 - The square footage of the land lots of the nearest 15 neighbors

## Project's Purpose

The purpose of this project is to advise Edegon and Company, a real estate investment firm in King County, Washington. The following Data and Analysis will help the firm predict the market value of a given house, while the conclusions offer recommendations for future investments.

### Importing Libraries

In [1]:

```
# Importing the neccessary libraries
import pandas as pd
# Import the neccessary libraries
import pandas as pd
import statsmodels as sm

from statsmodels.api import formula
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import scipy.stats as stats
import statsmodels.formula.api as smf
import statsmodels.stats.api as sms
import statsmodels.api as sm
from statsmodels.formula.api import ols
from sklearn import datasets, linear_model
import seaborn as sns
from sklearn import preprocessing
from sklearn.preprocessing import LabelEncoder, StandardScaler
from sklearn import metrics
from sklearn.metrics import r2_score
from sklearn.metrics import mean_squared_error, make_scorer
from sklearn.model_selection import cross_val_score
from sklearn.feature_selection import RFE
from sklearn.linear_model import LinearRegression
from sklearn.model_selection import train_test_split
from sklearn.metrics import mean_absolute_error
from sklearn.metrics import mean_squared_error, r2_score
from matplotlib.gridspec import GridSpec
import warnings
warnings.filterwarnings("ignore")

import seaborn_image as isns
isns.set_context(fontfamily="times") # Setting up global font type
# Uploading the data
kc_data = pd.read_csv("kc_house_data.csv", parse_dates = ['date'])

# Looking that the data has been uploaded properly and have a first glance
kc_data.head()
```

Out[1]:

	id	date	price	bedrooms	bathrooms	sqft_living	sqft_lot	floors	waterfront	view	...	grade	sqft_
0	7129300520	2014-10-13	221900.0		3	1.00	1180	5650	1.0	NaN	NONE	...	7 Average
1	6414100192	2014-12-09	538000.0		3	2.25	2570	7242	2.0	NO	NONE	...	7 Average
2	5631500400	2015-02-25	180000.0		2	1.00	770	10000	1.0	NO	NONE	...	6 Low Average
3	2487200875	2014-12-09	604000.0		4	3.00	1960	5000	1.0	NO	NONE	...	7 Average
4	1954400510	2015-02-18	510000.0		3	2.00	1680	8080	1.0	NO	NONE	...	8 Good

5 rows × 21 columns

## Clean the data: remove, replace, and/or fill missing values/errors/outliers

```
In [2]: # Converting price unites to $ millions so that the data appears
# cleaner in graphs later on.

kc_data['price'] = kc_data['price']
```

```
In [3]: # Checking the size of the data.

kc_data.shape
```

Out[3]: (21597, 21)

```
In [4]: kc_data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 21597 entries, 0 to 21596
Data columns (total 21 columns):
 #   Column      Non-Null Count  Dtype  
--- 
 0   id          21597 non-null   int64  
 1   date         21597 non-null   datetime64[ns]
 2   price        21597 non-null   float64 
 3   bedrooms     21597 non-null   int64  
 4   bathrooms    21597 non-null   float64 
 5   sqft_living  21597 non-null   int64  
 6   sqft_lot     21597 non-null   int64  
 7   floors       21597 non-null   float64 
 8   waterfront   19221 non-null   object  
 9   view         21534 non-null   object  
 10  condition    21597 non-null   object  
 11  grade        21597 non-null   object  
 12  sqft_above   21597 non-null   int64  
 13  sqft_basement 21597 non-null   object  
 14  yr_built    21597 non-null   int64  
 15  yr_renovated 17755 non-null   float64 
 16  zipcode      21597 non-null   int64  
 17  lat          21597 non-null   float64 
 18  long         21597 non-null   float64 
 19  sqft_living15 21597 non-null   int64  
 20  sqft_lot15   21597 non-null   int64  
dtypes: datetime64[ns](1), float64(6), int64(9), object(5)
memory usage: 3.5+ MB
```

```
In [5]: # Checking the columns that exist in the data.

columns = list(kc_data.columns)
print(columns)
```

```
['id', 'date', 'price', 'bedrooms', 'bathrooms', 'sqft_living', 'sqft_lot', 'floors', 'waterfront',
'vew', 'condition', 'grade', 'sqft_above', 'sqft_basement', 'yr_built', 'yr_renovated', 'zipcode',
'lat', 'long', 'sqft_living15', 'sqft_lot15']
```

```
In [6]: kc_data.isnull().sum()
```

```
Out[6]: id          0
date        0
price       0
bedrooms    0
bathrooms   0
sqft_living 0
sqft_lot    0
```

```
floors          0
waterfront     2376
view           63
condition       0
grade           0
sqft_above      0
sqft_basement   0
yr_built        0
yr_renovated    3842
zipcode         0
lat             0
long            0
sqft_living15   0
sqft_lot15      0
dtype: int64
```

In [7]:

```
'''Visualizing the null values using heatmap. This allows me to see
the big picture of the data more clearly.'''
```

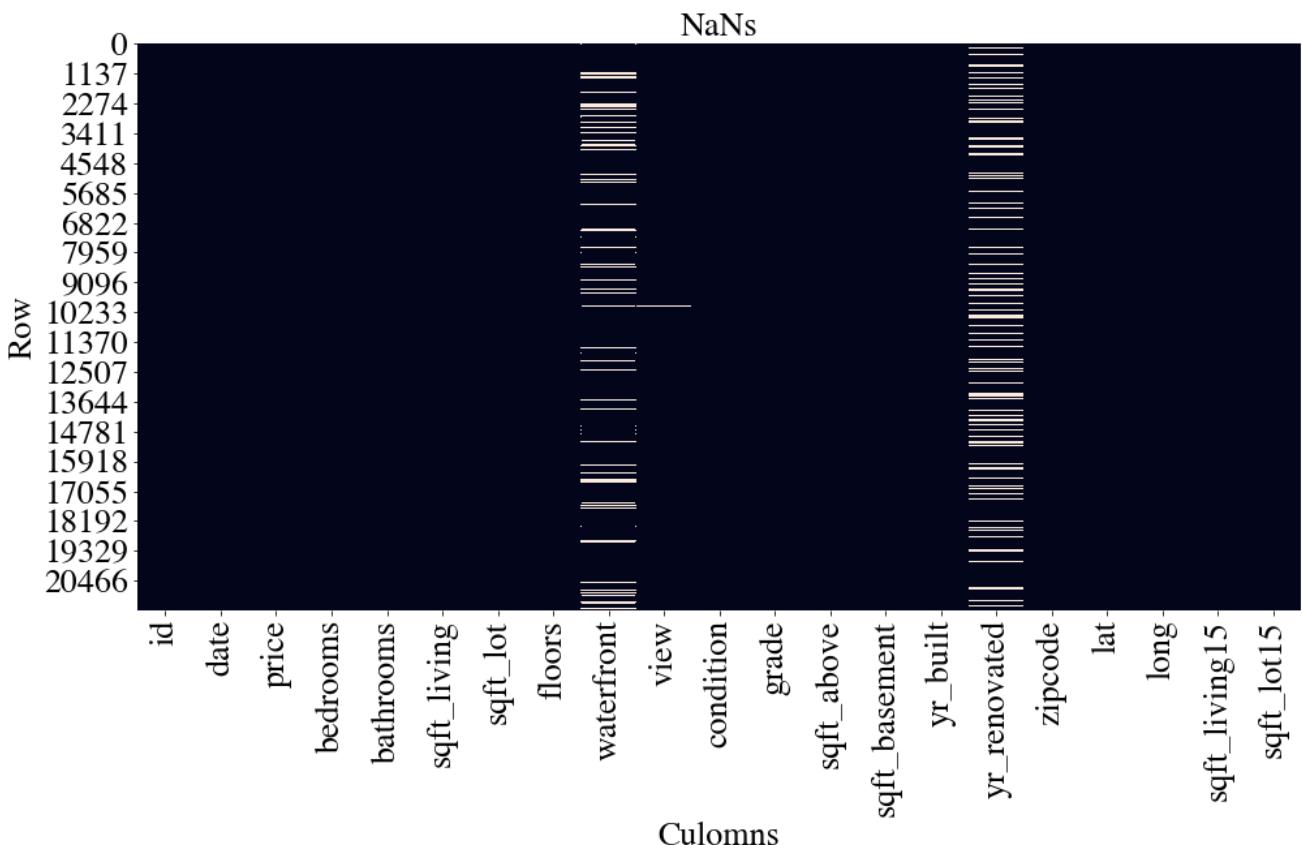
```
fig, ax = plt.subplots(figsize=(16,8))

plt.tick_params(labelsize=22)

sns.heatmap(kc_data.isnull(), cbar=False)

plt.title("NaNs", fontsize=26)
plt.xlabel('Culomns', fontsize=26)
plt.ylabel('Row', fontsize=26)
plt.tick_params(axis='both', which='major', labelsize=26)

plt.show()
```



Checking the percentage of null values to determined whether I can delete raws of the respective NaN values and not loose a significant amount of data.

In [8]:

```
percent_null = kc_data.isnull().sum() * 100 / len(kc_data)

missing_value_kc_data = pd.DataFrame({'column_name': kc_data.columns,
                                         'percent_missing': percent_null})
```

```
percent_null
```

```
Out[8]: id      0.000000
date     0.000000
price    0.000000
bedrooms 0.000000
bathrooms 0.000000
sqft_living 0.000000
sqft_lot   0.000000
floors    0.000000
waterfront 11.001528
view     0.291707
condition 0.000000
grade     0.000000
sqft_above 0.000000
sqft_basement 0.000000
yr_built   0.000000
yr_renovated 17.789508
zipcode   0.000000
lat       0.000000
long      0.000000
sqft_living15 0.000000
sqft_lot15  0.000000
dtype: float64
```

View column has a small number of null values, therefore we can remove the rows in which the view column appears as NaN.

```
In [9]: # Let's drop all the rows in which there is NaNs in the view column.
kc_data = kc_data.dropna(subset=['view'])
```

Year renovated and waterfront show a larger number of null values. I will replace the null with zero for the years renovated and then I will change it to the integer type of data.

```
In [10]: kc_data['yr_renovated'] = kc_data['yr_renovated'].fillna(0)
```

```
In [11]: kc_data['yr_renovated'] = kc_data['yr_renovated'].astype(int)
```

```
In [12]: kc_data['yr_renovated'].value_counts()
```

```
Out[12]: 0      20791
2014    73
2003    31
2013    31
2007    30
...
1946    1
1951    1
1948    1
1953    1
1976    1
Name: yr_renovated, Length: 70, dtype: int64
```

Examining waterfront, the percentage of the missing data is 11% and we will be left with 19,164 eateries. Therefore, I decided to clean it by removing the respective rows. There is a '?' in the data.

```
In [13]: kc_data.dropna(subset=['waterfront'], inplace=True)
```

```
In [14]: # We will run the is sum of null code again to see what's left.
kc_data.isnull().sum()
```

```
Out[14]: id      0
date     0
price    0
bedrooms 0
bathrooms 0
sqft_living 0
```

```

sqft_lot      0
floors        0
waterfront    0
view          0
condition     0
grade          0
sqft_above    0
sqft_basement 0
yr_built      0
yr_renovated  0
zipcode        0
lat            0
long           0
sqft_living15 0
sqft_lot15    0
dtype: int64

```

In [15]: `kc_data.info()`

```

<class 'pandas.core.frame.DataFrame'>
Int64Index: 19164 entries, 1 to 21596
Data columns (total 21 columns):
 #   Column      Non-Null Count  Dtype  
--- 
 0   id          19164 non-null   int64  
 1   date         19164 non-null   datetime64[ns]
 2   price        19164 non-null   float64 
 3   bedrooms     19164 non-null   int64  
 4   bathrooms    19164 non-null   float64 
 5   sqft_living  19164 non-null   int64  
 6   sqft_lot     19164 non-null   int64  
 7   floors        19164 non-null   float64 
 8   waterfront   19164 non-null   object  
 9   view          19164 non-null   object  
 10  condition    19164 non-null   object  
 11  grade         19164 non-null   object  
 12  sqft_above   19164 non-null   int64  
 13  sqft_basement 19164 non-null   object  
 14  yr_built     19164 non-null   int64  
 15  yr_renovated 19164 non-null   int64  
 16  zipcode       19164 non-null   int64  
 17  lat           19164 non-null   float64 
 18  long          19164 non-null   float64 
 19  sqft_living15 19164 non-null   int64  
 20  sqft_lot15   19164 non-null   int64  
dtypes: datetime64[ns](1), float64(5), int64(10), object(5)
memory usage: 3.2+ MB

```

The data type for `sqft_basement` is shown to be 'object' and is supposed to be an integer or float. Scanning the `sqft_basement` values to understand what values appear as objects.

In [16]: `# sqft_basement 21534 non-null object should be a number  
kc_data['sqft_basement'].unique()`

```

Out[16]: array(['400.0', '0.0', '910.0', '1530.0', '?', '730.0', '300.0', '970.0',
   '760.0', '720.0', '700.0', '820.0', '780.0', '790.0', '330.0',
   '1620.0', '360.0', '588.0', '1510.0', '410.0', '990.0', '600.0',
   '550.0', '1000.0', '1600.0', '1700.0', '500.0', '1040.0', '880.0',
   '1010.0', '240.0', '265.0', '290.0', '800.0', '540.0', '560.0',
   '840.0', '770.0', '570.0', '1490.0', '620.0', '1250.0', '1270.0',
   '120.0', '650.0', '180.0', '1130.0', '450.0', '1640.0', '1460.0',
   '1020.0', '1030.0', '750.0', '640.0', '1070.0', '490.0', '1310.0',
   '630.0', '2000.0', '390.0', '430.0', '210.0', '1950.0', '440.0',
   '220.0', '1160.0', '860.0', '580.0', '2060.0', '1820.0', '1180.0',
   '380.0', '200.0', '1150.0', '1200.0', '680.0', '1450.0', '1170.0',
   '1080.0', '960.0', '280.0', '870.0', '1100.0', '1400.0', '530.0',
   '660.0', '1220.0', '900.0', '420.0', '1580.0', '1380.0', '475.0',
   '690.0', '270.0', '350.0', '935.0', '710.0', '1370.0', '980.0',
   '850.0', '1470.0', '160.0', '950.0', '460.0', '50.0', '1900.0',
   '340.0', '470.0', '370.0', '140.0', '480.0', '1760.0', '130.0',
   '520.0', '890.0', '1110.0', '150.0', '1720.0', '810.0', '190.0',
   '1290.0', '670.0', '1800.0', '1120.0', '60.0', '1050.0', '940.0',
   '310.0', '930.0', '1390.0', '610.0', '1830.0', '1300.0', '510.0',
   '1590.0', '920.0', '1320.0', '1420.0', '1240.0', '1960.0',
   '1560.0', '2020.0', '1190.0', '2110.0', '1280.0', '250.0',
   '1230.0', '170.0', '1780.0', '830.0', '1330.0', '1410.0', '590.0',
   '1500.0', '1140.0', '260.0', '100.0', '320.0', '1480.0', '1260.0'],
   dtype='object')

```

```
'1284.0', '1670.0', '1350.0', '740.0', '2570.0', '1060.0',
'1090.0', '110.0', '2500.0', '90.0', '1940.0', '1550.0', '2350.0',
'2490.0', '1340.0', '1481.0', '1360.0', '1135.0', '1520.0',
'1850.0', '1660.0', '2130.0', '2600.0', '243.0', '1210.0',
'1024.0', '1798.0', '1610.0', '1440.0', '1690.0', '1570.0',
'1650.0', '1910.0', '1630.0', '2360.0', '1852.0', '2400.0',
'1790.0', '2150.0', '230.0', '70.0', '1430.0', '1680.0', '2100.0',
'3000.0', '1870.0', '1710.0', '2030.0', '875.0', '1540.0',
'2850.0', '2170.0', '506.0', '906.0', '145.0', '2040.0', '784.0',
'1750.0', '374.0', '518.0', '2720.0', '2730.0', '1840.0', '3480.0',
'1920.0', '2330.0', '1860.0', '2050.0', '4820.0', '1913.0', '80.0',
'2010.0', '3260.0', '2200.0', '415.0', '1730.0', '652.0', '2196.0',
'1930.0', '1810.0', '40.0', '2080.0', '2580.0', '1548.0', '1740.0',
'235.0', '861.0', '1890.0', '2220.0', '792.0', '2070.0', '4130.0',
'2090.0', '2250.0', '2240.0', '2160.0', '1990.0', '768.0', '515.0',
'2550.0', '435.0', '1008.0', '2300.0', '2610.0', '666.0', '3500.0',
'172.0', '2190.0', '1245.0', '1525.0', '1880.0', '862.0', '946.0',
'1281.0', '414.0', '276.0', '1248.0', '602.0', '516.0', '176.0',
'225.0', '266.0', '283.0', '2310.0', '10.0', '1770.0', '2120.0',
'295.0', '207.0', '915.0', '556.0', '417.0', '143.0', '508.0',
'2810.0', '20.0', '274.0', '248.0], dtype=object)
```

I will replace it and 0 with a NaN and then drop the respective rows to remove it from the data.

```
In [17]: kc_data['sqft_basement'].replace('?' and '0', np.nan, inplace = True)
```

```
In [18]: kc_data['sqft_basement'].replace('0.0', np.nan, inplace = True)
```

```
In [19]: kc_data['sqft_basement'].replace('?', np.nan, inplace = True)
```

```
In [20]: # Dropping NaNs from sqft_basement
kc_data.dropna(subset=['sqft_basement'], inplace = True)
```

```
In [21]: kc_data['sqft_basement'].unique()
```

```
Out[21]: array(['400.0', '910.0', '1530.0', '730.0', '300.0', '970.0', '760.0',
    '720.0', '700.0', '820.0', '780.0', '790.0', '330.0', '1620.0',
    '360.0', '588.0', '1510.0', '410.0', '990.0', '600.0', '550.0',
    '1000.0', '1600.0', '1700.0', '500.0', '1040.0', '880.0', '1010.0',
    '240.0', '265.0', '290.0', '800.0', '540.0', '560.0', '840.0',
    '770.0', '570.0', '1490.0', '620.0', '1250.0', '1270.0', '120.0',
    '650.0', '180.0', '1130.0', '450.0', '1640.0', '1460.0', '1020.0',
    '1030.0', '750.0', '640.0', '1070.0', '490.0', '1310.0', '630.0',
    '2000.0', '390.0', '430.0', '210.0', '1950.0', '440.0', '220.0',
    '1160.0', '860.0', '580.0', '2060.0', '1820.0', '1180.0', '380.0',
    '200.0', '1150.0', '1200.0', '680.0', '1450.0', '1170.0', '1080.0',
    '960.0', '280.0', '870.0', '1100.0', '1400.0', '530.0', '660.0',
    '1220.0', '900.0', '420.0', '1580.0', '1380.0', '475.0', '690.0',
    '270.0', '350.0', '935.0', '710.0', '1370.0', '980.0', '850.0',
    '1470.0', '160.0', '950.0', '460.0', '50.0', '1900.0', '340.0',
    '470.0', '370.0', '140.0', '480.0', '1760.0', '130.0', '520.0',
    '890.0', '1110.0', '150.0', '1720.0', '810.0', '190.0', '1290.0',
    '670.0', '1800.0', '1120.0', '60.0', '1050.0', '940.0', '310.0',
    '930.0', '1390.0', '610.0', '1830.0', '1300.0', '510.0', '1590.0',
    '920.0', '1320.0', '1420.0', '1240.0', '1960.0', '1560.0',
    '2020.0', '1190.0', '2110.0', '1280.0', '250.0', '1230.0', '170.0',
    '1780.0', '830.0', '1330.0', '1410.0', '590.0', '1500.0', '1140.0',
    '260.0', '100.0', '320.0', '1480.0', '1260.0', '1284.0', '1670.0',
    '1350.0', '740.0', '2570.0', '1060.0', '1090.0', '110.0', '2500.0',
    '90.0', '1940.0', '1550.0', '2350.0', '2490.0', '1340.0', '1481.0',
    '1360.0', '1135.0', '1520.0', '1850.0', '1660.0', '2130.0',
    '2600.0', '243.0', '1210.0', '1024.0', '1798.0', '1610.0',
    '1440.0', '1690.0', '1570.0', '1650.0', '1910.0', '1630.0',
    '2360.0', '1852.0', '2400.0', '1790.0', '2150.0', '230.0', '70.0',
    '1430.0', '1680.0', '2100.0', '3000.0', '1870.0', '1710.0',
    '2030.0', '1540.0', '1540.0', '2850.0', '2170.0', '506.0', '906.0',
    '145.0', '2040.0', '784.0', '1750.0', '374.0', '518.0', '2720.0',
    '2730.0', '1840.0', '3480.0', '1920.0', '2330.0', '1860.0',
    '2050.0', '4820.0', '1913.0', '80.0', '2010.0', '3260.0', '2200.0',
    '415.0', '1730.0', '652.0', '2196.0', '1930.0', '1810.0', '40.0',
    '2080.0', '2580.0', '1548.0', '1740.0', '235.0', '861.0', '1890.0'],
    dtype=object)
```

```
'2220.0', '792.0', '2070.0', '4130.0', '2090.0', '2250.0',
'2240.0', '2160.0', '1990.0', '768.0', '515.0', '2550.0', '435.0',
'1008.0', '2300.0', '2610.0', '666.0', '3500.0', '172.0', '2190.0',
'1245.0', '1525.0', '1880.0', '862.0', '946.0', '1281.0', '414.0',
'276.0', '1248.0', '602.0', '516.0', '176.0', '225.0', '266.0',
'283.0', '2310.0', '10.0', '1770.0', '2120.0', '295.0', '207.0',
'915.0', '556.0', '417.0', '143.0', '508.0', '2810.0', '20.0',
'274.0', '248.0'], dtype=object)
```

In [22]:

```
kc_data['sqft_basement'] = kc_data['sqft_basement'].str.split \
('.', n=1, expand = True)
```

In [23]:

```
kc_data['sqft_basement'] = kc_data['sqft_basement'].astype(int)
```

In [24]:

```
kc_data['grade'] = kc_data['grade'].astype(str)
```

In [25]:

```
kc_data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 7370 entries, 1 to 21591
Data columns (total 21 columns):
 #   Column           Non-Null Count  Dtype  
 ---  --  
 0    id               7370 non-null   int64  
 1    date              7370 non-null   datetime64[ns]
 2    price             7370 non-null   float64 
 3    bedrooms          7370 non-null   int64  
 4    bathrooms         7370 non-null   float64 
 5    sqft_living       7370 non-null   int64  
 6    sqft_lot          7370 non-null   int64  
 7    floors             7370 non-null   float64 
 8    waterfront        7370 non-null   object  
 9    view               7370 non-null   object  
 10   condition         7370 non-null   object  
 11   grade              7370 non-null   object  
 12   sqft_above         7370 non-null   int64  
 13   sqft_basement     7370 non-null   int64  
 14   yr_built           7370 non-null   int64  
 15   yr_renovated      7370 non-null   int64  
 16   zipcode            7370 non-null   int64  
 17   lat                7370 non-null   float64 
 18   long               7370 non-null   float64 
 19   sqft_living15      7370 non-null   int64  
 20   sqft_lot15         7370 non-null   int64  
dtypes: datetime64[ns](1), float64(5), int64(11), object(4)
memory usage: 1.2+ MB
```

In [26]:

```
kc_data.dropna(subset=['sqft_basement'], inplace = True)
```

In [27]:

```
# Double checking that the '?' was removed.
```

```
kc_data.sqft_basement.unique()
```

```
Out[27]: array([ 400,  910, 1530,  730,  300,  970,  760,  720,  700,  820,  780,
    790,  330, 1620,  360,  588, 1510,  410,  990,  600,  550, 1000,
   1600, 1700,  500, 1040,  880, 1010,  240,  265,  290,  800,  540,
   560,  840,  770,  570, 1490,  620, 1250, 1270, 120,  650, 180,
  1130,  450, 1640, 1460, 1020, 1030,  750,  640, 1070,  490, 1310,
   630, 2000,  390,  430,  210, 1950,  440,  220, 1160,  860,  580,
  2060, 1820, 1180,  380,  200, 1150, 1200,  680, 1450, 1170, 1080,
   960,  280,  870, 1100, 1400,  530,  660, 1220,  900,  420, 1580,
  1380,  475,  690,  270,  350,  935,  710, 1370,  980,  850, 1470,
   160,  950,  460,   50, 1900,  340,  470,  370,  140,  480, 1760,
   130,  520,  890, 1110,  150, 1720,  810,  190, 1290,  670, 1800,
  1120,   60, 1050,  940,  310,  930, 1390,  610, 1830, 1300,  510,
  1590,  920, 1320, 1420, 1240, 1960, 1560, 2020, 1190, 2110, 1280,
   250, 1230,  170, 1780,  830, 1330, 1410,  590, 1500, 1140,  260,
   100,  320, 1480, 1260, 1284, 1670, 1350,  740, 2570, 1060, 1090,
   110, 2500,   90, 1940, 1550, 2350, 2490, 1340, 1481, 1360, 1135,
  1520, 1850, 1660, 2130, 2600,  243, 1210, 1024, 1798, 1610, 1440,
```

```
1690, 1570, 1650, 1910, 1630, 2360, 1852, 2400, 1790, 2150, 230,
70, 1430, 1680, 2100, 3000, 1870, 1710, 2030, 875, 1540, 2850,
2170, 506, 906, 145, 2040, 784, 1750, 374, 518, 2720, 2730,
1840, 3480, 1920, 2330, 1860, 2050, 4820, 1913, 80, 2010, 3260,
2200, 415, 1730, 652, 2196, 1930, 1810, 40, 2080, 2580, 1548,
1740, 235, 861, 1890, 2220, 792, 2070, 4130, 2090, 2250, 2240,
2160, 1990, 768, 515, 2550, 435, 1008, 2300, 2610, 666, 3500,
172, 2190, 1245, 1525, 1880, 862, 946, 1281, 414, 276, 1248,
602, 516, 176, 225, 266, 283, 2310, 10, 1770, 2120, 295,
207, 915, 556, 417, 143, 508, 2810, 20, 274, 248])
```

In [28]:

```
'''Creating two new columns, 'month' and 'year' by extracting them
from the date column. This will help me detect any seasonality trends.'''
```

```
def extract_date(df,column):
    kc_data[column+"year"] = kc_data[column].apply(lambda x: x.year)
    kc_data[column+"_month"] = kc_data[column].apply(lambda x: x.month)
```

In [29]:

```
extract_date(kc_data, 'date')
```

In [30]:

```
kc_data.head()
```

Out[30]:

	<b>id</b>	<b>date</b>	<b>price</b>	<b>bedrooms</b>	<b>bathrooms</b>	<b>sqft_living</b>	<b>sqft_lot</b>	<b>floors</b>	<b>waterfront</b>	<b>view</b>	<b>...</b>	<b>sqft_baseme</b>
1	6414100192	2014-12-09	538000.0	3	2.25	2570	7242	2.0	NO	NONE	...	4
3	2487200875	2014-12-09	604000.0	4	3.00	1960	5000	1.0	NO	NONE	...	9
5	7237550310	2014-05-12	1230000.0	4	4.50	5420	101930	1.0	NO	NONE	...	15
8	2414600126	2015-04-15	229500.0	3	1.00	1780	7470	1.0	NO	NONE	...	7
11	9212900260	2014-05-27	468000.0	2	1.00	1160	6000	1.0	NO	NONE	...	3

5 rows × 23 columns

In [31]:

```
# dropping 'date' column since we do not need it anymore
kc_data.drop(['date'], axis=1, inplace=True)
```

In [32]:

```
# Using describe method to check for outliers.
```

```
kc_data.describe()
```

Out[32]:

	<b>id</b>	<b>price</b>	<b>bedrooms</b>	<b>bathrooms</b>	<b>sqft_living</b>	<b>sqft_lot</b>	<b>floors</b>	<b>sqft_above</b>
<b>count</b>	7.370000e+03	7.370000e+03	7370.000000	7370.000000	7370.000000	7370.000000	7370.000000	7370.000000
<b>mean</b>	4.608717e+09	6.236722e+05	3.558480	2.272693	2313.011805	13188.630665	1.324830	1573.544912
<b>std</b>	2.870696e+09	4.497373e+05	1.014971	0.777863	959.555858	30776.711805	0.479015	726.383103
<b>min</b>	2.800031e+06	1.000000e+05	1.000000	0.500000	680.000000	572.000000	1.000000	480.000000
<b>25%</b>	2.145425e+09	3.750000e+05	3.000000	1.750000	1680.000000	5000.000000	1.000000	1117.000000
<b>50%</b>	3.971701e+09	5.130000e+05	3.000000	2.250000	2100.000000	7520.000000	1.000000	1370.000000
<b>75%</b>	7.338402e+09	7.110000e+05	4.000000	2.750000	2700.000000	10660.750000	2.000000	1780.000000
<b>max</b>	9.900000e+09	7.700000e+06	33.000000	8.000000	13540.000000	871200.000000	3.500000	9410.000000

## Continuing Scrubbing

- There are some categorical variables such as: waterfront, view, condition, grade, yr\_built and zip code. I will handle these later on.
- The maximum square feet is 13,450 and the minimum is 680 which suggests widely distributed data.
- In the bedroom column the maximum number is 33 and this seems to be an outlier or perhaps even a place holder, so I will remove that data point below.

```
In [33]: # kc_data['bedrooms'].idxmax()
```

```
In [34]: # I will remove 33 in the bedrooms column given that it is an outlier
# and I will use the idxmax() method.
```

```
kc_data['bedrooms'] = kc_data['bedrooms'].drop(kc_data['bedrooms'].idxmax())
kc_data.describe()
```

	<b>id</b>	<b>price</b>	<b>bedrooms</b>	<b>bathrooms</b>	<b>sqft_living</b>	<b>sqft_lot</b>	<b>floors</b>	<b>sqft_above</b>
<b>count</b>	7.370000e+03	7.370000e+03	7369.000000	7370.000000	7370.000000	7370.000000	7370.000000	7370.000000
<b>mean</b>	4.608717e+09	6.236722e+05	3.554485	2.272693	2313.011805	13188.630665	1.324830	1573.544912
<b>std</b>	2.870696e+09	4.497373e+05	0.955325	0.777863	959.555858	30776.711805	0.479015	726.383103
<b>min</b>	2.800031e+06	1.000000e+05	1.000000	0.500000	680.000000	572.000000	1.000000	480.000000
<b>25%</b>	2.145425e+09	3.750000e+05	3.000000	1.750000	1680.000000	5000.000000	1.000000	1117.000000
<b>50%</b>	3.971701e+09	5.130000e+05	3.000000	2.250000	2100.000000	7520.000000	1.000000	1370.000000
<b>75%</b>	7.338402e+09	7.110000e+05	4.000000	2.750000	2700.000000	10660.750000	2.000000	1780.000000
<b>max</b>	9.900000e+09	7.700000e+06	11.000000	8.000000	13540.000000	871200.000000	3.500000	9410.000000

```
In [35]: # Confirming that there are no missing values.

missing_value_kc_data
```

	<b>column_name</b>	<b>percent_missing</b>
<b>id</b>	id	0.000000
<b>date</b>	date	0.000000
<b>price</b>	price	0.000000
<b>bedrooms</b>	bedrooms	0.000000
<b>bathrooms</b>	bathrooms	0.000000
<b>sqft_living</b>	sqft_living	0.000000
<b>sqft_lot</b>	sqft_lot	0.000000
<b>floors</b>	floors	0.000000
<b>waterfront</b>	waterfront	11.001528
<b>view</b>	view	0.291707
<b>condition</b>	condition	0.000000
<b>grade</b>	grade	0.000000
<b>sqft_above</b>	sqft_above	0.000000
<b>sqft_basement</b>	sqft_basement	0.000000
<b>yr_built</b>	yr_built	0.000000
<b>yr_renovated</b>	yr_renovated	17.789508
<b>zipcode</b>	zipcode	0.000000
<b>lat</b>	lat	0.000000
<b>long</b>	long	0.000000

column_name	percent_missing
sqft_living15	0.000000
sqft_lot15	0.000000

The data in both condition and view columns contain numbers and words in them. I will convert the data type to integer by replacing it with numbers, keeping the range of ranking.

In [36]: `kc_data['grade'].unique()`

Out[36]: `array(['7 Average', '11 Excellent', '9 Better', '8 Good', '5 Fair', '6 Low Average', '10 Very Good', '12 Luxury', '13 Mansion', '4 Low'], dtype=object)`

In [37]: `kc_data['grade'] = kc_data['grade'].str.extract(r'(\d+)', expand = True)  
kc_data['grade'].unique()`

Out[37]: `array(['7', '11', '9', '8', '5', '6', '10', '12', '13', '4'], dtype=object)`

In [38]: `kc_data['grade'] = kc_data['grade'].astype(int)`

In [39]: `# Setting up encoding by assigning an integer value for each unique category  
dic_cond = {'Poor' : 1, 'Fair' : 2, 'Average': 3, 'Good' : 4, 'Very Good': 5}  
dic_view = {'NONE':1, 'FAIR':2, 'AVERAGE':3, 'GOOD':4, 'EXCELLENT':5}  
#dic_waterfront ={'NO':0, 'YES':1}  
kc_data['condition'] = kc_data['condition'].map(dic_cond)  
kc_data['view'] = kc_data['view'].map(dic_view)  
#kc_data['waterfront'] = kc_data['waterfront'].map(dic_waterfront)  
kc_data.head()`

Out[39]:

	id	price	bedrooms	bathrooms	sqft_living	sqft_lot	floors	waterfront	view	condition	...	sqft_base
1	6414100192	538000.0	3.0	2.25	2570	7242	2.0	NO	1	3	...	
3	2487200875	604000.0	4.0	3.00	1960	5000	1.0	NO	1	5	...	
5	7237550310	1230000.0	4.0	4.50	5420	101930	1.0	NO	1	3	...	
8	2414600126	229500.0	3.0	1.00	1780	7470	1.0	NO	1	3	...	
11	9212900260	468000.0	2.0	1.00	1160	6000	1.0	NO	1	4	...	

5 rows × 22 columns

In [40]: `kc_data.info()`

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 7370 entries, 1 to 21591
Data columns (total 22 columns):
 #   Column      Non-Null Count  Dtype  
--- 
 0   id          7370 non-null   int64  
 1   price        7370 non-null   float64 
 2   bedrooms     7369 non-null   float64 
 3   bathrooms    7370 non-null   float64 
 4   sqft_living  7370 non-null   int64  
 5   sqft_lot     7370 non-null   int64  
 6   floors       7370 non-null   float64 
 7   waterfront   7370 non-null   object  
 8   view         7370 non-null   int64  
 9   condition    7370 non-null   int64  
 10  grade        7370 non-null   int64  
 11  sqft_above   7370 non-null   int64  
 12  sqft_basement 7370 non-null   int64  
 13  yr_built    7370 non-null   int64  
 14  yr_renovated 7370 non-null   int64  
 15  zipcode      7370 non-null   int64  
 16  lat          7370 non-null   float64
```

```

17  long           7370 non-null   float64
18  sqft_living15 7370 non-null   int64
19  sqft_lot15    7370 non-null   int64
20  dateyear       7370 non-null   int64
21  date_month     7370 non-null   int64
dtypes: float64(6), int64(15), object(1)
memory usage: 1.5+ MB

```

In [41]: `kc_data.head()`

	<code>id</code>	<code>price</code>	<code>bedrooms</code>	<code>bathrooms</code>	<code>sqft_living</code>	<code>sqft_lot</code>	<code>floors</code>	<code>waterfront</code>	<code>view</code>	<code>condition</code>	...	<code>sqft_base</code>
<b>1</b>	6414100192	538000.0	3.0	2.25	2570	7242	2.0	NO	1	3	...	
<b>3</b>	2487200875	604000.0	4.0	3.00	1960	5000	1.0	NO	1	5	...	
<b>5</b>	7237550310	1230000.0	4.0	4.50	5420	101930	1.0	NO	1	3	...	
<b>8</b>	2414600126	229500.0	3.0	1.00	1780	7470	1.0	NO	1	3	...	
<b>11</b>	9212900260	468000.0	2.0	1.00	1160	6000	1.0	NO	1	4	...	

5 rows × 22 columns

## Exploratory Data Analysis

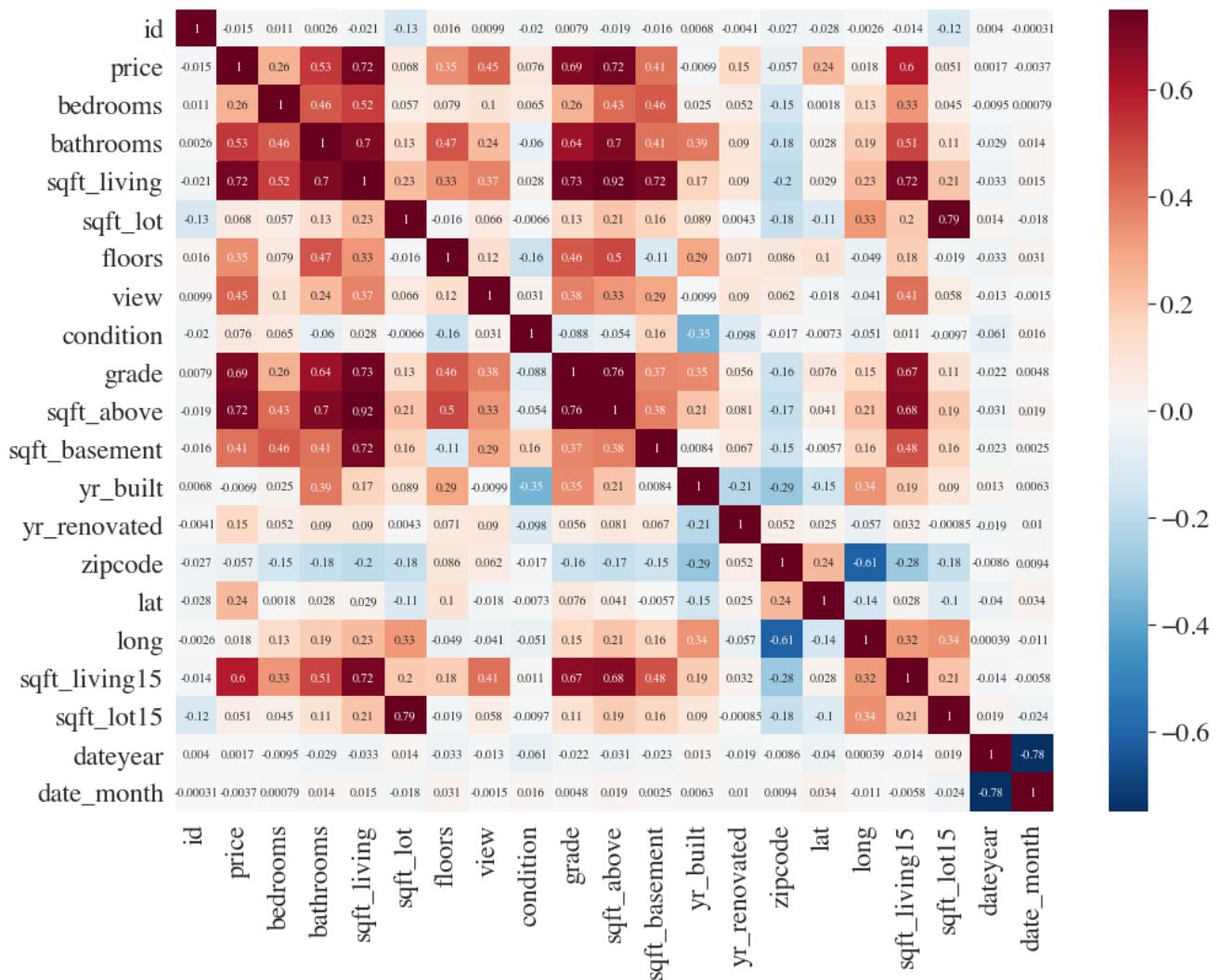
### Correlation

```

In [42]: corr = kc_data.corr()
plt.figure(figsize=(16, 12))
sns.set(font_scale=2)
sns.set_context(fontfamily="times")
heatmap = sns.heatmap(corr, annot=True, linewidths=0, vmin=-0.75,
                      vmax=0.75, cmap="RdBu_r")

```

## King County Data Analysis\_FV



In our data, I encountered 45 houses that were resold in 2014 and 2015. The majority of these were resold for a higher price. The grade or condition of the houses did not change, but the resale took place in a different time of the year.

In [43]:

```
# Creating a new database for the duplicate (resale) data
kc_data_duplicate = kc_data[kc_data.duplicated(subset=['id'], keep=False)]
kc_data_duplicate.head()
```

Out[43]:

	id	price	bedrooms	bathrooms	sqft_living	sqft_lot	floors	waterfront	view	condition	...	sqft_b...
93	6021501535	430000.0	3.0	1.50	1580	5000	1.0	NO	1	3	...	
94	6021501535	700000.0	3.0	1.50	1580	5000	1.0	NO	1	3	...	
313	4139480200	1380000.0	4.0	3.25	4290	12103	1.0	NO	4	3	...	
314	4139480200	1400000.0	4.0	3.25	4290	12103	1.0	NO	4	3	...	
1084	9834200885	360000.0	4.0	2.50	2080	4080	1.0	NO	1	5	...	

5 rows × 22 columns

In [44]:

```
# Extracting only the necessary columns
kc_data_duplicate = kc_data_duplicate[['id', 'date_month', 'price',
                                         'grade', 'condition']]
kc_data_duplicate
```

Out[44]:

	id	date_month	price	grade	condition
93	6021501535	7	430000.0	8	3
94	6021501535	12	700000.0	8	3

		<b>id</b>	<b>date_month</b>	<b>price</b>	<b>grade</b>	<b>condition</b>	
		<b>313</b>	4139480200	6	1380000.0	11	3
		<b>314</b>	4139480200	12	1400000.0	11	3
		<b>1084</b>	9834200885	7	360000.0	7	5
		...	...	...	...	...	
		<b>18689</b>	3558900590	3	692500.0	7	3
		<b>18976</b>	7856400300	7	1410000.0	10	5
		<b>18977</b>	7856400300	3	1510000.0	10	5
		<b>19536</b>	643300040	11	481000.0	7	4
		<b>19537</b>	643300040	3	719521.0	7	4

90 rows × 5 columns

```
In [45]: '''Creating a new data frame in which I only include the duplicate data.
Consolidating it using group by 'id' where one raw represents one house
that was sold and then re-sold at a later point.'''
kc_group_id = kc_data_dubllicate.set_index(['id', kc_data_dubllicate.groupby('id')
    .cumcount()])[['price','date_month','grade','condition']].unstack().add_prefix('price').reset_index()
```

```
In [46]: kc_group_id.head()
```

```
Out[46]:
```

	<b>id</b>	<b>priceprice</b>	<b>pricedate_month</b>	<b>pricegrade</b>	<b>pricecondition</b>				
		<b>price0</b>	<b>price1</b>	<b>price0</b>	<b>price1</b>	<b>price0</b>	<b>price1</b>	<b>price0</b>	<b>price1</b>
<b>0</b>	526059224	260000.0	470000.0	9	2	7	7	3	3
<b>1</b>	641900050	335000.0	499950.0	8	2	7	7	3	3
<b>2</b>	643300040	481000.0	719521.0	11	3	7	7	4	4
<b>3</b>	1139600270	300000.0	310000.0	7	3	8	8	3	3
<b>4</b>	1217000340	185000.0	340000.0	6	2	7	7	4	4

```
In [47]: kc_group_id.columns
```

```
Out[47]: MultiIndex([( ('id', ''),
    ('priceprice', 'price0'),
    ('priceprice', 'price1'),
    ('pricedate_month', 'price0'),
    ('pricedate_month', 'price1'),
    ('pricegrade', 'price0'),
    ('pricegrade', 'price1'),
    ('pricecondition', 'price0'),
    ('pricecondition', 'price1'))], )
```

```
In [48]: # It turns into ta multi-inex dataframe -
# I will remove the layer by using droplevel()
kc_group_id.columns = kc_group_id.columns.droplevel(level=0)
```

```
In [49]: # Generating a list of numerizing the houses.
myList = list(range(1, 46))
```

```
In [50]: kc_group_id['home_no.'] = myList
kc_group_id.head()
```

```
Out[50]:
```

	<b>price0</b>	<b>price1</b>	<b>price0</b>	<b>price1</b>	<b>price0</b>	<b>price1</b>	<b>price0</b>	<b>price1</b>	<b>home_no.</b>
--	---------------	---------------	---------------	---------------	---------------	---------------	---------------	---------------	-----------------

	price0	price1	price0	price1	price0	price1	price0	price1	home_no.
0	526059224	260000.0	470000.0	9	2	7	7	3	1
1	641900050	335000.0	499950.0	8	2	7	7	3	2
2	643300040	481000.0	719521.0	11	3	7	7	4	3
3	1139600270	300000.0	310000.0	7	3	8	8	3	4
4	1217000340	185000.0	340000.0	6	2	7	7	4	5

In [51]:

```
# Changing column names to clarify.

kc_group_id.columns.values[0] = 'id'
kc_group_id.columns.values[1] = 'price_1'
kc_group_id.columns.values[2] = 'price_2'
kc_group_id.columns.values[3] = 'month_1'
kc_group_id.columns.values[4] = 'month_2'
kc_group_id.columns.values[5] = 'grade_1'
kc_group_id.columns.values[6] = 'grade_2'
kc_group_id.columns.values[5] = 'cond_1'
kc_group_id.columns.values[6] = 'cond_2'
```

In [52]:

```
# Creating a new data frame where home_no. is the index.
buy_sell = pd.DataFrame(kc_group_id['home_no.'].index)
```

In [53]:

```
marks = buy_sell # setting x-ticks

x = np.arange(len(marks)) # the label locations

# set the plot, format, and labels

fig, ax = plt.subplots(figsize=(19,12))
bar_width = 0.3
ax1 = ax.bar(x - bar_width / 2,
              kc_group_id['price_1'].values,
              width = 0.45,
              color = '#666699',
              label='price 1')
ax2 = ax.bar(x + bar_width / 2,
              kc_group_id['price_2'].values,
              width = 0.45,
              color = '#CCAA33',
              label='price 2')
#ax.yaxis.set_major_formatter(currency) #CCAA33
plt.ylim(0,2000000)

plt.tick_params(labelsize=22)

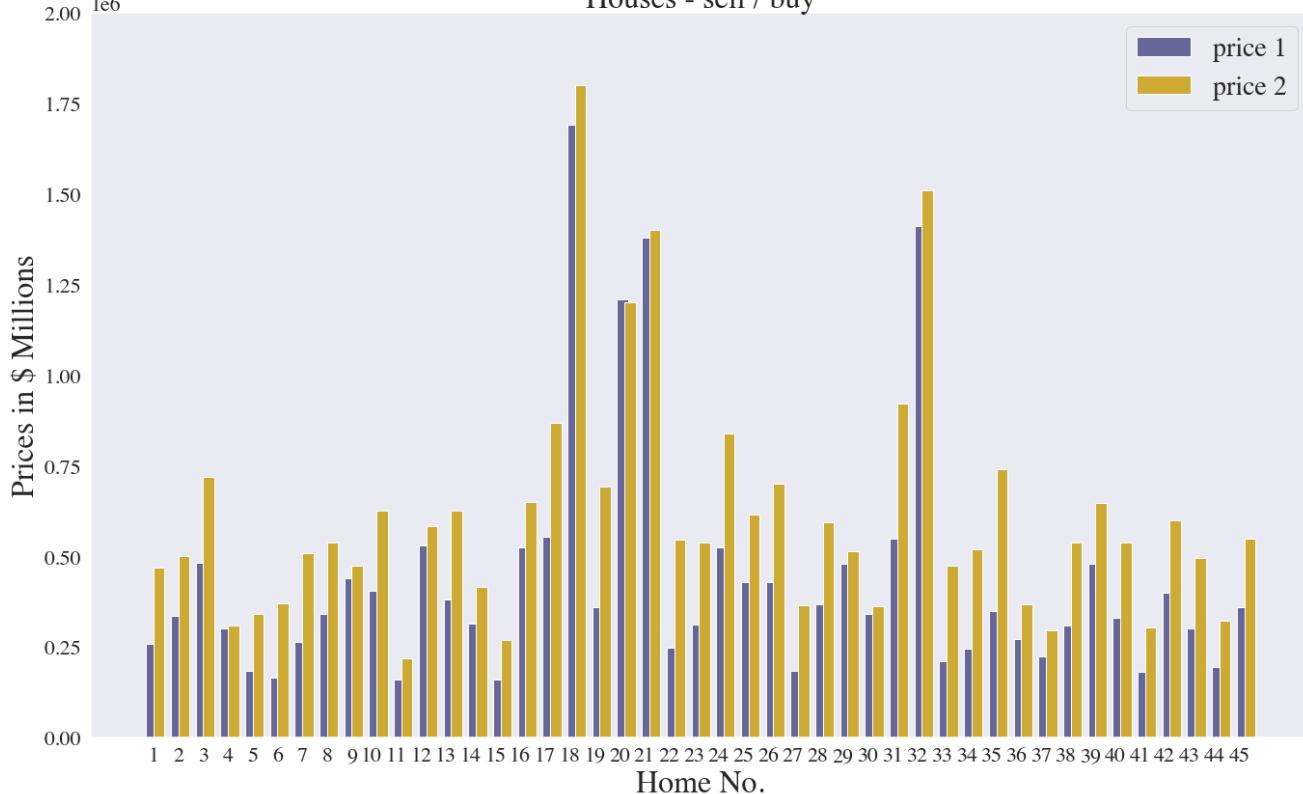
ax.set_xticks(x + bar_width / 2)
ax.set_xticklabels(kc_group_id['home_no.'].unique())

plt.setp(ax.get_xticklabels(), rotation=0, ha='right')
# cite: https://www.pythonguides.com/matplotlib-x-axis-label/

ax.grid(color='#AF3150', linestyle='-', linewidth=0.1)
ax.set_xlabel('Home No.', fontsize = 32)
ax.set_ylabel('Prices in $ Millions', fontsize = 32)
# Add title and legends

ax.set_title('Houses - sell / buy', fontsize = 32)
ax.legend(loc="upper right", frameon=True, fontsize=28)
# format the layout and display the visualization
fig.tight_layout()
plt.show()
```

## Houses - sell / buy



In [54]:

```
# Creating a column that captures the difference of the price
# differences(gross profit).

kc_group_id['price_diff'] = kc_group_id['price_2'] - kc_group_id['price_1']
```

In [55]:

```
# Looking tinto the new dataset
kc_group_id.head()
```

Out[55]:

	id	price_1	price_2	month_1	month_2	cond_1	cond_2	price0	price1	home_no.	price_diff
0	526059224	260000.0	470000.0	9	2	7	7	3	3	1	210000.0
1	641900050	335000.0	499950.0	8	2	7	7	3	3	2	164950.0
2	643300040	481000.0	719521.0	11	3	7	7	4	4	3	238521.0
3	1139600270	300000.0	310000.0	7	3	8	8	3	3	4	10000.0
4	1217000340	185000.0	340000.0	6	2	7	7	4	4	5	155000.0

In [56]:

```
# Creating a new data set using groupby of the month when
# the home was sold
group_month = kc_group_id.groupby(['month_2']).mean()
group_month = pd.DataFrame.reset_index(group_month)

group_month.head()
```

Out[56]:

	month_2	id	price_1	price_2	month_1	cond_1	cond_2	price0	price1	home_no
0	1	5.286512e+09	361483.000000	553625.000000	6.250000	7.000000	7.000000	3.500000	3.500000	25.00000
1	2	4.510416e+09	299475.363636	483804.545455	8.181818	7.272727	7.272727	3.272727	3.272727	20.90909
2	3	4.853603e+09	494596.666667	684534.733333	7.866667	7.400000	7.400000	3.333333	3.333333	21.46666
3	4	6.686515e+09	391100.000000	531714.285714	9.285714	7.428571	7.428571	3.285714	3.285714	31.28571
4	5	2.766601e+09	255500.000000	528470.000000	9.000000	6.500000	6.500000	3.000000	3.000000	14.50000

```
In [57]: # Creating a function that has bars with range of colors - darker from
# tightest and lighter to the lowest.
def colors_from_values(values: pd.Series, palette_name:str, ascending=True):
    values = values.sort_values(ascending=ascending).reset_index()
    indices = values.sort_values(by=values.columns[0]).index
    palette = sns.color_palette(palette_name, len(values))
    return np.array(palette).take(indices, axis=0)

s = group_month[ "price_diff"]
#s2 = total_group_month[ "price"]
```

```
In [58]: # Plot bar displaying the months of the release day and
#making the darkest color to be the highest.

fig, ax = plt.subplots(figsize=(16, 8))

# Create plot here with sns.

sns.barplot(x="month_2", y="price_diff", data=group_month,
            palette=colors_from_values(s, "Blues_d"))

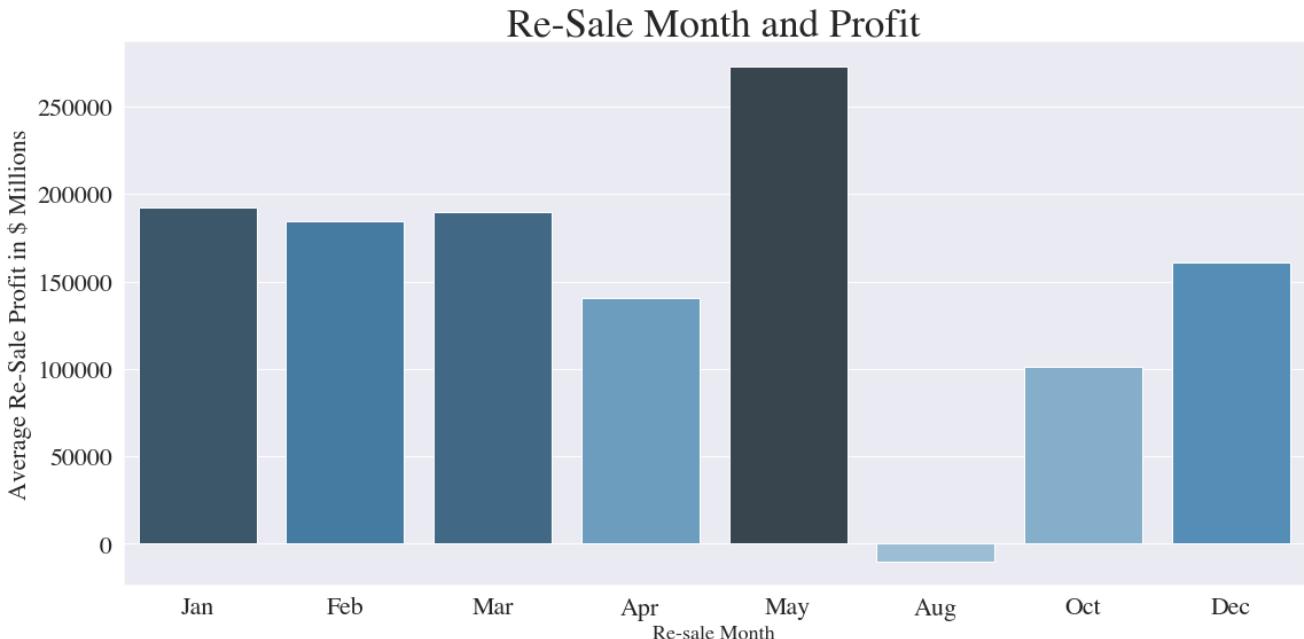
# Label and define fontsize for main and axis titles.

plt.xlabel('Re-sale Month', fontsize=18)
plt.ylabel('Average Re-Sale Profit in $ Millions', fontsize=22)
plt.title('Re-Sale Month and Profit', fontsize=35)
plt.tick_params(axis='both', which='major', labelsize=22)

# Set x-axis tick labels.

ax.set_xticklabels(['Jan', 'Feb', 'Mar', 'Apr', 'May', 'Aug', 'Oct', 'Dec'])

plt.tight_layout()
plt.show()
```



The resale price was highest during the month of May, followed by January and March. In the summer, there were no resales, and those that did take place (August) lost money. This suggests that the timing of the sale makes a difference.

## Where houses hold most value?

### Zipcode

In [59]:

```
''' will group the zipcodes by price and check their mean
so that I could see if there is any pattern of the prices '''
group_zipcode = kc_data.groupby(['zipcode'])['price'].mean()
```

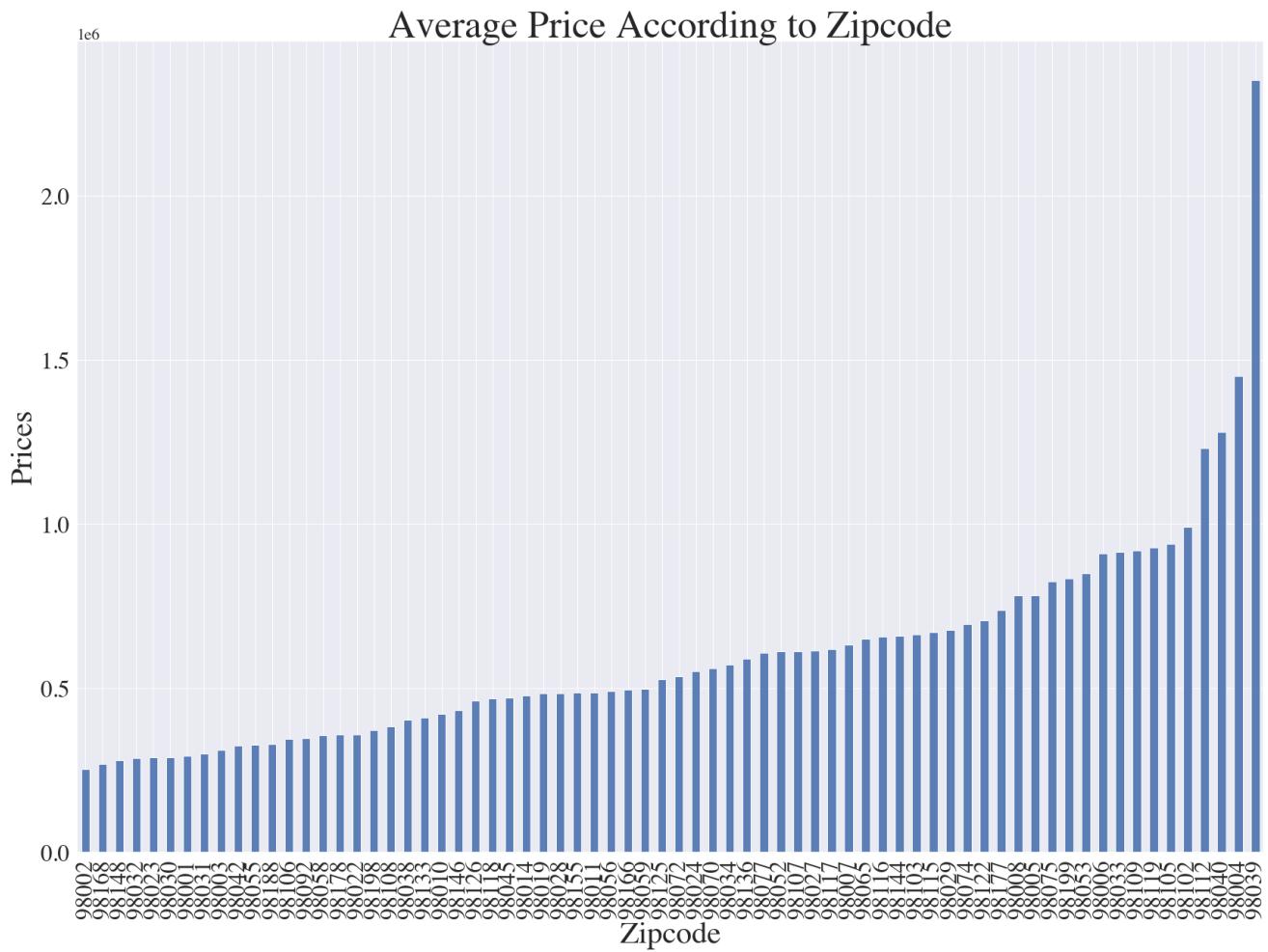
In [60]:

```
# Let's view the data with a sorted value

plt.figure(figsize=(8, 8))
sns.set_context(fontfamily="times")
group_zipcode = group_zipcode.sort_values()
group_zipcode.plot(kind='bar',x='zipcode',y='price',align='center',
                    alpha=0.9,figsize=(24,18))
# the plot gets saved to 'output.png'

plt.title('Average Price According to Zipcode', fontsize=52)
plt.xticks(rotation = 90,fontsize=32)
plt.yticks(rotation = 0,fontsize=32)
plt.xlabel('Zipcode', fontsize=42)
plt.ylabel('Prices', fontsize=42)
plt.tight_layout()

plt.show()
plt.savefig('output.png')
```



&lt;Figure size 432x288 with 0 Axes&gt;

In [61]:

```
# Creating a new dataset for the top 5% zipcodes
top5p = kc_data.sort_values(by= 'zipcode', ascending = False).head(368)
top5p.head()
```

Out[61]:

	id	price	bedrooms	bathrooms	sqft_living	sqft_lot	floors	waterfront	view	condition	...	sqft_l
3153	6821100195	830000.0	4.0	3.00	2020	6000	1.0	NO	1	3	...	

	<b>id</b>	<b>price</b>	<b>bedrooms</b>	<b>bathrooms</b>	<b>sqft_living</b>	<b>sqft_lot</b>	<b>floors</b>	<b>waterfront</b>	<b>view</b>	<b>condition</b>	...	<b>sqft_l</b>
	<b>8678</b>	6822100750	700000.0	3.0	1.75	1500	6000	1.0	NO	1	5	...
	<b>19452</b>	3271800870	1230000.0	4.0	2.25	2020	5800	1.0	NO	4	4	...
	<b>3110</b>	5035300750	850000.0	3.0	1.75	2450	8603	1.0	NO	1	5	...
	<b>3119</b>	3271800850	765000.0	3.0	1.75	2440	5800	1.0	NO	4	4	...

5 rows × 22 columns

In [62]:

```
# Creating a new dataset for the top 20% zipcodes
top20p = kc_data.sort_values(by= 'price', ascending = False).head(1474)
top20p.head()
```

Out[62]:

	<b>id</b>	<b>price</b>	<b>bedrooms</b>	<b>bathrooms</b>	<b>sqft_living</b>	<b>sqft_lot</b>	<b>floors</b>	<b>waterfront</b>	<b>view</b>	<b>condition</b>	...	<b>sqft_b</b>
	<b>7245</b>	6762700020	7700000.0	6.0	8.00	12050	27600	2.5	NO	4	4	...
	<b>3910</b>	9808700762	7060000.0	5.0	4.50	10040	37325	2.0	YES	3	3	...
	<b>9245</b>	9208900037	6890000.0	6.0	7.75	9890	31374	2.0	NO	5	3	...
	<b>4407</b>	2470100110	5570000.0	5.0	5.75	9200	35069	2.0	NO	1	3	...
	<b>1446</b>	8907500070	5350000.0	5.0	5.00	8000	23985	2.0	NO	5	3	...

5 rows × 22 columns

Looking into any 20 % of the most expensive houses with their respective latitude, longitude. Houses seem to be scattered around with high prices being less frequent while the majority of the houses are below \$2 million.

In [63]:

```
# Creating a new dataset for the top 20% and mapping out latitude and longitude
top20p_long_lat = top20p[['lat', 'long']]
top20p_long_lat
```

Out[63]:

	<b>lat</b>	<b>long</b>
	<b>7245</b>	47.6298 -122.323
	<b>3910</b>	47.6500 -122.214
	<b>9245</b>	47.6305 -122.240
	<b>4407</b>	47.6289 -122.233
	<b>1446</b>	47.6232 -122.220
	...	...
	<b>13392</b>	47.6853 -122.305
	<b>16371</b>	47.6296 -122.205
	<b>3145</b>	47.7027 -122.282
	<b>19693</b>	47.6214 -122.062
	<b>1604</b>	47.4961 -122.063

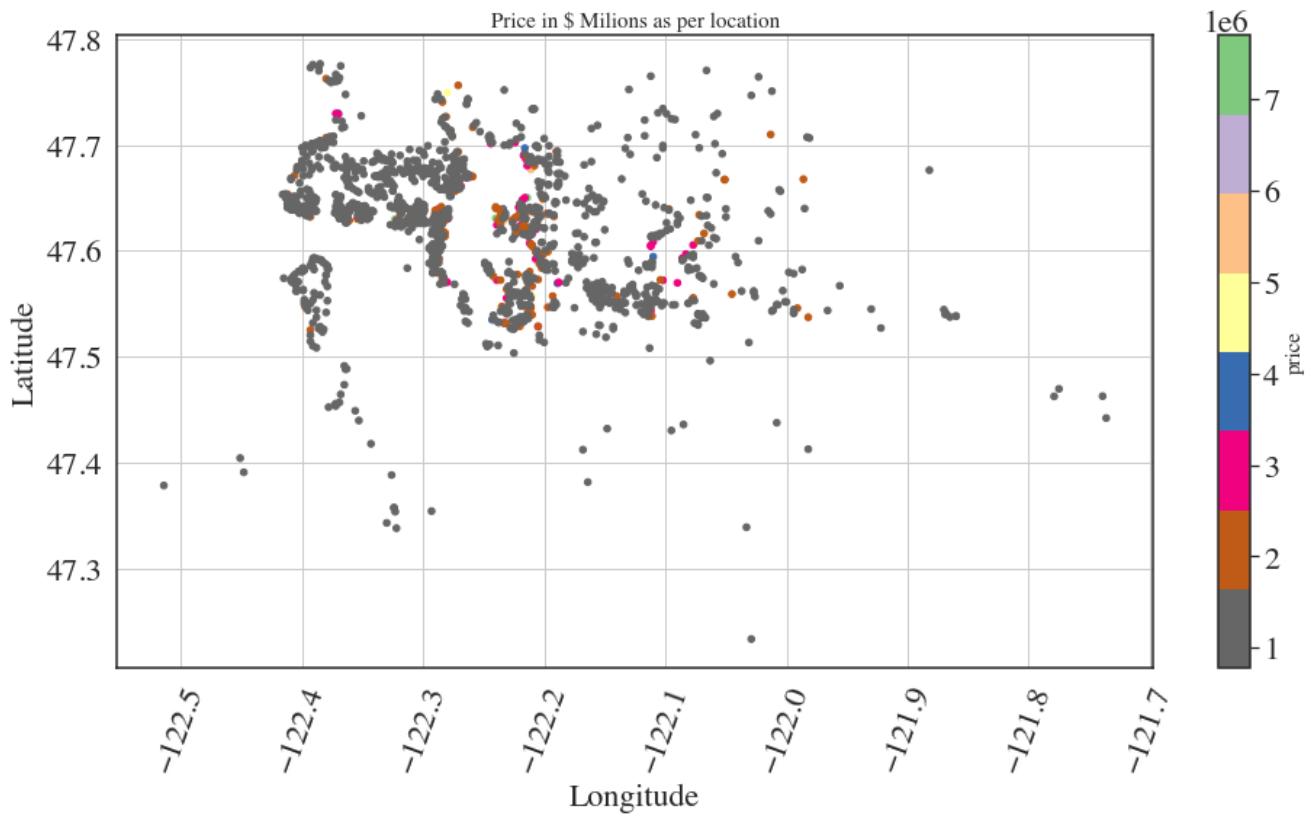
1474 rows × 2 columns

In [64]:

```
plt.style.use("seaborn-ticks")
sns.set_context(fontfamily="times")
top20p.plot(kind="scatter", x="long", y="lat", figsize=(16, 8), c="price",
            cmap="Accent_r", colorbar=True, sharex=False)

plt.xticks(rotation = 70)
plt.grid(which='both')
plt.title('Price in $ Millions as per location')
```

```
plt.xlabel('Longitude', fontsize=22)
plt.ylabel('Latitude', fontsize=22)
plt.savefig('output.png')
plt.show()
```



```
In [65]: # I will group the zipcodes and check their mean so that
# I could see if there is any pattern of the prices
group_zipcode = top20p.groupby(['zipcode'])['price'].mean()
group_zipcode.head()
```

```
Out[65]: zipcode
98001    8.500000e+05
98003    8.100000e+05
98004    1.606250e+06
98005    9.391482e+05
98006    1.216673e+06
Name: price, dtype: float64
```

Extracting top and bottom 20 % of the most expensive houses with their respective latitude, longitude, and zip codes.

```
In [66]: zipcode = top20p.groupby('zipcode', as_index = False)
zipcode
```

```
Out[66]: <pandas.core.groupby.generic.DataFrameGroupBy object at 0x7fc838533610>
```

```
In [67]: # Let's view the data with a sorted value
plt.figure(figsize=(12, 8))
sns.set(font_scale=2)
sns.set_context(fontfamily="times")

group_zipcode = group_zipcode.sort_values()
group_zipcode.plot(kind='bar', x='zipcode', y='price', align='center',
                    alpha=0.8, figsize=(20, 20))
# the plot gets saved to 'output.png'

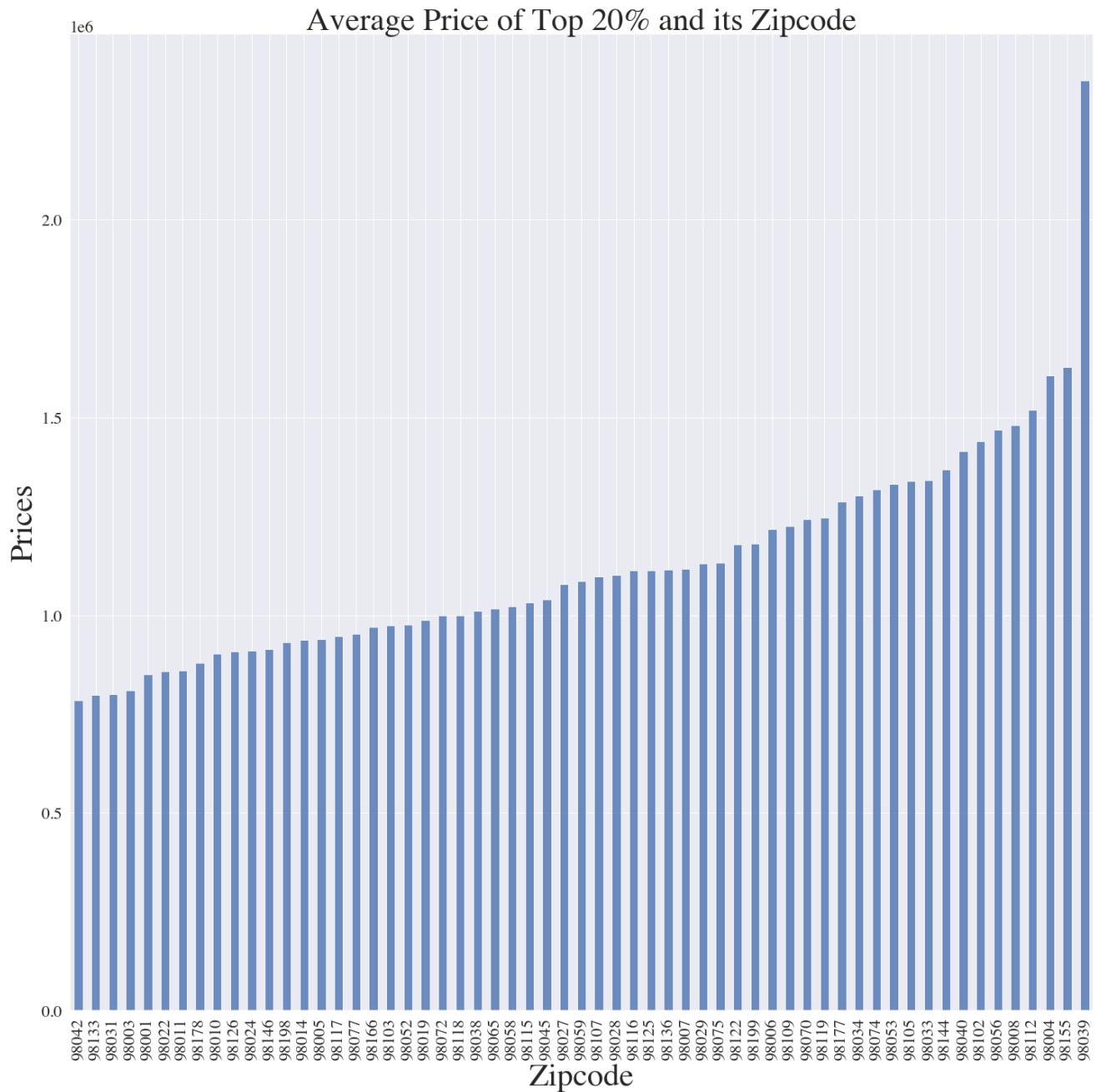
plt.title('Average Price of Top 20% and its Zipcode', fontsize=42)
```

```

plt.xticks(rotation = 90)
plt.xlabel('zipcode', fontsize=42)
plt.ylabel('Prices', fontsize=42)
plt.tight_layout()

plt.show()
plt.savefig('output.png')

```



&lt;Figure size 432x288 with 0 Axes&gt;

In [68]:

```

# Creating a new dataset for the bottom 20%
bottom20p = kc_data.sort_values(by= 'price', ascending = False).tail(368)
bottom20p

```

Out[68]:

	id	price	bedrooms	bathrooms	sqft_living	sqft_lot	floors	waterfront	view	condition	...	sqft_b
<b>9430</b>	4302201085	248000.0	3.0	1.00	1470	7680	1.0	NO	1	3	...	
<b>1619</b>	1310500550	248000.0	4.0	2.25	2320	8760	1.0	NO	1	4	...	
<b>8412</b>	2172000846	248000.0	4.0	2.00	2080	13510	1.0	NO	1	3	...	
<b>4834</b>	5151600480	248000.0	3.0	1.75	1840	19501	1.0	NO	1	4	...	

	<b>id</b>	<b>price</b>	<b>bedrooms</b>	<b>bathrooms</b>	<b>sqft_living</b>	<b>sqft_lot</b>	<b>floors</b>	<b>waterfront</b>	<b>view</b>	<b>condition</b>	<b>...</b>	<b>sqft_b</b>
<b>4295</b>	2122059160	248000.0	5.0	1.75	2190	16788	1.0	NO	3	3	...	
...	...	...	...	...	...	...	...	...	...	...	...	...
<b>12729</b>	5560000650	135000.0	3.0	1.00	1520	8450	1.0	NO	1	2	...	
<b>10376</b>	3361402041	134000.0	3.0	1.00	1270	8508	1.0	NO	1	4	...	
<b>3686</b>	6303401050	132500.0	3.0	0.75	850	8573	1.0	NO	1	3	...	
<b>3481</b>	3352402250	119900.0	2.0	1.00	700	3180	1.0	NO	1	3	...	
<b>5634</b>	7224000980	100000.0	4.0	1.00	1120	2685	1.0	NO	1	3	...	

368 rows × 22 columns

In [69]:

```
# Grouping the bottom 20 % by zipcode
group_zipcode_b = bottom20p.groupby(['zipcode'])['price'].mean()
group_zipcode_b.head()
```

Out[69]:

```
zipcode
98001    213632.521739
98002    218162.500000
98003    223143.518519
98006    247500.000000
98010    200000.000000
Name: price, dtype: float64
```

In [70]:

```
# Grouping the bottom 20 % by zipcode
zipcode_b = bottom20p.groupby('zipcode', as_index = False)
zipcode_b.head()
```

Out[70]:

	<b>id</b>	<b>price</b>	<b>bedrooms</b>	<b>bathrooms</b>	<b>sqft_living</b>	<b>sqft_lot</b>	<b>floors</b>	<b>waterfront</b>	<b>view</b>	<b>condition</b>	<b>...</b>	<b>sqft_b</b>
<b>9430</b>	4302201085	248000.0	3.0	1.00	1470	7680	1.0	NO	1	3	...	
<b>1619</b>	1310500550	248000.0	4.0	2.25	2320	8760	1.0	NO	1	4	...	
<b>8412</b>	2172000846	248000.0	4.0	2.00	2080	13510	1.0	NO	1	3	...	
<b>4834</b>	5151600480	248000.0	3.0	1.75	1840	19501	1.0	NO	1	4	...	
<b>4295</b>	2122059160	248000.0	5.0	1.75	2190	16788	1.0	NO	3	3	...	
...	...	...	...	...	...	...	...	...	...	...	...	...
<b>2350</b>	7229700105	172500.0	2.0	2.00	1510	20685	1.0	NO	1	2	...	
<b>19547</b>	42000245	171000.0	4.0	2.00	1520	19672	1.0	NO	1	3	...	
<b>9865</b>	1219000473	164950.0	3.0	1.75	1570	15330	1.0	NO	1	3	...	
<b>8716</b>	7883603425	155000.0	3.0	1.00	1250	6250	1.0	NO	1	2	...	
<b>5811</b>	7568700480	153000.0	2.0	1.00	1140	10152	1.0	NO	1	3	...	

135 rows × 22 columns

In [71]:

```
# Comparing the data of the two top and bottom 20%
sns.set(font_scale=3)
plt.figure(2, figsize=(8,8))

# plt.figure(figsize=(18, 12))
isns.set_context(fontfamily="times")
plt.subplot(1,2,1) # two subplots
#sns.histplot(data=waterfront_non, kde=True)
group_zipcode_b = group_zipcode_b.sort_values()
group_zipcode_b.plot(kind='bar',x='zipcode',y='price',
                     alpha=0.5,figsize=(22,12))
# the plot gets saved to 'output.png'
```

```
#sns.set(font="Garamond")
# plt.axvline(np.median(waterfront_non), color='b', linestyle='--')

#m = np.mean(waterfront_non)
#m = round(m, 2)

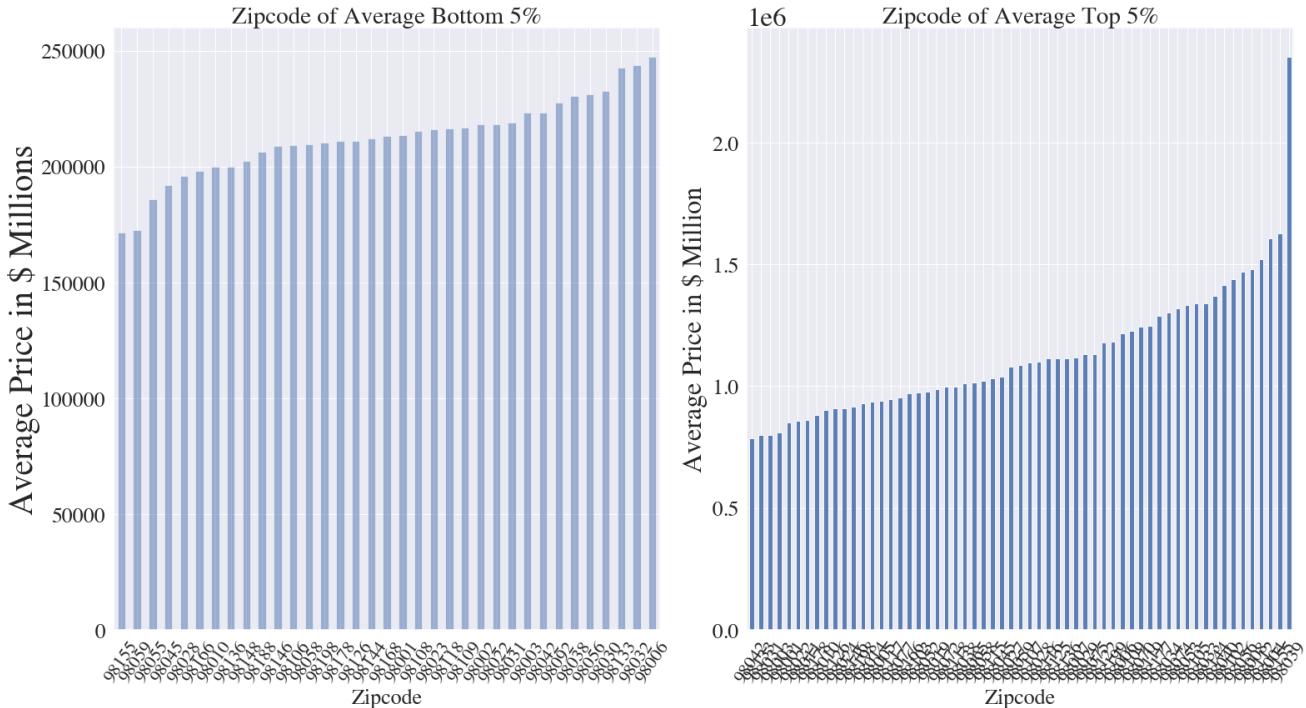
plt.title('Zipcode of Average Bottom 5%', fontsize=29)
plt.xticks(rotation=55, fontsize=22)
plt.yticks(rotation=0, fontsize=26)
plt.xlabel('Zipcode', fontsize=26)
plt.ylabel('Average Price in $ Millions', labelpad=0.3, fontsize=40)

plt.subplot(1, 2, 1)
group_zipcode = group_zipcode.sort_values()
group_zipcode.plot(kind='bar', x='zipcode', y='price',
                    alpha=0.9, figsize=(22, 12))

plt.title('Zipcode of Average Top 5%', fontsize=29);
plt.xticks(rotation=55, fontsize=22)
plt.yticks(rotation=0, fontsize=26)
plt.xlabel('Zipcode', fontsize=26)
plt.ylabel('Average Price in $ Million', labelpad=5, fontsize=32)

plt.tight_layout()

plt.show()
```



## Does the view or waterfront play a big role in house prices?

### View

Looking into the price distribution in respect to the ranking of view using a box plot.

The majority of houses are shown to have a low grade view.

Only 7% of houses have what is considered a "good" or "excellent" view, and these range from 800K dollars to 2 million dollars in value. By comparison, 83% of houses do not have a view, and these range from 350K-500K dollars in value.

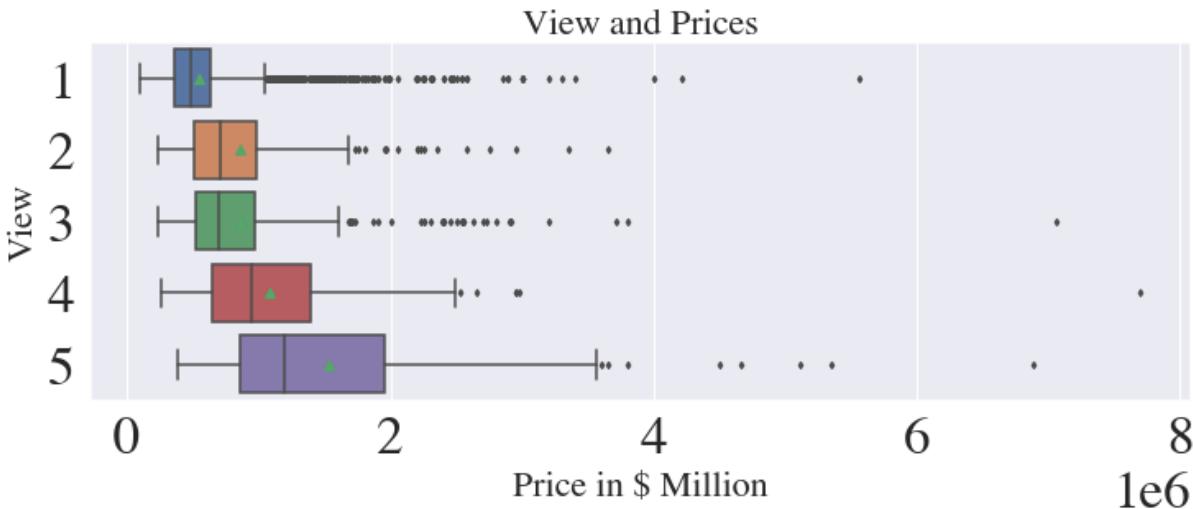
In [72]: fig, ax = plt.subplots(figsize=(12, 4))

```

sns.set_context(fontfamily="times")
sns.boxplot(y = kc_data['view'], x = kc_data['price'],
            width = 0.8, orient = 'h', showmeans = True,
            fliersize = 3, ax = ax)
plt.title('View and Prices', fontsize=22)
plt.xlabel('Price in $ Million', fontsize=22)
plt.ylabel('View', fontsize=22)

```

Out[72]: Text(0, 0.5, 'View')



In [73]: kc\_data['view'].value\_counts()

```

Out[73]: 1    6147
3     501
4    305
2    212
5    205
Name: view, dtype: int64

```

## Waterfront

Examining the distribution of waterfront using a box plot.

Zeroing into the distribution of the houses with waterfront and houses without waterfront.

In particular, waterfront homes are significantly more valuable than those without. Homes without a waterfront typically range from 300K-600K dollars, while waterfront homes typically cost more than three times that amount, from 900K-2.6M dollars.

```

In [74]: # We would need to visualize the data to clearly see where the data rests.
# Let's use boxplot to visualize waterfront:

from scipy import stats, linalg

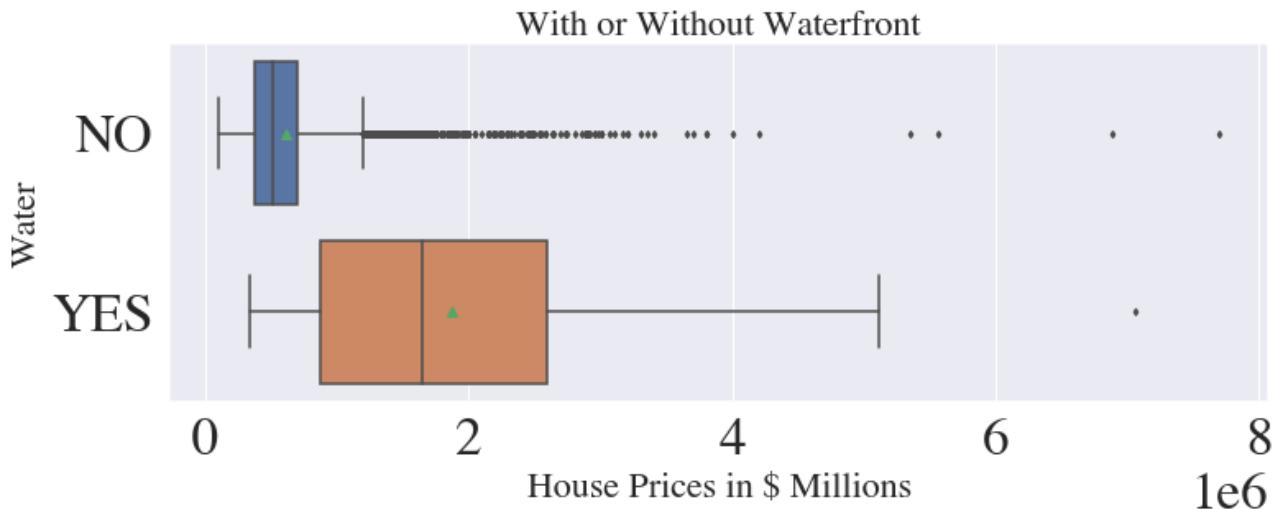
fig, ax = plt.subplots(figsize=(12,4))

sns.boxplot(y = kc_data['waterfront'], x = kc_data['price'],
            width = 0.8, orient = 'h', showmeans = True,
            fliersize = 3, ax = ax)
plt.title('With or Without Waterfront', fontsize=22)
plt.xlabel('House Prices in $ Millions', fontsize=22)
plt.ylabel('Water', fontsize=22)

# Calculate the correlation coefficient
#r, p = stats.pointbiserialr(kc_data['waterfront'], kc_data['price'])
#print ('point biserial correlation r is %s with p = %s' %(r,p))

```

```
plt.show()
```



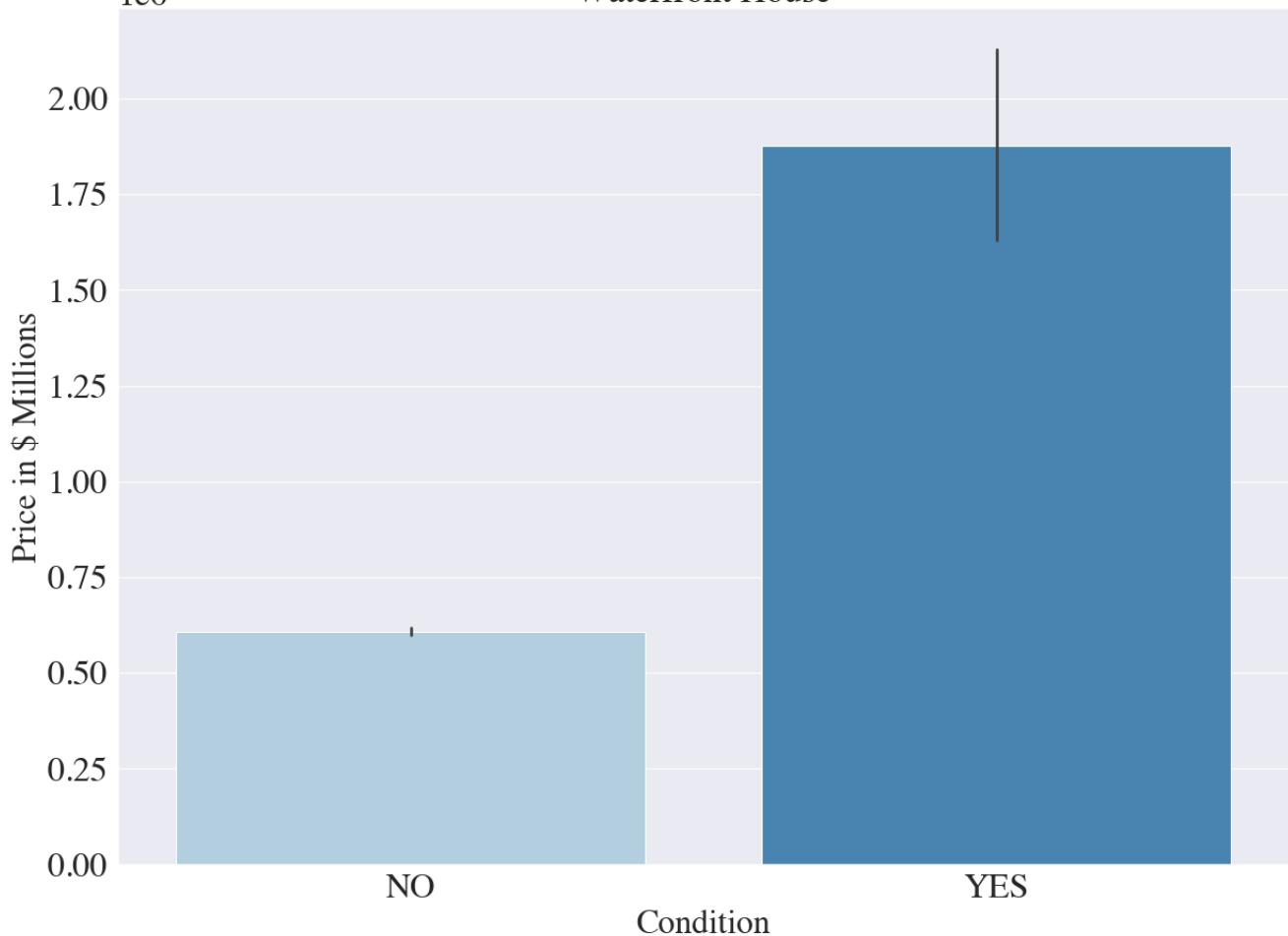
In [75]:

```
# Plotting a bar chart to see the comparison in a simpler
# way to add to presentation
sns.set(font_scale=3)
sns.set_context(fontfamily="times")
plt.figure(1, figsize=(20,15))

sns.barplot(x='waterfront', y='price', data=kc_data, palette='Blues')
plt.title('Waterfront House' , fontsize=34)
plt.xlabel('Condition', fontsize=32)
plt.ylabel('Price in $ Millions', fontsize=32)
```

Out[75]: Text(0, 0.5, 'Price in \$ Millions')

## Waterfront House



```
In [76]: # Dividing the data into water front and not water front to check the
# distribution for each.
waterfront_non = kc_data.loc[kc_data['waterfront']=='NO', 'price']
```

```
In [77]: # Glance at non waterfront houses
waterfront_non.head()
```

```
Out[77]: 1      538000.0
3      604000.0
5      1230000.0
8      229500.0
11     468000.0
Name: price, dtype: float64
```

```
In [78]: # The portion of the data with waterfront
waterfront = kc_data.loc[kc_data['waterfront']=='YES', 'price']
waterfront.head()
```

```
Out[78]: 49      1350000.0
230     655000.0
246     2400000.0
300     3080000.0
457     705000.0
Name: price, dtype: float64
```

```
In [79]: # The portion of the data with waterfront
#kc_water=kc_data['waterfront']=0
```

```
In [80]: # We will look closely at the distributions of water front and non
# waterfront side by side.
```

```

plt.figure(figsize=(26, 12))
sns.set(font_scale=3)
sns.set_context(fontfamily="times")
plt.subplot(1,2,1) # two subplots
sns.histplot(data=waterfront_non, kde=True)

#sns.set(font="Garamond")
plt.axvline(np.median(waterfront_non),color='b', linestyle='--')

m = np.mean(waterfront_non)
m = round(m,2)

plt.title('Price Distribution of Houses wo/ Waterfront in Millions, Mean = $' +str(m),
          fontsize=30);
plt.xticks(rotation =0, fontsize=42)
plt.yticks(rotation =0, fontsize=42)
plt.xlabel('Price in $ Millions',fontsize=42)
plt.ylabel('Count',fontsize=40)

plt.subplot(1,2,2)
sns.histplot(data=waterfront, kde=True)
plt.axvline(np.median(waterfront),color='b', linestyle='--')

m = np.mean(waterfront)
m = round(m,2)

plt.title('Price Distribution of Houses w / Waterfront in Millions, Mean = $' +str(m),
          fontsize=29);
plt.xticks(rotation =0, fontsize=42)
plt.yticks(rotation =0, fontsize=42)
plt.xlabel('Price in $ Millions',fontsize=42)
plt.ylabel('Count',fontsize=40)

plt.tight_layout()

plt.show()

```



```
In [81]: kc_data['waterfront'] = kc_data['waterfront'].replace(['NO', 'YES'], [0,1])
```

## How many square feet should the house/lot be to hold its value?

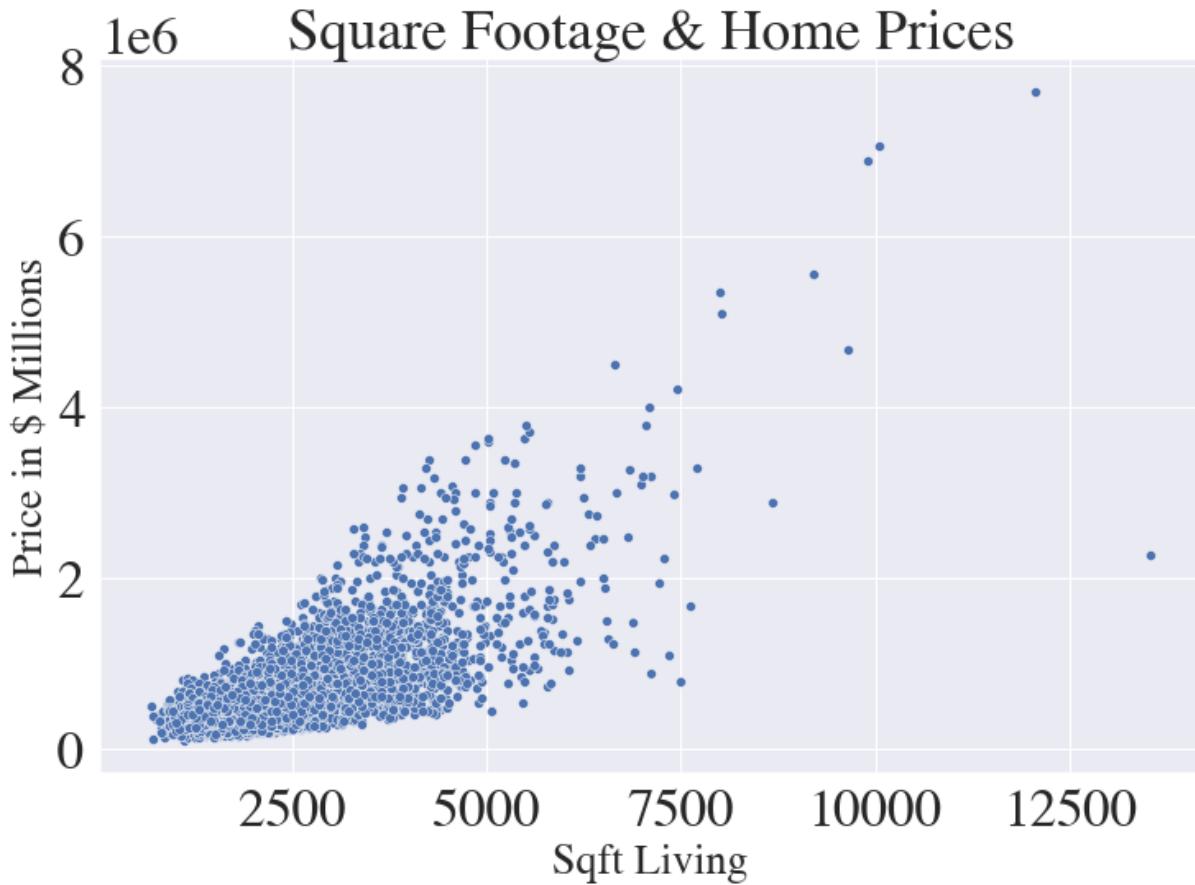
I plotted a scatter plot to show the strong correlation to price and soft living. I also included additional information about the year built to check if any pattern could be captured. But unexpectedly, the year a house was built did not show a relationship to price.

```
In [82]: plt.subplots(figsize=(12,8))
```

```
sns.set_context(fontfamily="times")
cmap = sns.cubehelix_palette(rot=-.2, as_cmap=True)
ax = sns.scatterplot(x="sqft_living", y="price",
                      palette=cmap, sizes=(900, 900),
                      data=kc_data)

plt.title('Square Footage & Home Prices', fontsize=35)
plt.xlabel('Sqft Living', fontsize=26)
plt.ylabel('Price in $ Millions', fontsize=26)
```

```
Out[82]: Text(0, 0.5, 'Price in $ Millions')
```



```
In [83]:
```

```
# Plotting number of bathrooms vs home price.
plt.subplots(figsize=(12,8))

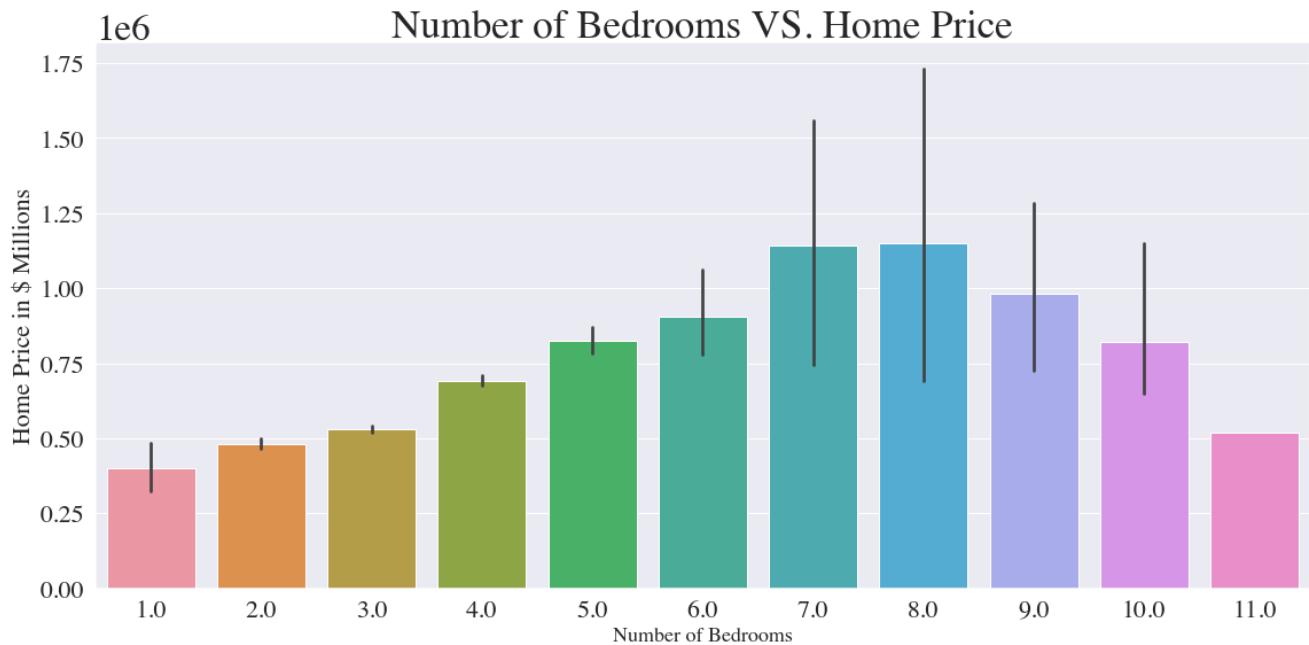
sns.set_context(fontfamily="times")
cmap = sns.cubehelix_palette(rot=-.2, as_cmap=True)
ax = sns.scatterplot(x="bathrooms", y="price",
                      palette=cmap, sizes=(900, 900),
                      data=kc_data)

plt.title('Number of Bathrooms VS. Home Price', fontsize=25)
plt.xlabel('Bathrooms', fontsize=26)
plt.ylabel('Price in $ Millions', fontsize=26)
```

```
Out[83]: Text(0, 0.5, 'Price in $ Millions')
```



```
In [84]: # Plotting number of bedrooms versus home price.  
fig, ax = plt.subplots(figsize=(16, 8))  
  
sns.barplot(x="bedrooms", y="price", data=kc_data)  
  
# Label and define fontsize for main and axis titles.  
  
plt.xlabel('Number of Bedrooms', fontsize=18)  
plt.ylabel('Home Price in $ Millions', fontsize=22)  
plt.title('Number of Bedrooms VS. Home Price', fontsize=35)  
plt.tick_params(axis='both', which='major', labelsize=22)  
  
# Set x-axis tick labels.  
  
plt.tight_layout()  
plt.show()
```



```
In [85]: # Plotting number of bathrooms versus home price.
```

```
fig, ax = plt.subplots(figsize=(16, 8))

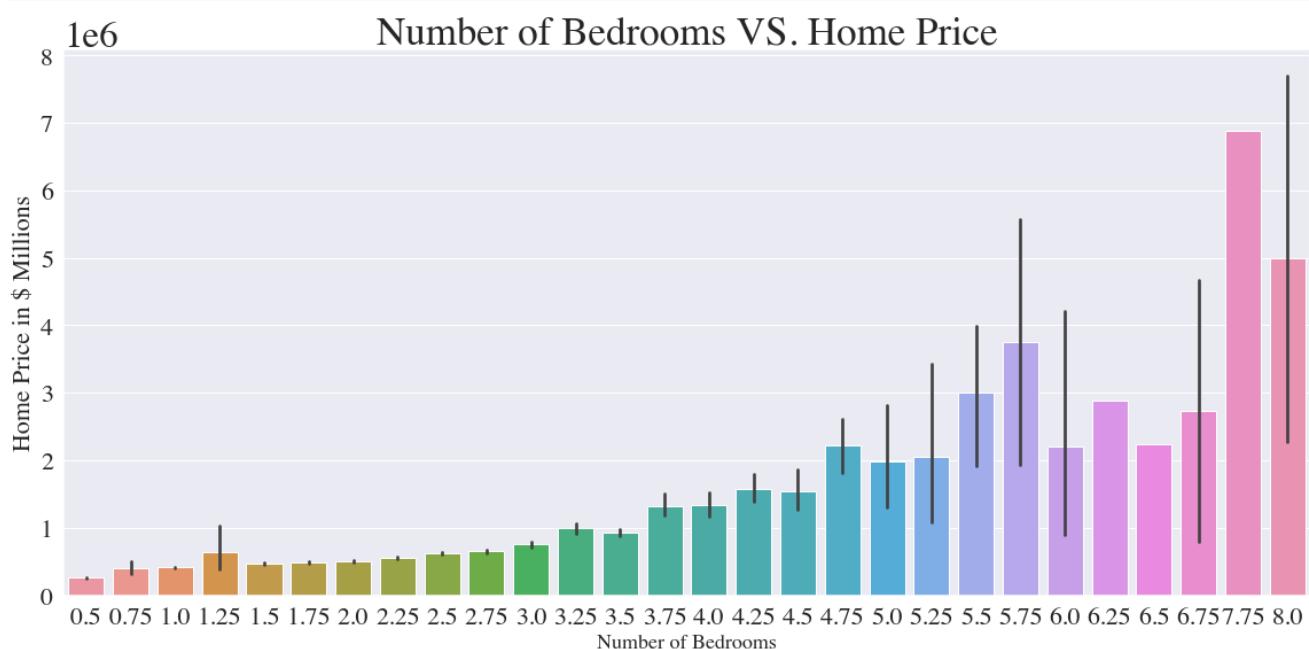
sns.barplot(x="bedrooms", y="price", data=kc_data)
sns.set_color_codes("pastel")

# Label and define fontsize for main and axis titles.

plt.xlabel('Number of Bedrooms', fontsize=18)
plt.ylabel('Home Price in $ Millions', fontsize=22)
plt.title('Number of Bedrooms VS. Home Price', fontsize=35)
plt.tick_params(axis='both', which='major', labelsize=22)

# Set x-axis tick labels.

plt.tight_layout()
plt.show()
```



```
In [86]: # Comparing the lot versus square living.
```

```

plt.figure(figsize=(20, 10))

sns.set(font_scale=2.8)

sns.set_context(fontfamily="times")
plt.subplot(1,2,1) # two subplots

cmap = sns.cubehelix_palette(rot=-.2, as_cmap=True)

ax = sns.scatterplot(x="sqft_lot", y="price",
                      hue="yr_built",
                      palette=cmap,
                      data=kc_data)

plt.title('Sqft of Lot and House Prices' , fontsize=42)
plt.xlabel('Sqft Lot', fontsize=42)
plt.ylabel('Price in $ Millions', fontsize=42)

plt.subplot(1,2,2)

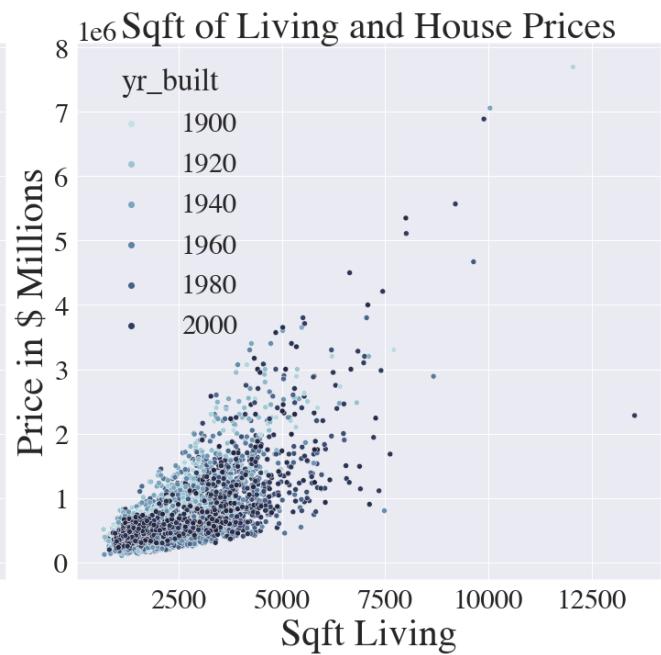
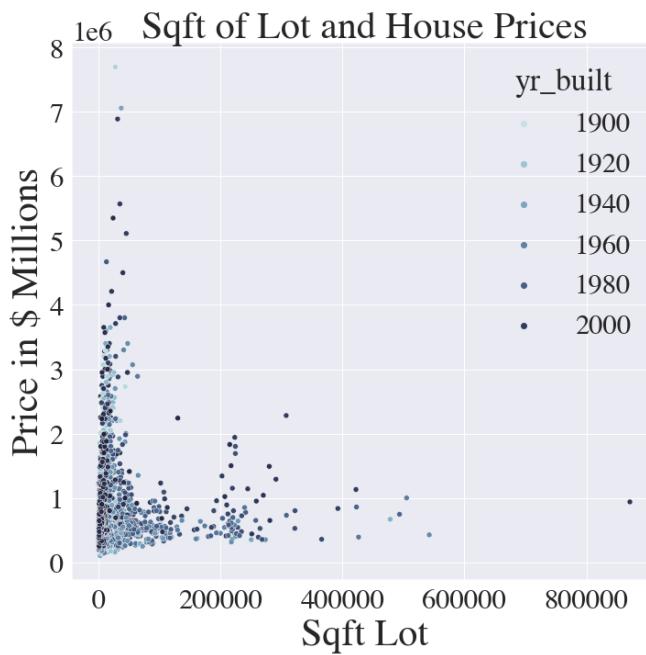
cmap = sns.cubehelix_palette(rot=-.2, as_cmap=True)

sns.set_context(fontfamily="times")
ax = sns.scatterplot(x="sqft_living", y="price", hue="yr_built",
                      palette=cmap,
                      data=kc_data)

plt.title('Sqft of Living and House Prices', fontsize=42)
plt.xlabel('Sqft Living', fontsize=42)
plt.ylabel('Price in $ Millions', fontsize=42)

plt.tight_layout()

```



In [87]:

```

# Correlation table gives us a precise number which supports the heatmap.

corrTable = kc_data.corr()
corrTable=round(corrTable,2)
corrTable

```

Out[87]:

	<b>id</b>	<b>price</b>	<b>bedrooms</b>	<b>bathrooms</b>	<b>sqft_living</b>	<b>sqft_lot</b>	<b>floors</b>	<b>waterfront</b>	<b>view</b>	<b>condition</b>	...	<b>sqft_bas</b>
<b>id</b>	1.00	-0.02	0.01	0.00	-0.02	-0.13	0.02	-0.00	0.01	-0.02	...	
<b>price</b>	-0.02	1.00	0.26	0.53	0.72	0.07	0.35	0.31	0.45	0.08	...	
<b>bedrooms</b>	0.01	0.26	1.00	0.46	0.52	0.06	0.08	-0.00	0.10	0.07	...	
<b>bathrooms</b>	0.00	0.53	0.46	1.00	0.70	0.13	0.47	0.09	0.24	-0.06	...	
<b>sqft_living</b>	-0.02	0.72	0.52	0.70	1.00	0.23	0.33	0.15	0.37	0.03	...	
<b>sqft_lot</b>	-0.13	0.07	0.06	0.13	0.23	1.00	-0.02	0.05	0.07	-0.01	...	
<b>floors</b>	0.02	0.35	0.08	0.47	0.33	-0.02	1.00	0.05	0.12	-0.16	...	
<b>waterfront</b>	-0.00	0.31	-0.00	0.09	0.15	0.05	0.05	1.00	0.38	0.01	...	
<b>view</b>	0.01	0.45	0.10	0.24	0.37	0.07	0.12	0.38	1.00	0.03	...	
<b>condition</b>	-0.02	0.08	0.07	-0.06	0.03	-0.01	-0.16	0.01	0.03	1.00	...	
<b>grade</b>	0.01	0.69	0.26	0.64	0.73	0.13	0.46	0.13	0.38	-0.09	...	
<b>sqft_above</b>	-0.02	0.72	0.43	0.70	0.92	0.21	0.50	0.13	0.33	-0.05	...	
<b>sqft_basement</b>	-0.02	0.41	0.46	0.41	0.72	0.16	-0.11	0.12	0.29	0.16	...	
<b>yr_built</b>	0.01	-0.01	0.03	0.39	0.17	0.09	0.29	-0.01	-0.01	-0.35	...	
<b>yr_renovated</b>	-0.00	0.15	0.05	0.09	0.09	0.00	0.07	0.08	0.09	-0.10	...	
<b>zipcode</b>	-0.03	-0.06	-0.15	-0.18	-0.20	-0.18	0.09	0.01	0.06	-0.02	...	
<b>lat</b>	-0.03	0.24	0.00	0.03	0.03	-0.11	0.10	-0.03	-0.02	-0.01	...	
<b>long</b>	-0.00	0.02	0.13	0.19	0.23	0.33	-0.05	-0.01	-0.04	-0.05	...	
<b>sqft_living15</b>	-0.01	0.60	0.33	0.51	0.72	0.20	0.18	0.13	0.41	0.01	...	
<b>sqft_lot15</b>	-0.12	0.05	0.04	0.11	0.21	0.79	-0.02	0.05	0.06	-0.01	...	
<b>dateyear</b>	0.00	0.00	-0.01	-0.03	-0.03	0.01	-0.03	-0.01	-0.01	-0.06	...	
<b>date_month</b>	-0.00	-0.00	0.00	0.01	0.02	-0.02	0.03	0.01	-0.00	0.02	...	

22 rows × 22 columns

It's evident that, unlike living space, lot size does not show a correlation to price.

## Grade and Condition

In [88]:

```
# Checking unique values for condition
kc_data['condition'].unique()
```

Out[88]:

array([3, 5, 4, 1, 2])

In [89]:

```
# Grouping condition
group_condition = kc_data.groupby(['condition']).mean()
group_condition = pd.DataFrame.reset_index(group_condition)
group_condition
```

Out[89]:

	<b>condition</b>	<b>id</b>	<b>price</b>	<b>bedrooms</b>	<b>bathrooms</b>	<b>sqft_living</b>	<b>sqft_lot</b>	<b>floors</b>	<b>waterfront</b>	
<b>0</b>	1	5.337300e+09	324333.333333	3.333333	1.666667	1850.000000	19043.000000	1.000000	0.000000	1.0
<b>1</b>	2	5.097944e+09	417773.460000	3.200000	1.800000	1861.400000	26088.940000	1.050000	0.020000	1.1
<b>2</b>	3	4.642844e+09	612184.257477	3.514252	2.350058	2313.367290	12714.375000	1.415421	0.011215	1.3
<b>3</b>	4	4.575608e+09	603975.530814	3.590193	2.118534	2281.827260	14584.501125	1.173639	0.011696	1.4
<b>4</b>	5	4.486960e+09	751617.242015	3.691267	2.318182	2425.753071	11056.217445	1.279484	0.017199	1.4

5 rows × 22 columns

```
In [90]: # Checking distribution of condition
```

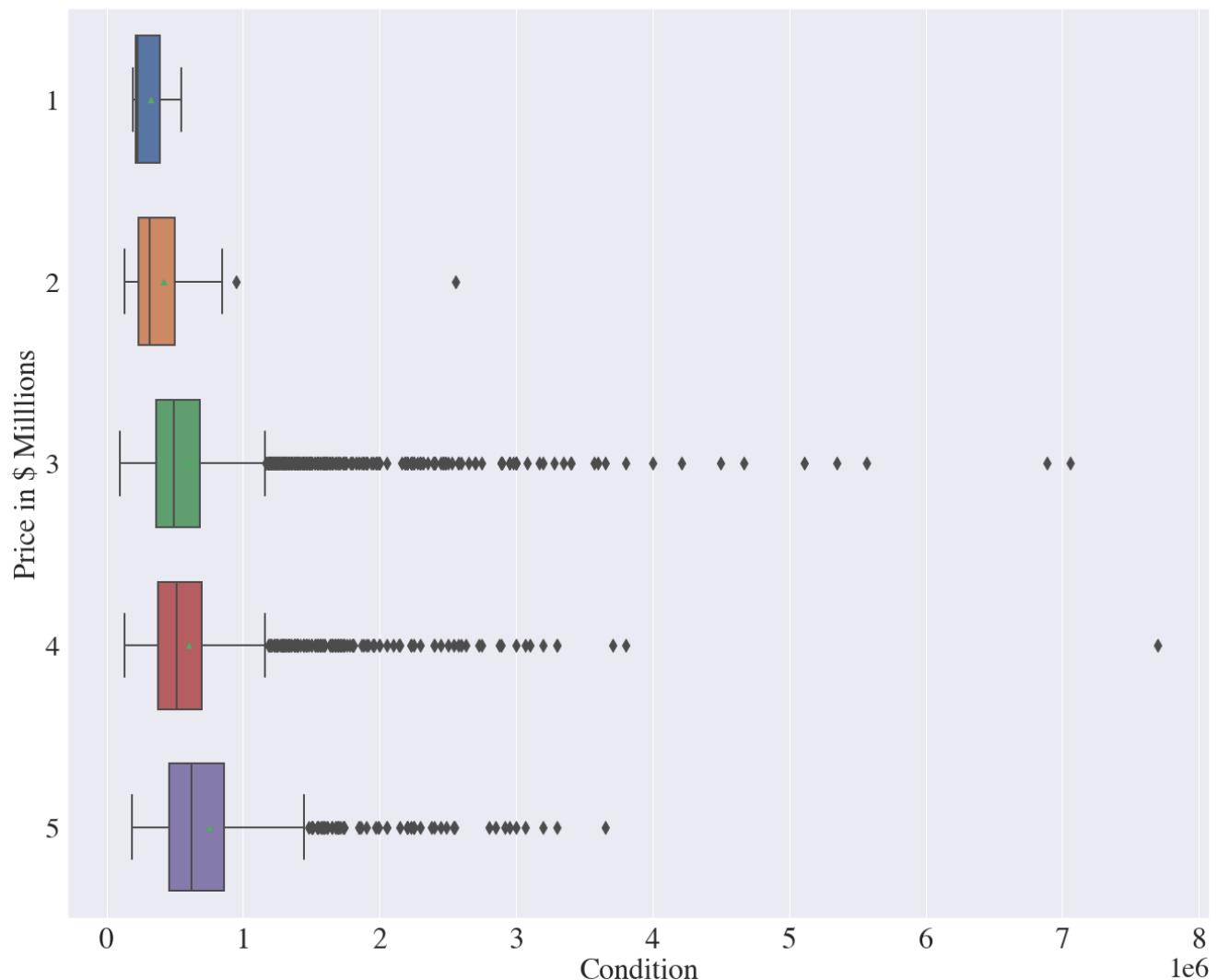
```
fig, axes = plt.subplots(1, 1, figsize=(22,18))

sns.set_context(fontfamily="times")

fig.suptitle('Condition and Price Distribution')
sns.boxplot(y = kc_data['condition'], x=kc_data['price'],
            width = 0.7, orient ='h', showmeans = True,
            linewidth = 2, fliersize =10)

plt.xlabel('Condition', fontsize=32)
plt.ylabel('Price in $ Millions', fontsize=32)
plt.xticks(fontsize=32, rotation = 0);
```

Condition and Price Distribution



## Condition and Grade

```
In [91]:
```

```
sns.set(font_scale=3)
sns.set_context(fontfamily="times")
plt.figure(2, figsize=(20,15))
the_grid = GridSpec(2, 2)
```

```

plt.subplot(the_grid[0, 1], title='Condition')

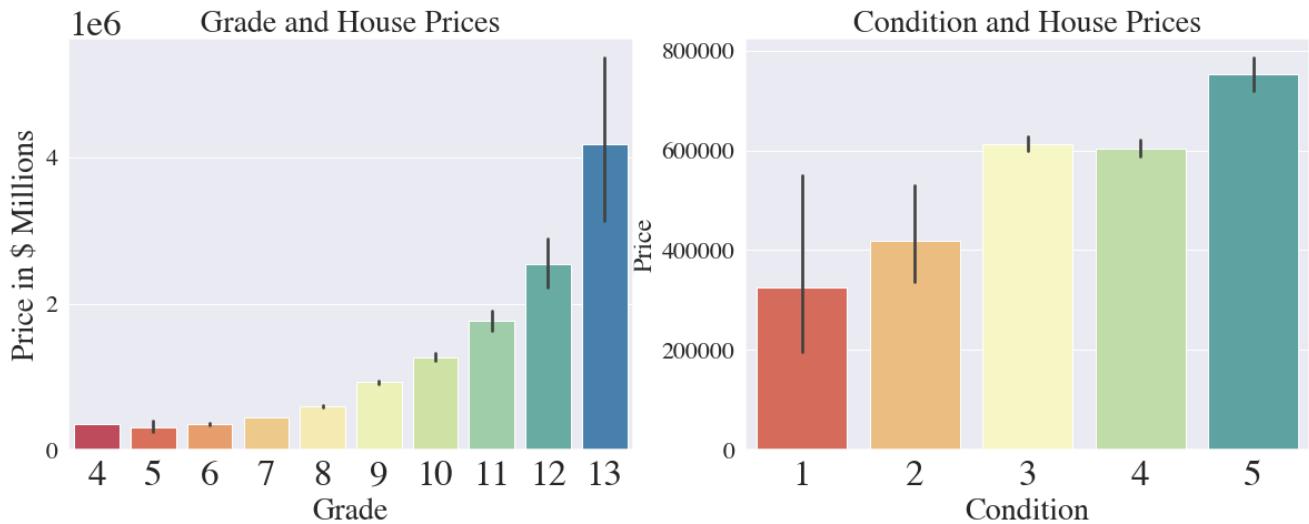
sns.barplot(x='condition', y='price', data=kc_data,
            palette='Spectral')
plt.title('Condition and House Prices', fontsize=28)
plt.xlabel('Condition', fontsize=28)
plt.ylabel('Price', fontsize=24)
plt.yticks(fontsize=22, rotation=0);

plt.subplot(the_grid[0, 0], title='Grade')

sns.barplot(x='grade', y='price', data=kc_data, palette='Spectral')

plt.title('Grade and House Prices', fontsize=28)
plt.xlabel('Grade', fontsize=28)
plt.ylabel('Price in $ Millions', fontsize=28)
plt.yticks(fontsize=22, rotation=0);
fig.tight_layout()
plt.show()

```



The higher the grade and condition the higher the price. However the price increases significantly with the increase of the house's grade.

## Year Built/Renovated

Looking closely, I build a line plot to access whether there was any trend with year built but as the graph shows there was not. Newer homes did not necessarily suggest that prices increased. From 1980 to 2000 house prices rose from 700K to \$1.1 million.

```

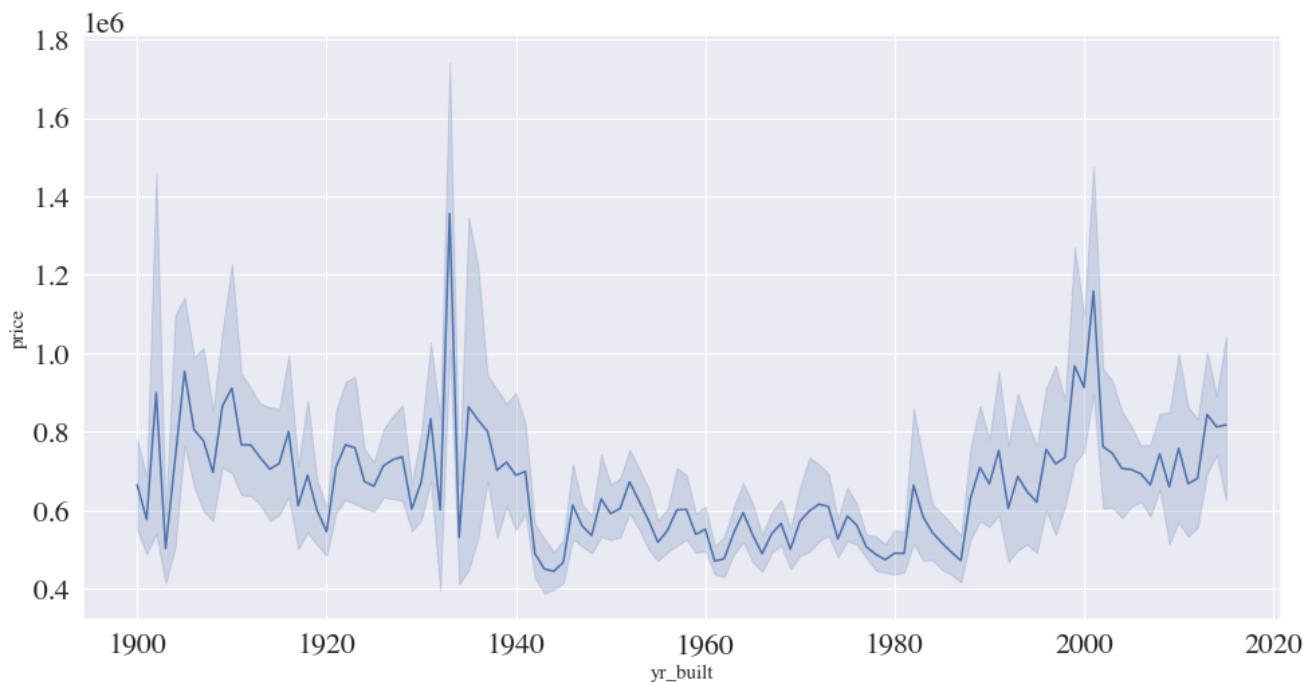
In [92]: # Plotting line plot
sns.set_style('whitegrid')
sns.set_color_codes("pastel")
sns.set(font_scale=2)
sns.set_context(fontfamily="times")

fig, ax = plt.subplots(1,1, figsize=(16,8))

sns.lineplot(data=kc_data, x="yr_built", y="price")

```

Out[92]: <AxesSubplot:xlabel='yr\_built', ylabel='price'>



## Year Renovated

```
In [93]: # Checking years
kc_data.yr_renovated.unique()
```

```
Out[93]: array([1991,      0,  2002, 1992, 1994, 1978, 2005, 2003, 1984, 2011, 2014,
   2013, 1988, 1995, 1977, 1998, 1970, 1989, 1990, 2004, 1986, 2007,
   1987, 2006, 2000, 1979, 1997, 1983, 2015, 2012, 2008, 1962, 1999,
   2001, 1985, 1980, 1993, 1955, 1996, 2010, 2009, 1969, 1940, 1975,
   1957, 1956, 1973, 1968, 1982, 1934, 1965, 1964])
```

```
In [94]: kc_data['yr_renovated'].value_counts()
```

```
Out[94]: 0        7052
2014       41
2013       17
2000       14
2008       13
2003       12
2005       12
2006       12
2004       11
2007       10
1990        9
1996        9
2010        9
2015        8
1987        8
1999        8
1991        8
1998        7
1984        7
2001        7
1970        6
2009        6
2002        6
1993        6
1986        6
2011        5
1992        5
1983        5
1989        4
1985        4
1995        4
1988        4
1994        3
1975        3
```

```

1982      3
1977      3
1980      3
1979      2
1969      2
1965      2
2012      2
1997      2
1964      1
1955      1
1956      1
1978      1
1962      1
1968      1
1940      1
1973      1
1957      1
1934      1
Name: yr_renovated, dtype: int64

```

Since the majority of the data shows 0 for the houses, I assume that these houses were not renovated.

```
In [95]: year_price = kc_data[['yr_renovated', 'price']]
year_price.head()
```

	yr_renovated	price
1	1991	5380000.0
3	0	604000.0
5	0	1230000.0
8	0	229500.0
11	0	468000.0

```
In [96]: # Removing the renovation years that are zero - these houses were
# not renovated
reno_years = year_price.replace(0, pd.np.nan).dropna(axis=0,
                                                       how='any').fillna(0).astype(int)
```

```
In [97]: '''Creating a new data frame - extracting year renovated and price.
Grouping by year renovated and plotting a bar graph into the avert
price for a given year.'''
group_yr_reno = reno_years.groupby(['yr_renovated']).mean()
group_yr_reno = pd.DataFrame.reset_index(group_yr_reno)
```

```
In [98]: '''I build a line plot to access wether here was any trend with year
renovated but as the graph shows there was not.'''

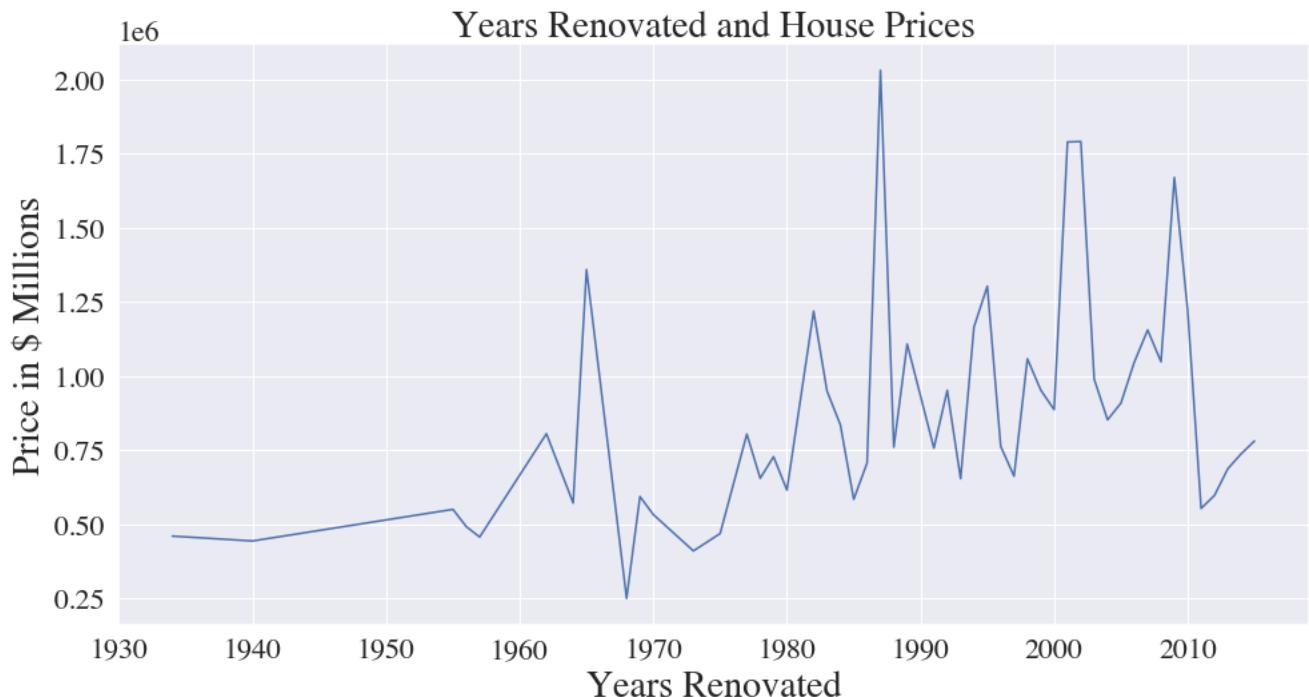
sns.set_style('whitegrid')
sns.set_color_codes("pastel")
sns.set(font_scale=2)
sns.set_context(fontfamily="times")

fig, ax = plt.subplots(1,1, figsize=(16,8))

plt.title('Years Renovated and House Prices' , fontsize=28)
plt.xlabel('Years Renovated' , fontsize=28)
plt.ylabel('Price in $ Millions' , fontsize=28)

sns.lineplot(data=group_yr_reno, x="yr_renovated", y="price")
```

```
Out[98]: <AxesSubplot:title={'center':'Years Renovated and House Prices'}, xlabel='Years Renovated', ylabel='P
rice in $ Millions'>
```



```
In [99]: # Let's check yr_built stats and asses the virable.
top20p.yr_built.describe()
```

```
Out[99]: count    1474.000000
mean     1965.005427
std      33.081355
min     1900.000000
25%    1937.000000
50%    1967.000000
75%    1996.000000
max    2015.000000
Name: yr_built, dtype: float64
```

```
In [100... # Here are the bins based on the values observed above.
# 5 values will result in 4 bins

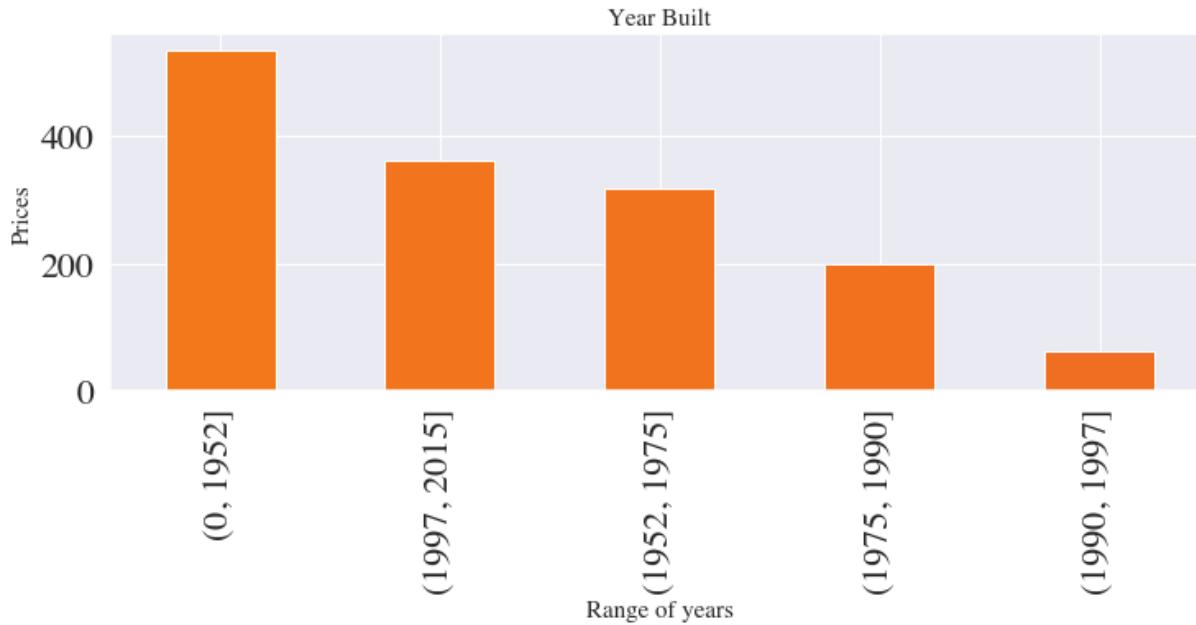
bins = [0, 1952, 1975, 1990, 1997, 2015]

#We'll pd.cut method to separate data into bins.
bins_yr_built = pd.cut(top20p['yr_built'], bins)

#We'll use .cat.as_unordered() method transforming the data to
# ordered categories.
bins_yr_built = bins_yr_built.cat.as_unordered()
#bins_yr_built.head()
```

```
In [101... #Let's visualize the bins
fig, ax = plt.subplots(figsize=(15,6))
from matplotlib import cm

color = cm.inferno_r(np.linspace(.3, .5, 40))
sns.set_context(fontfamily="times")
bins_yr_built.value_counts().plot(kind='bar', stacked=True, color=color,
                                 legend=False, figsize=(12, 4))
plt.xlabel('Range of years')
plt.ylabel('Prices')
plt.title('Year Built')
#plt.legend()
plt.show()
```



## Mid-low-range house prices investment opportunities

In [102...]

```
# Checking the distribution for house prices.

fig, ax = plt.subplots(figsize=(16, 8))
sns.histplot(kc_data["price"], alpha=.5)
plt.title('Price Distribution', fontsize=28)
plt.xlabel('Price', fontsize=32)
plt.ylabel('Count', fontsize=32)
plt.show()
```

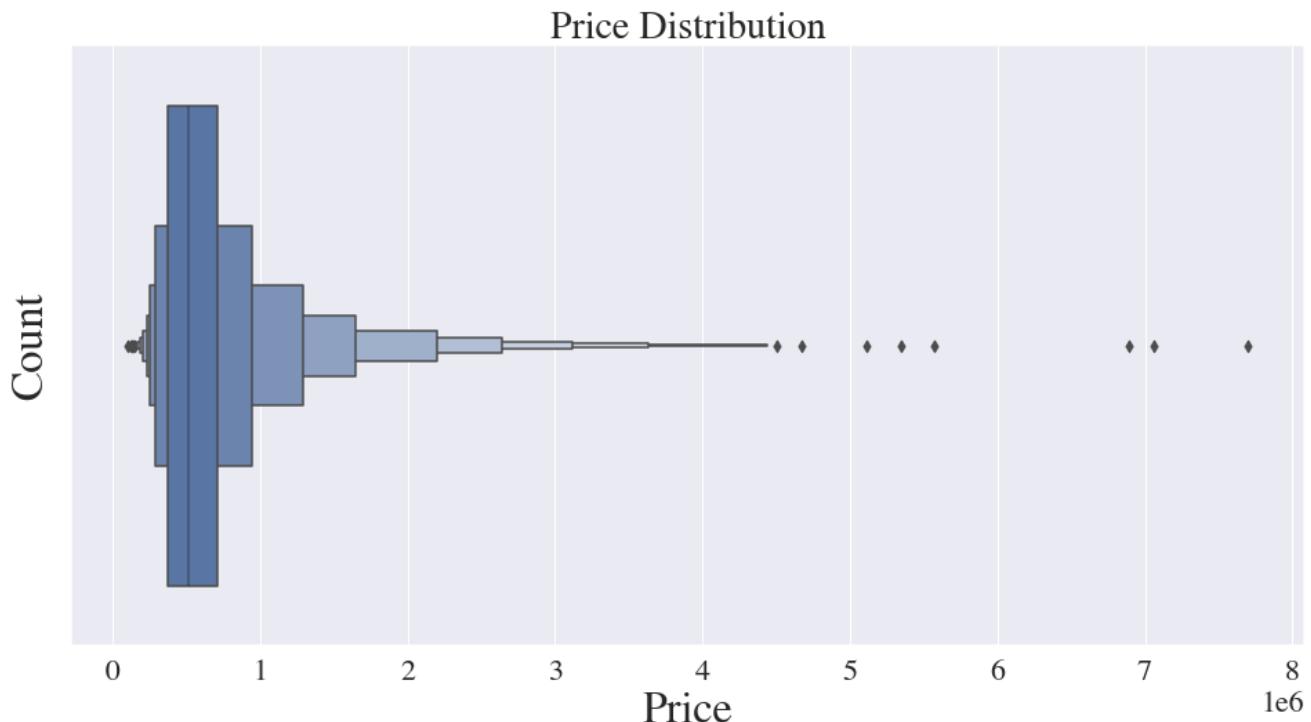


In [103...]

```
# Checking the distribution for house prices.

fig, ax = plt.subplots(figsize=(16, 8))
sns.boxenplot(x=kc_data["price"])
plt.title('Price Distribution', fontsize=28)
plt.xlabel('Price', fontsize=32)
```

```
plt.ylabel('Count', fontsize =32)
plt.show()
```



In [104... `kc_data['price'].unique()`

Out[104... `array([ 538000., 604000., 1230000., ..., 747450., 608500., 3570000.])`

The majority of the houses fall between 250K to 1 million dollars.

In [105... `# Filter the dataset to get mid range prices
mid_price = kc_data[(kc_data['price'] < np.quantile(kc_data['price'], 0.9))
& (kc_data['bathrooms'].isin(range(3, 6)))
& (kc_data['view'].isin(range(3,5)))
& (kc_data['sqft_living'].isin(range(2000,5700)))]`

`# View summary statistics
mid_price.describe()`

Out[105... 

	<code>id</code>	<code>price</code>	<code>bedrooms</code>	<code>bathrooms</code>	<code>sqft_living</code>	<code>sqft_lot</code>	<code>floors</code>	<code>waterfront</code>	<code>view</code>
<code>count</code>	3.400000e+01	34.00000	34.000000	34.000000	34.000000	34.000000	34.000000	34.000000	34.000000
<code>mean</code>	4.810090e+09	718650.000	4.323529	3.176471	3282.235294	17310.029412	1.602941	0.0	3.352941
<code>std</code>	2.865201e+09	192865.463	1.036328	0.386953	672.085089	18885.111257	0.519023	0.0	0.485071
<code>min</code>	2.690010e+08	315000.000	3.000000	3.000000	2350.000000	3900.000000	1.000000	0.0	3.000000
<code>25%</code>	2.358001e+09	565250.000	4.000000	3.000000	2792.500000	6250.000000	1.000000	0.0	3.000000
<code>50%</code>	4.058801e+09	749500.000	4.000000	3.000000	3140.000000	9734.500000	1.750000	0.0	3.000000
<code>75%</code>	7.380576e+09	867000.000	5.000000	3.000000	3687.500000	18136.500000	2.000000	0.0	4.000000
<code>max</code>	9.523104e+09	1030000.000	7.000000	4.000000	4660.000000	80471.000000	3.000000	0.0	4.000000

8 rows × 22 columns

In [106... `mid_price= mid_price[['price','sqft_living','zipcode']]`

In [107... `group_mid_zip = mid_price.groupby(['zipcode'])['price'].mean()`

In [108...]

```
group_mid_zip = mid_price.sort_values(by= 'price', ascending = False)
group_mid_zip.head()
```

Out[108...]

	price	sqft_living	zipcode
<b>20056</b>	1030000.0	3880	98034
<b>7069</b>	990000.0	2550	98199
<b>1034</b>	980000.0	3680	98199
<b>17480</b>	959750.0	3060	98008
<b>10581</b>	951250.0	2710	98199

## Preparing for Modeling

In order to prepare for the model prediction, I will be dealing with the following elements:

- \* Split the data- dependent(X) and independent(y)
- \* Handle categorical variables by using dummy encoding.
- \* Ensure that there is no multicollinearity that none of the independent variables are correlated.
- \* Scale the data.

In [109...]

```
kc_data.isnull().sum()
```

Out[109...]

```
id          0
price       0
bedrooms    1
bathrooms   0
sqft_living 0
sqft_lot    0
floors      0
waterfront  0
view        0
condition   0
grade        0
sqft_above  0
sqft_basement 0
yr_built    0
yr_renovated 0
zipcode     0
lat         0
long        0
sqft_living15 0
sqft_lot15  0
dateyear    0
date_month  0
dtype: int64
```

In [110...]

```
kc_data.dropna(subset=[ 'bedrooms' ], inplace=True)
```

In [111...]

```
kc_data.isnull().sum()
```

Out[111...]

```
id          0
price       0
bedrooms    0
bathrooms   0
sqft_living 0
sqft_lot    0
floors      0
waterfront  0
view        0
condition   0
grade        0
sqft_above  0
sqft_basement 0
```

```
yr_built      0
yr_renovated 0
zipcode       0
lat           0
long          0
sqft_living15 0
sqft_lot15   0
dateyear     0
date_month    0
dtype: int64
```

## Split the data: dependent(X) and independent(y)

I will split the data into dependent and independent variable X and y. I will make sure there are no new NaNs values.

```
In [172...]: # Split features X and target y
X = kc_data.drop('price', axis = 1)
y = kc_data['price']
```

```
In [173...]: # Creating a copy of X
X_copy = X.copy()
```

## Adding New Columns

I am adding new columns where the model can understand better the values. Year built and renovated would be hard to the model to understand therefore, I will subtract the year renovated from the year the house was sold. I will do the same for the year the house was built. The new column will have the number of years as opposed to just four digit year.

```
In [174...]: # Adding a column of number of years house has been built
X['houselfe'] = X['dateyear'] - X['yr_built']
```

```
In [175...]: # Adding a column of number of years the house was renovated.
X['yr_renovated'] = X['yr_renovated'].replace(0, 2022)
```

```
In [176...]: # Creating a new column called 'renovated'. Subtracting date year from
# year renovated.
X['renovated'] = X['yr_renovated'] - X['dateyear']
```

```
In [177...]: # There a lot of 0s in the year renovated which we will replace with
# the year the house was sold because we assume that the respective
# house was not renovated.

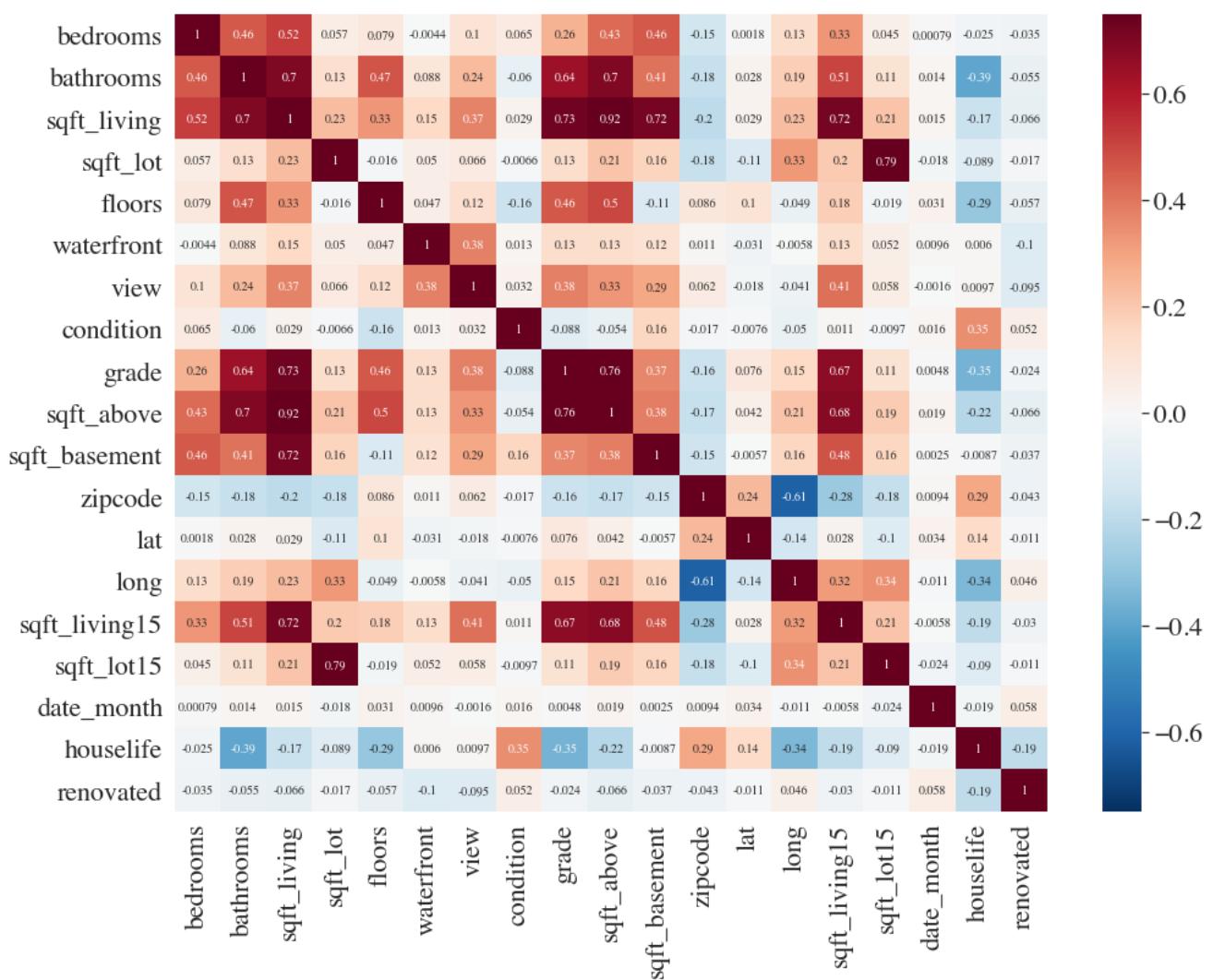
for indx, row in X.iterrows():
    if row['yr_renovated']==0:
        X['yr_renovated'].loc[indx] = row['dateyear']
```

```
In [178...]: X.drop(['yr_built', 'yr_renovated', 'dateyear'], axis=1, inplace=True)
```

```
In [179...]: # Dropping 'id' -since it has so meaningful value.
X.drop(['id'], axis=1, inplace=True)
```

## Checking for Multicollinearity

```
In [180...]: corr = X.corr()
plt.figure(figsize=(16, 12))
sns.set(font_scale=2)
sns.set_context(fontfamily="times")
heatmap = sns.heatmap(corr, annot=True, linewidths=0, vmin=-0.75,
                      vmax=0.75, cmap="RdBu_r")
```



### Check VIF Score

Creating a function that generates a list of two variables and the respective correlation to check for multicolliniartiy. I will not include a correlation higher than 0.6.

In [181...]

```
# We will extract all the variables beside the target variable.
kc_pred = X
kc_pred.head()
```

Out[181...]

	bedrooms	bathrooms	sqft_living	sqft_lot	floors	waterfront	view	condition	grade	sqft_above	sqft_basement	zipcode	lat	long	sqft_living15	sqft_lot15	date_month	houselife	renovated
1	3.0	2.25	2570	7242	2.0		0	1	3	7	2170		400	\$					
3	4.0	3.00	1960	5000	1.0		0	1	5	7	1050		910	\$					
5	4.0	4.50	5420	101930	1.0		0	1	3	11	3890		1530	\$					
8	3.0	1.00	1780	7470	1.0		0	1	3	7	1050		730	\$					
11	2.0	1.00	1160	6000	1.0		0	1	4	7	860		300	\$					

In [182...]

```
# Double checking null values
kc_pred.isnull().sum()
```

Out[182...]

bedrooms	0
bathrooms	0
sqft_living	0
sqft_lot	0
floors	0
waterfront	0

```
view          0
condition     0
grade         0
sqft_above    0
sqft_basement 0
zipcode        0
lat           0
long          0
sqft_living15 0
sqft_lot15    0
date_month    0
housetype      0
renovated     0
dtype: int64
```

```
In [183...]: from statsmodels.stats.outliers_influence import variance_inflation_factor
def vif_scores(kc_pred):

    kc_pred_temp = kc_pred.copy()

    VIF_Scores = pd.DataFrame()
    VIF_Scores[ "Independent Features" ] = kc_pred_temp.columns
    VIF_Scores[ "VIF_Scores" ] = [variance_inflation_factor(kc_pred_temp.values,i)
                                  for i in range(kc_pred_temp.shape[1])]

    return VIF_Scores

vif_scores(kc_pred)
```

	Independent Features	VIF_Scores
0	bedrooms	2.330536e+01
1	bathrooms	2.649350e+01
2	sqft_living	inf
3	sqft_lot	3.294432e+00
4	floors	1.648491e+01
5	waterfront	1.197943e+00
6	view	4.507693e+00
7	condition	3.206290e+01
8	grade	1.654118e+02
9	sqft_above	inf
10	sqft_basement	inf
11	zipcode	2.256854e+06
12	lat	1.706998e+05
13	long	2.022170e+06
14	sqft_living15	2.700967e+01
15	sqft_lot15	3.428056e+00
16	date_month	5.582151e+00
17	housetype	7.031338e+00
18	renovated	2.705799e+00

```
In [184...]: # Dropping high VIF
X.drop(['sqft_living15', 'sqft_lot15', 'housetype','sqft_above','sqft_basement'], axis = 1,inplace =True)
```

```
In [185...]: # Running vif score one more time
vif_scores(X)
```

	Independent Features	VIF_Scores
--	----------------------	------------

	Independent Features	VIF_Scores
0	bedrooms	2.303511e+01
1	bathrooms	2.357956e+01
2	sqft_living	2.400372e+01
3	sqft_lot	1.377627e+00
4	floors	1.263046e+01
5	waterfront	1.194717e+00
6	view	4.239099e+00
7	condition	2.807544e+01
8	grade	1.355188e+02
9	zipcode	2.070907e+06
10	lat	1.649436e+05
11	long	1.871179e+06
12	date_month	5.577196e+00
13	renovated	2.526631e+00

## Categorical Values

Using `get_dummies` method in order to create a column for waterfront and not waterfront homes. Also, each zipcode will have their own column. This way the model can work better with such data.

Here are all the categorical features which we will convert to dummy variables by using `get_dummies` method.

- Zipcode
- Waterfront

In [186...]

```
# Creating a column of yes_waterfront and no_waterfront
X = pd.get_dummies(X, columns=['waterfront'])
```

In [187...]

```
# Creating a column for each zipcode
X = pd.get_dummies(X, columns=['zipcode'])
```

In [188...]

```
X.head()
```

Out[188...]

	bedrooms	bathrooms	sqft_living	sqft_lot	floors	view	condition	grade	lat	long	...	zipcode_98146	zipcode_98103
1	3.0	2.25	2570	7242	2.0	1	3	7	47.7210	-122.319	...	0	0
3	4.0	3.00	1960	5000	1.0	1	5	7	47.5208	-122.393	...	0	0
5	4.0	4.50	5420	101930	1.0	1	3	11	47.6561	-122.005	...	0	0
8	3.0	1.00	1780	7470	1.0	1	3	7	47.5123	-122.337	...	1	0
11	2.0	1.00	1160	6000	1.0	1	4	7	47.6900	-122.292	...	0	0

5 rows × 84 columns

## Implementing VIF Score function using statsmodels.

VIF starts at 1 and has no upper limit VIF = 1, no correlation between the independent variable and the other variables VIF exceeding 5 or 10 indicates high multicollinearity between this independent variable and the others.

In [189...]

```
# Dropping more variables that have large VIF
```

In [190...]

X.info()

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 7369 entries, 1 to 21591
Data columns (total 84 columns):
 #   Column           Non-Null Count  Dtype  
--- 
 0   bedrooms        7369 non-null    float64
 1   bathrooms       7369 non-null    float64
 2   sqft_living     7369 non-null    int64  
 3   sqft_lot        7369 non-null    int64  
 4   floors          7369 non-null    float64
 5   view            7369 non-null    int64  
 6   condition       7369 non-null    int64  
 7   grade           7369 non-null    int64  
 8   lat              7369 non-null    float64
 9   long             7369 non-null    float64
 10  date_month      7369 non-null    int64  
 11  renovated        7369 non-null    int64  
 12  waterfront_0    7369 non-null    uint8  
 13  waterfront_1    7369 non-null    uint8  
 14  zipcode_98001   7369 non-null    uint8  
 15  zipcode_98002   7369 non-null    uint8  
 16  zipcode_98003   7369 non-null    uint8  
 17  zipcode_98004   7369 non-null    uint8  
 18  zipcode_98005   7369 non-null    uint8  
 19  zipcode_98006   7369 non-null    uint8  
 20  zipcode_98007   7369 non-null    uint8  
 21  zipcode_98008   7369 non-null    uint8  
 22  zipcode_98010   7369 non-null    uint8  
 23  zipcode_98011   7369 non-null    uint8  
 24  zipcode_98014   7369 non-null    uint8  
 25  zipcode_98019   7369 non-null    uint8  
 26  zipcode_98022   7369 non-null    uint8  
 27  zipcode_98023   7369 non-null    uint8  
 28  zipcode_98024   7369 non-null    uint8  
 29  zipcode_98027   7369 non-null    uint8  
 30  zipcode_98028   7369 non-null    uint8  
 31  zipcode_98029   7369 non-null    uint8  
 32  zipcode_98030   7369 non-null    uint8  
 33  zipcode_98031   7369 non-null    uint8  
 34  zipcode_98032   7369 non-null    uint8  
 35  zipcode_98033   7369 non-null    uint8  
 36  zipcode_98034   7369 non-null    uint8  
 37  zipcode_98038   7369 non-null    uint8  
 38  zipcode_98039   7369 non-null    uint8  
 39  zipcode_98040   7369 non-null    uint8  
 40  zipcode_98042   7369 non-null    uint8  
 41  zipcode_98045   7369 non-null    uint8  
 42  zipcode_98052   7369 non-null    uint8  
 43  zipcode_98053   7369 non-null    uint8  
 44  zipcode_98055   7369 non-null    uint8  
 45  zipcode_98056   7369 non-null    uint8  
 46  zipcode_98058   7369 non-null    uint8  
 47  zipcode_98059   7369 non-null    uint8  
 48  zipcode_98065   7369 non-null    uint8  
 49  zipcode_98070   7369 non-null    uint8  
 50  zipcode_98072   7369 non-null    uint8  
 51  zipcode_98074   7369 non-null    uint8  
 52  zipcode_98075   7369 non-null    uint8  
 53  zipcode_98077   7369 non-null    uint8  
 54  zipcode_98092   7369 non-null    uint8  
 55  zipcode_98102   7369 non-null    uint8  
 56  zipcode_98103   7369 non-null    uint8  
 57  zipcode_98105   7369 non-null    uint8  
 58  zipcode_98106   7369 non-null    uint8  
 59  zipcode_98107   7369 non-null    uint8  
 60  zipcode_98108   7369 non-null    uint8  
 61  zipcode_98109   7369 non-null    uint8  
 62  zipcode_98112   7369 non-null    uint8  
 63  zipcode_98115   7369 non-null    uint8  
 64  zipcode_98116   7369 non-null    uint8  
 65  zipcode_98117   7369 non-null    uint8  
 66  zipcode_98118   7369 non-null    uint8  
 67  zipcode_98119   7369 non-null    uint8  
 68  zipcode_98122   7369 non-null    uint8  
 69  zipcode_98125   7369 non-null    uint8  
 70  zipcode_98126   7369 non-null    uint8
```

```

71 zipcode_98133 7369 non-null uint8
72 zipcode_98136 7369 non-null uint8
73 zipcode_98144 7369 non-null uint8
74 zipcode_98146 7369 non-null uint8
75 zipcode_98148 7369 non-null uint8
76 zipcode_98155 7369 non-null uint8
77 zipcode_98166 7369 non-null uint8
78 zipcode_98168 7369 non-null uint8
79 zipcode_98177 7369 non-null uint8
80 zipcode_98178 7369 non-null uint8
81 zipcode_98188 7369 non-null uint8
82 zipcode_98198 7369 non-null uint8
83 zipcode_98199 7369 non-null uint8
dtypes: float64(5), int64(7), uint8(72)
memory usage: 1.2 MB

```

In [196... `print(X.shape, y.shape)`

(7369, 84) (7369,)

## Scaling the data

In [197... `colname = list(X)`

In [198... `sc_X = StandardScaler()`  
`sc_X = sc_X.fit_transform(X)`

## Model and Interpretation

### Baseline model (Most correlated features)

In [199... `# y_train = pd.DataFrame(y_train)`

In [200... `# X.dropna(inplace=True)`

In [201... `y.shape`

Out[201... (7369,)

In [202... `y = pd.DataFrame(y)`  
`X = pd.DataFrame(X) # columns`

In [203... `X.reset_index(drop=True, inplace=True)`  
`y.reset_index(drop=True, inplace=True)`

In [204... `# Run OLS Regression - using the most correlated features for the model`  
`# X_train_base = X_train[best_features_base]`  
`#Fitting the training data`  
`X_ols = sm.add_constant(sc_X)`  
`model_base = sm.OLS(y, X_ols).fit()`  
`model_base.summary()`

Out[204... OLS Regression Results

<b>Dep. Variable:</b>	price	<b>R-squared:</b>	0.796
<b>Model:</b>	OLS	<b>Adj. R-squared:</b>	0.794
<b>Method:</b>	Least Squares	<b>F-statistic:</b>	347.1
<b>Date:</b>	Thu, 13 Oct 2022	<b>Prob (F-statistic):</b>	0.00

**Time:** 14:56:21    **Log-Likelihood:** -1.0051e+05  
**No. Observations:** 7369    **AIC:** 2.012e+05  
**Df Residuals:** 7286    **BIC:** 2.018e+05  
**Df Model:** 82  
**Covariance Type:** nonrobust

	<b>coef</b>	<b>std err</b>	<b>t</b>	<b>P&gt; t </b>	<b>[0.025</b>	<b>.975]</b>
<b>const</b>	6.245e+05	3348.994	186.465	0.000	6.18e+05	6.31e+05
<b>x1</b>	-3.023e+04	3075.215	-9.832	0.000	-3.63e+04	-2.42e+04
<b>x2</b>	9048.8361	3801.683	2.380	0.017	1596.436	1.65e+04
<b>x3</b>	2.191e+05	4587.146	47.768	0.000	2.1e+05	2.28e+05
<b>x4</b>	-5403.1022	2812.628	-1.921	0.055	-1.09e+04	110.464
<b>x5</b>	-1.764e+04	3219.273	-5.478	0.000	-2.39e+04	-1.13e+04
<b>x6</b>	4.958e+04	2953.452	16.788	0.000	4.38e+04	5.54e+04
<b>x7</b>	2.288e+04	2531.545	9.037	0.000	1.79e+04	2.78e+04
<b>x8</b>	8.996e+04	4189.616	21.472	0.000	8.17e+04	9.82e+04
<b>x9</b>	3.139e+04	1.86e+04	1.687	0.092	-5084.551	6.79e+04
<b>x10</b>	5798.8329	1.53e+04	0.380	0.704	-2.41e+04	3.57e+04
<b>x11</b>	-9239.7977	2401.931	-3.847	0.000	-1.39e+04	-4531.317
<b>x12</b>	-9968.4999	2439.858	-4.086	0.000	-1.48e+04	-5185.673
<b>x13</b>	1.116e+16	3.29e+16	0.339	0.734	-5.34e+16	7.57e+16
<b>x14</b>	1.116e+16	3.29e+16	0.339	0.734	-5.34e+16	7.57e+16
<b>x15</b>	-2.309e+16	6.81e+16	-0.339	0.734	-1.57e+17	1.1e+17
<b>x16</b>	-1.379e+16	4.07e+16	-0.339	0.734	-9.35e+16	6.59e+16
<b>x17</b>	-2.422e+16	7.14e+16	-0.339	0.734	-1.64e+17	1.16e+17
<b>x18</b>	-2.963e+16	8.73e+16	-0.339	0.734	-2.01e+17	1.42e+17
<b>x19</b>	-2.309e+16	6.81e+16	-0.339	0.734	-1.57e+17	1.1e+17
<b>x20</b>	-3.931e+16	1.16e+17	-0.339	0.734	-2.67e+17	1.88e+17
<b>x21</b>	-1.563e+16	4.61e+16	-0.339	0.734	-1.06e+17	7.47e+16
<b>x22</b>	-2.826e+16	8.33e+16	-0.339	0.734	-1.92e+17	1.35e+17
<b>x23</b>	-1.044e+16	3.08e+16	-0.339	0.734	-7.08e+16	4.99e+16
<b>x24</b>	-2.144e+16	6.32e+16	-0.339	0.734	-1.45e+17	1.02e+17
<b>x25</b>	-1.076e+16	3.17e+16	-0.339	0.734	-7.29e+16	5.14e+16
<b>x26</b>	-1.428e+16	4.21e+16	-0.339	0.734	-9.68e+16	6.82e+16
<b>x27</b>	-1.474e+16	4.35e+16	-0.339	0.734	-9.99e+16	7.05e+16
<b>x28</b>	-3.47e+16	1.02e+17	-0.339	0.734	-2.35e+17	1.66e+17
<b>x29</b>	-1.044e+16	3.08e+16	-0.339	0.734	-7.08e+16	4.99e+16
<b>x30</b>	-3.489e+16	1.03e+17	-0.339	0.734	-2.37e+17	1.67e+17
<b>x31</b>	-2.568e+16	7.57e+16	-0.339	0.734	-1.74e+17	1.23e+17
<b>x32</b>	-1.727e+16	5.09e+16	-0.339	0.734	-1.17e+17	8.26e+16
<b>x33</b>	-1.93e+16	5.69e+16	-0.339	0.734	-1.31e+17	9.22e+16
<b>x34</b>	-2.175e+16	6.41e+16	-0.339	0.734	-1.47e+17	1.04e+17
<b>x35</b>	-1.766e+16	5.21e+16	-0.339	0.734	-1.2e+17	8.44e+16
<b>x36</b>	-3.018e+16	8.9e+16	-0.339	0.734	-2.05e+17	1.44e+17
<b>x37</b>	-3.722e+16	1.1e+17	-0.339	0.734	-2.52e+17	1.78e+17

x38	-1.964e+16	5.79e+16	-0.339	0.734	-1.33e+17	9.39e+16
x39	-1.166e+16	3.44e+16	-0.339	0.734	-7.91e+16	5.58e+16
x40	-2.985e+16	8.8e+16	-0.339	0.734	-2.02e+17	1.43e+17
x41	-2.542e+16	7.5e+16	-0.339	0.734	-1.72e+17	1.22e+17
x42	-1.542e+16	4.54e+16	-0.339	0.734	-1.05e+17	7.37e+16
x43	-3.376e+16	9.95e+16	-0.339	0.734	-2.29e+17	1.61e+17
x44	-1.379e+16	4.07e+16	-0.339	0.734	-9.35e+16	6.59e+16
x45	-2.22e+16	6.55e+16	-0.339	0.734	-1.51e+17	1.06e+17
x46	-2.503e+16	7.38e+16	-0.339	0.734	-1.7e+17	1.2e+17
x47	-2.907e+16	8.57e+16	-0.339	0.734	-1.97e+17	1.39e+17
x48	-2.112e+16	6.23e+16	-0.339	0.734	-1.43e+17	1.01e+17
x49	-1.606e+16	4.73e+16	-0.339	0.734	-1.09e+17	7.68e+16
x50	-1.379e+16	4.07e+16	-0.339	0.734	-9.35e+16	6.59e+16
x51	-2.476e+16	7.3e+16	-0.339	0.734	-1.68e+17	1.18e+17
x52	-2.449e+16	7.22e+16	-0.339	0.734	-1.66e+17	1.17e+17
x53	-1.998e+16	5.89e+16	-0.339	0.734	-1.35e+17	9.55e+16
x54	-1.519e+16	4.48e+16	-0.339	0.734	-1.03e+17	7.26e+16
x55	-1.895e+16	5.59e+16	-0.339	0.734	-1.28e+17	9.06e+16
x56	-2.031e+16	5.99e+16	-0.339	0.734	-1.38e+17	9.71e+16
x57	-3.756e+16	1.11e+17	-0.339	0.734	-2.55e+17	1.8e+17
x58	-3.114e+16	9.18e+16	-0.339	0.734	-2.11e+17	1.49e+17
x59	-3.207e+16	9.46e+16	-0.339	0.734	-2.17e+17	1.53e+17
x60	-2.755e+16	8.12e+16	-0.339	0.734	-1.87e+17	1.32e+17
x61	-2.555e+16	7.53e+16	-0.339	0.734	-1.73e+17	1.22e+17
x62	-1.981e+16	5.84e+16	-0.339	0.734	-1.34e+17	9.47e+16
x63	-3.238e+16	9.55e+16	-0.339	0.734	-2.19e+17	1.55e+17
x64	-4.494e+16	1.32e+17	-0.339	0.734	-3.05e+17	2.15e+17
x65	-3.535e+16	1.04e+17	-0.339	0.734	-2.4e+17	1.69e+17
x66	-4.227e+16	1.25e+17	-0.339	0.734	-2.87e+17	2.02e+17
x67	-3.866e+16	1.14e+17	-0.339	0.734	-2.62e+17	1.85e+17
x68	-2.755e+16	8.12e+16	-0.339	0.734	-1.87e+17	1.32e+17
x69	-3.018e+16	8.9e+16	-0.339	0.734	-2.05e+17	1.44e+17
x70	-3.217e+16	9.49e+16	-0.339	0.734	-2.18e+17	1.54e+17
x71	-3.176e+16	9.36e+16	-0.339	0.734	-2.15e+17	1.52e+17
x72	-3.356e+16	9.89e+16	-0.339	0.734	-2.28e+17	1.6e+17
x73	-3.072e+16	9.06e+16	-0.339	0.734	-2.08e+17	1.47e+17
x74	-3.581e+16	1.06e+17	-0.339	0.734	-2.43e+17	1.71e+17
x75	-2.422e+16	7.14e+16	-0.339	0.734	-1.64e+17	1.16e+17
x76	-8.254e+15	2.43e+16	-0.339	0.734	-5.6e+16	3.94e+16
x77	-3.227e+16	9.52e+16	-0.339	0.734	-2.19e+17	1.54e+17
x78	-2.657e+16	7.83e+16	-0.339	0.734	-1.8e+17	1.27e+17
x79	-2.422e+16	7.14e+16	-0.339	0.734	-1.64e+17	1.16e+17
x80	-2.963e+16	8.73e+16	-0.339	0.734	-2.01e+17	1.42e+17
x81	-2.767e+16	8.16e+16	-0.339	0.734	-1.88e+17	1.32e+17

```

x82 -1.708e+16 5.03e+16 -0.339 0.734 -1.16e+17 8.16e+16
x83 -2.422e+16 7.14e+16 -0.339 0.734 -1.64e+17 1.16e+17
x84 -3.765e+16 1.11e+17 -0.339 0.734 -2.55e+17 1.8e+17

Omnibus: 6178.878 Durbin-Watson: 1.993
Prob(Omnibus): 0.000 Jarque-Bera (JB): 682302.263
Skew: 3.425 Prob(JB): 0.00
Kurtosis: 49.640 Cond. No. 4.78e+15

```

Notes:

- [1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
- [2] The smallest eigenvalue is 1.16e-27. This might indicate that there are strong multicollinearity problems or that the design matrix is singular.

In [205...]

```

# predict on X
y_pred = model_base.predict(X_ols)
print(y_pred)

[ 585285.  524425. 1390829. ...  545853.  979721.  460183.]

```

## RMSE/MSE

In [206...]

```

rms_1 = mean_squared_error(y, y_pred)
print('MSE', rms_1)

MSE 41221262647.66047

```

In [207...]

```

rmse_1 = np.sqrt(rms_1)
print('RMSE', rmse_1)

RMSE 203030.201319066

```

R Squared is only 81% - let's try to use the stepwise\_selection function to see if the R Squared increases.

## Model 2, using stepwise\_selection function

Using statsmodels stepwise selection in order to select features based on its p-values.

In [208...]

```

import statsmodels.api as sm

def stepwise_selection(X, y,
                      initial_list=[],
                      threshold_in=0.01,
                      threshold_out = 0.05,
                      verbose=True):
    """
    Perform a forward-backward feature selection
    based on p-value from statsmodels.api.OLS
    Arguments:
        X - pandas.DataFrame with candidate features
        y - list-like with the target
        initial_list - list of features to start with (column names of X)
        threshold_in - include a feature if its p-value < threshold_in
        threshold_out - exclude a feature if its p-value > threshold_out
        verbose - whether to print the sequence of inclusions and exclusions
    Returns: list of selected features
    Always set threshold_in < threshold_out to avoid infinite looping.
    See https://en.wikipedia.org/wiki/Stepwise_regression for the details
    """
    included = list(initial_list)
    while True:
        changed=False

```

```

# forward step
excluded = list(set(X.columns)-set(included))
new_pval = pd.Series(index=excluded)
for new_column in excluded:
    model = sm.OLS(y, sm.add_constant(pd.DataFrame(X[included+[new_column]]))).fit()
    new_pval[new_column] = model.pvalues[new_column]
best_pval = new_pval.min()
if best_pval < threshold_in:
    best_feature = new_pval.idxmin()
    included.append(best_feature)
    changed=True
    if verbose:
        print('Add  {:30} with p-value {:.6}'.format(best_feature, best_pval))

# backward step
model = sm.OLS(y, sm.add_constant(pd.DataFrame(X[included]))).fit()
# use all coefs except intercept
pvalues = model.pvalues.iloc[1:]
worst_pval = pvalues.max() # null if pvalues is empty
if worst_pval > threshold_out:
    # changed=True
    # worst_feature = pvalues.argmax()
    # included.remove(worst_feature)
    # if verbose:
    #     print('Drop {:30} with p-value {:.6}'.format(worst_feature, worst_pval))
if not changed:
    break
return included

```

In [209...]

```

result = stepwise_selection(X, y, verbose = True)
print('resulting features:')
print(result)

```

Add	grade	with p-value 0.0
Add	sqft_living	with p-value 0.0
Add	lat	with p-value 2.42007e-164
Add	waterfront_1	with p-value 1.67653e-180
Add	waterfront_0	with p-value 6.81662e-213
Add	zipcode_98004	with p-value 1.29421e-88
Add	zipcode_98039	with p-value 6.18844e-86
Add	zipcode_98112	with p-value 1.69006e-87
Add	view	with p-value 3.43324e-82
Add	long	with p-value 1.7e-45
Add	zipcode_98040	with p-value 1.42666e-39
Add	zipcode_98105	with p-value 2.04925e-35
Add	condition	with p-value 8.71856e-31
Add	zipcode_98119	with p-value 1.38336e-26
Add	bedrooms	with p-value 9.45259e-26
Add	zipcode_98155	with p-value 8.63517e-23
Add	zipcode_98133	with p-value 9.14686e-24
Add	zipcode_98028	with p-value 6.24159e-22
Add	zipcode_98102	with p-value 2.69847e-19
Add	zipcode_98177	with p-value 2.0398e-16
Add	zipcode_98011	with p-value 3.06666e-14
Add	zipcode_98072	with p-value 2.03528e-15
Add	zipcode_98125	with p-value 6.34316e-16
Add	zipcode_98034	with p-value 2.02094e-18
Add	zipcode_98077	with p-value 1.17851e-15
Add	zipcode_98019	with p-value 3.44484e-13
Add	zipcode_98109	with p-value 2.19304e-11
Add	zipcode_98178	with p-value 1.43299e-09
Add	zipcode_98070	with p-value 7.78935e-10
Add	zipcode_98122	with p-value 1.25999e-07
Add	zipcode_98166	with p-value 2.16511e-07
Add	renovated	with p-value 1.02948e-06
Add	zipcode_98053	with p-value 1.92387e-06
Add	zipcode_98014	with p-value 1.46544e-06
Add	zipcode_98065	with p-value 2.03e-06
Add	zipcode_98199	with p-value 8.71529e-07
Add	zipcode_98052	with p-value 8.8402e-06
Add	zipcode_98056	with p-value 2.82845e-05

```

Add zipcode_98116      with p-value 0.000122841
Add date_month          with p-value 0.000159867
Add zipcode_98022      with p-value 0.000253374
Add floors              with p-value 0.000126604
Add zipcode_98144      with p-value 0.00012259
Add zipcode_98136      with p-value 0.000130705
Add zipcode_98074      with p-value 0.000185135
Add zipcode_98103      with p-value 0.00138966
Add zipcode_98033      with p-value 0.0022897
Add zipcode_98115      with p-value 0.0029891
Add zipcode_98198      with p-value 0.00260878
Add zipcode_98107      with p-value 0.0030569
Add zipcode_98010      with p-value 0.00826678

resulting features:
['grade', 'sqft_living', 'lat', 'waterfront_1', 'waterfront_0', 'zipcode_98004', 'zipcode_98039', 'zipcode_98112', 'view', 'long', 'zipcode_98040', 'zipcode_98105', 'condition', 'zipcode_98119', 'bedrooms', 'zipcode_98155', 'zipcode_98133', 'zipcode_98028', 'zipcode_98102', 'zipcode_98177', 'zipcode_98011', 'zipcode_98072', 'zipcode_98125', 'zipcode_98034', 'zipcode_98077', 'zipcode_98019', 'zipcode_98109', 'zipcode_98178', 'zipcode_98070', 'zipcode_98122', 'zipcode_98166', 'renovated', 'zipcode_98053', 'zipcode_98014', 'zipcode_98065', 'zipcode_98199', 'zipcode_98052', 'zipcode_98056', 'zipcode_98116', 'date_month', 'zipcode_98022', 'floors', 'zipcode_98144', 'zipcode_98136', 'zipcode_98074', 'zipcode_98103', 'zipcode_98033', 'zipcode_98115', 'zipcode_98198', 'zipcode_98107', 'zipcode_98010']

```

The function has chosen the following features:

```
In [229... best_features = result
```

```
In [230... X_2 = X[best_features]
```

```
In [231... X_2.shape
```

```
Out[231... (7369, 51)
```

## Model 2, using stepwise\_selection function

```
In [232... X_2 = sm.add_constant(X_2)
model_2 = sm.OLS(y, X_2).fit()
model_2.summary()
```

OLS Regression Results						
Dep. Variable:	price	R-squared:	0.794			
Model:	OLS	Adj. R-squared:	0.792			
Method:	Least Squares	F-statistic:	563.3			
Date:	Thu, 13 Oct 2022	Prob (F-statistic):	0.00			
Time:	15:03:14	Log-Likelihood:	-1.0056e+05			
No. Observations:	7369	AIC:	2.012e+05			
Df Residuals:	7318	BIC:	2.016e+05			
Df Model:	50					
Covariance Type:	nonrobust					
	coef	std err	t	P> t	[0.025	0.975]
<b>const</b>	-3.666e+07	2.56e+06	-14.309	0.000	-4.17e+07	-3.16e+07
<b>grade</b>	8.339e+04	3596.733	23.186	0.000	7.63e+04	9.04e+04
<b>sqft_living</b>	229.6969	4.486	51.204	0.000	220.903	238.491
<b>lat</b>	9.747e+05	3.41e+04	28.612	0.000	9.08e+05	1.04e+06
<b>waterfront_1</b>	-1.796e+07	1.28e+06	-14.018	0.000	-2.05e+07	-1.54e+07
<b>waterfront_0</b>	-1.87e+07	1.28e+06	-14.599	0.000	-2.12e+07	-1.62e+07
<b>zipcode_98004</b>	4.988e+05	1.91e+04	26.154	0.000	4.61e+05	5.36e+05

## King County Data Analysis\_FV

<b>zipcode_98039</b>	1.115e+06	4.67e+04	23.881	0.000	1.02e+06	1.21e+06
<b>zipcode_98112</b>	4.184e+05	1.78e+04	23.498	0.000	3.83e+05	4.53e+05
<b>view</b>	5.18e+04	2973.261	17.423	0.000	4.6e+04	5.76e+04
<b>long</b>	-6.863e+04	2.94e+04	-2.334	0.020	-1.26e+05	-1.1e+04
<b>zipcode_98040</b>	2.619e+05	1.87e+04	13.997	0.000	2.25e+05	2.99e+05
<b>zipcode_98105</b>	2.141e+05	1.84e+04	11.614	0.000	1.78e+05	2.5e+05
<b>condition</b>	3.47e+04	3602.975	9.630	0.000	2.76e+04	4.18e+04
<b>zipcode_98119</b>	2.405e+05	2.08e+04	11.573	0.000	2e+05	2.81e+05
<b>bedrooms</b>	-2.957e+04	3041.877	-9.721	0.000	-3.55e+04	-2.36e+04
<b>zipcode_98155</b>	-2.435e+05	1.92e+04	-12.710	0.000	-2.81e+05	-2.06e+05
<b>zipcode_98133</b>	-2.055e+05	1.84e+04	-11.164	0.000	-2.42e+05	-1.69e+05
<b>zipcode_98028</b>	-2.678e+05	2.29e+04	-11.702	0.000	-3.13e+05	-2.23e+05
<b>zipcode_98102</b>	2.804e+05	2.74e+04	10.246	0.000	2.27e+05	3.34e+05
<b>zipcode_98177</b>	-1.636e+05	2.06e+04	-7.954	0.000	-2.04e+05	-1.23e+05
<b>zipcode_98011</b>	-2.457e+05	2.67e+04	-9.202	0.000	-2.98e+05	-1.93e+05
<b>zipcode_98072</b>	-2.328e+05	2.37e+04	-9.806	0.000	-2.79e+05	-1.86e+05
<b>zipcode_98125</b>	-1.403e+05	1.86e+04	-7.561	0.000	-1.77e+05	-1.04e+05
<b>zipcode_98034</b>	-1.36e+05	1.66e+04	-8.205	0.000	-1.69e+05	-1.04e+05
<b>zipcode_98077</b>	-3.134e+05	3.68e+04	-8.511	0.000	-3.86e+05	-2.41e+05
<b>zipcode_98019</b>	-3.028e+05	3.95e+04	-7.675	0.000	-3.8e+05	-2.25e+05
<b>zipcode_98109</b>	2.346e+05	2.78e+04	8.424	0.000	1.8e+05	2.89e+05
<b>zipcode_98178</b>	-1.177e+05	1.97e+04	-5.964	0.000	-1.56e+05	-7.9e+04
<b>zipcode_98070</b>	-2.056e+05	4.02e+04	-5.110	0.000	-2.84e+05	-1.27e+05
<b>zipcode_98122</b>	1.34e+05	1.87e+04	7.155	0.000	9.73e+04	1.71e+05
<b>zipcode_98166</b>	-8.452e+04	2.09e+04	-4.050	0.000	-1.25e+05	-4.36e+04
<b>renovated</b>	-1820.4906	440.589	-4.132	0.000	-2684.171	-956.810
<b>zipcode_98053</b>	-2.17e+05	4.01e+04	-5.409	0.000	-2.96e+05	-1.38e+05
<b>zipcode_98014</b>	-2.777e+05	5.14e+04	-5.404	0.000	-3.78e+05	-1.77e+05
<b>zipcode_98065</b>	-1.873e+05	3.53e+04	-5.301	0.000	-2.57e+05	-1.18e+05
<b>zipcode_98199</b>	1.102e+05	1.62e+04	6.825	0.000	7.86e+04	1.42e+05
<b>zipcode_98052</b>	-6.204e+04	1.76e+04	-3.533	0.000	-9.65e+04	-2.76e+04
<b>zipcode_98056</b>	-7.919e+04	2.17e+04	-3.656	0.000	-1.22e+05	-3.67e+04
<b>zipcode_98116</b>	9.345e+04	1.64e+04	5.687	0.000	6.12e+04	1.26e+05
<b>date_month</b>	-2829.6283	773.793	-3.657	0.000	-4346.485	-1312.772
<b>zipcode_98022</b>	1.135e+05	3.83e+04	2.966	0.003	3.85e+04	1.89e+05
<b>floors</b>	-3.085e+04	6239.912	-4.943	0.000	-4.31e+04	-1.86e+04
<b>zipcode_98144</b>	8.091e+04	1.58e+04	5.131	0.000	5e+04	1.12e+05
<b>zipcode_98136</b>	8.423e+04	1.84e+04	4.583	0.000	4.82e+04	1.2e+05
<b>zipcode_98074</b>	-6.538e+04	2.32e+04	-2.821	0.005	-1.11e+05	-2e+04
<b>zipcode_98103</b>	7.104e+04	1.6e+04	4.431	0.000	3.96e+04	1.02e+05
<b>zipcode_98033</b>	7.359e+04	1.91e+04	3.858	0.000	3.62e+04	1.11e+05
<b>zipcode_98115</b>	4.748e+04	1.39e+04	3.422	0.001	2.03e+04	7.47e+04
<b>zipcode_98198</b>	-6.76e+04	2.29e+04	-2.954	0.003	-1.12e+05	-2.27e+04
<b>zipcode_98107</b>	5.99e+04	2.09e+04	2.871	0.004	1.9e+04	1.01e+05

```
zipcode_98010    1.379e+05  5.22e+04   2.642  0.008  3.56e+04  2.4e+05

  Omnibus: 6120.856  Durbin-Watson:      1.990
  Prob(Omnibus):    0.000  Jarque-Bera (JB):  661979.758
  Skew:        3.377  Prob(JB):          0.00
  Kurtosis:     48.939  Cond. No.       8.07e+16
```

Notes:

- [1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
- [2] The smallest eigenvalue is 7.11e-24. This might indicate that there are strong multicollinearity problems or that the design matrix is singular.

In [233...]

```
## predict on X
y_pred_2 = model_2.predict(X_2)
print(y_pred_2)
```

```
0      5.912843e+05
1      4.998293e+05
2      1.382598e+06
3      3.467582e+05
4      4.815624e+05
...
7364    4.381029e+05
7365    1.400076e+06
7366    5.309018e+05
7367    9.821098e+05
7368    4.587546e+05
Length: 7369, dtype: float64
```

MSE/RMSE

In [234...]

```
rms_2 = mean_squared_error(y, y_pred_2)
print('MSE', rms_2)
```

MSE 41716383255.777504

In [235...]

```
rmse_2 = np.sqrt(rms_2)
print('RMSE', rmse_2)
```

RMSE 204245.88920166178

## Evaluating and Interpreting the Regression Model 1

Using LinearRegression() to fit the final model.

In [236...]

```
linreg = LinearRegression()

# Fit the model on X and y final
linreg.fit(X_2, y)
```

Out[236...]

LinearRegression()

In [237...]

```
# calcualte y_hat
y_hat = linreg.predict(X_2)
y_hat
```

Out[237...]

```
array([[ 591284.26274724],
       [ 499829.25000514],
       [1382598.09775002],
       ...,
       [ 530901.77924874],
```

```
[ 982109.81156497],
[ 458754.64043183]))
```

In [238...]

```
# Calculate intercept
print('Model Intercept:', linreg.intercept_)
```

```
Model Intercept: [-54993452.91998314]
```

In [239...]

```
# We will use sklearn.metrics to calculate the test
# data Mean Square Error

residuals = y - y_hat
```

Root Mean Squared Error - the average deviation between the predicted house and the actual house price is roughly \$200K.

R squared - 79% of the variability observed in the house prices is explained by the independent variables 9 (i.e sqft\_living, view, grade, waterfront...etc.) in a regression model.

## Homoscedasticity

In [246...]

```
# Creating a new data frame to store the predicted and the actual values
y['actual'] = pd.DataFrame(y)

y_hat['predict'] = pd.DataFrame(y_hat)
```

In [248...]

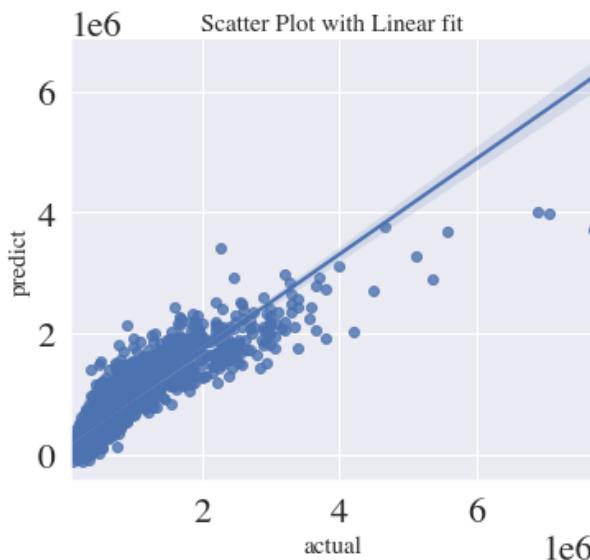
```
# Merging the data frames

resid = pd.concat([y['actual'], y_hat['predict']], axis=1,)
```

In [249...]

```
# Plotting the error terms with predicted and actual values.

sns.lmplot(x='actual', y='predict', data=resid)
plt.title("Scatter Plot with Linear fit");
```



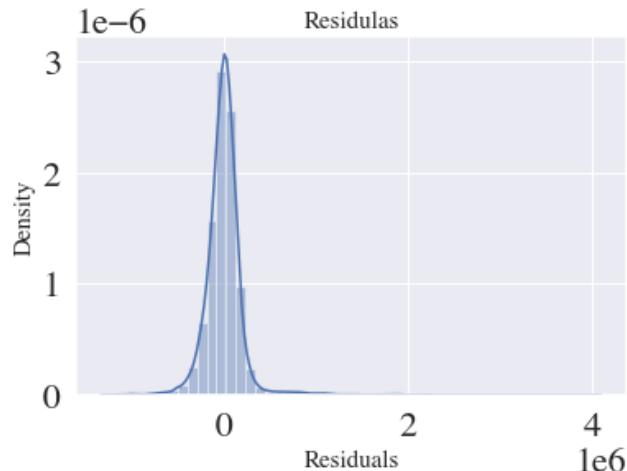
The assumptions validated since the graph shows similar variances for actual and predicted. They follow a linear direction.

Plotting a histogram of the residuals. Ensuring that the residuals are distributed normally.

In [250...]

```
sns.distplot(residuals)
plt.title('Residuals')
plt.xlabel('Residuals')
```

```
plt.ylabel('Density')
plt.show()
```



For the most part the the residuals do follow normal distribution.

### Conclusions:

I have determined that the most valuable assets of a house in King County are zip code, view, grade and condition, square footage, and seasonality. Below are investment recommendations for Edegon and Company:

**LOCATION:** Invest in the zip codes where the value of the house is higher than average in order to increase the chances of maintaining the house value. Consider investing in zip codes 98118, 98116, 98109, 98122, whose market value is currently mid-range but also include some of the most profitable housing features.

**VIEW:** Prioritize a house with a great view, particularly if it has a waterfront.

**SEASONALITY:** Sell during the spring season when prices are at their peak. On average, During the months of March and April, the average price of a house increases by 34,000- 38,000 dollars.

**GRADE** Very important, more than house age. Keeping high end finishes and choosing high quality materials will lead to a profitable outcome.

**SIZE:** Look for large living area rather than a lot size! Houses ranging from 2,500 sqft to 5,000 sqft have a high correlation to house prices.