1893534_jupyterfile

November 23, 2019

1 King Country, USA House Price Prediction

1.0.1 Importing Libraries

In [1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import statsmodels.api as sm
import scipy.stats as stats
from sklearn.feature_selection import f_regression
from statsmodels.stats.anova import anova_lm
import seaborn as sns

sns.set()
pd.set_option('display.notebook_repr_html', True)
pd.set_option('display.precision', 2)
%matplotlib notebook
plt.rcParams['figure.figsize'] = 10, 10
```

1.0.2 Importing Dataset

In [2]:
```
df = pd.read_csv('kc_house_data1.csv')
```

In [3]:
```
df.head()
```

Out[3]:

	price	bedrooms	bathrooms	sqft_living	sqft_lot	floors	waterfront	view	condition	grade	sqft_above	sqft_basement	yr_built	yr_renovated
0	221900.0	3	1.00	1180	5650	1.0	0	0	3	7	1180	0	0	-1991
1	538000.0	3	2.25	2570	7242	2.0	0	0	3	7	2170	400	-4	0
2	180000.0	2	1.00	770	10000	1.0	0	0	3	6	770	0	-22	-1991
3	604000.0	4	3.00	1960	5000	1.0	0	0	5	7	1050	910	10	-1991
4	510000.0	3	2.00	1680	8080	1.0	0	0	3	8	1680	0	32	-1991

```
             lat    long
        0  47.51 -122.26
        1  47.72 -122.32
        2  47.74 -122.23
        3  47.52 -122.39
        4  47.62 -122.05
```

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

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 21613 entries, 0 to 21612
Data columns (total 16 columns):
price            21613 non-null float64
bedrooms         21613 non-null int64
bathrooms        21613 non-null float64
sqft_living      21613 non-null int64
sqft_lot         21613 non-null int64
floors           21613 non-null float64
waterfront       21613 non-null int64
view             21613 non-null int64
condition        21613 non-null int64
grade            21613 non-null int64
sqft_above       21613 non-null int64
sqft_basement    21613 non-null int64
yr_built         21613 non-null int64
yr_renovated     21613 non-null int64
lat              21613 non-null float64
long             21613 non-null float64
dtypes: float64(5), int64(11)
memory usage: 2.6 MB
```

```
In [5]: df['floors'].value_counts()
```

```
Out[5]: 1.0    10680
        2.0     8241
        1.5     1910
        3.0      613
        2.5      161
        3.5        8
        Name: floors, dtype: int64
```

```
In [6]: X = df.iloc[:, 1:]
        y = df.iloc[:, 0]
```

```
In [7]: X.describe()
```

```
Out[7]:        bedrooms  bathrooms  sqft_living  sqft_lot    floors  waterfront  \
        count  21613.00   21613.00     21613.00  2.16e+04  21613.00    2.16e+04
```

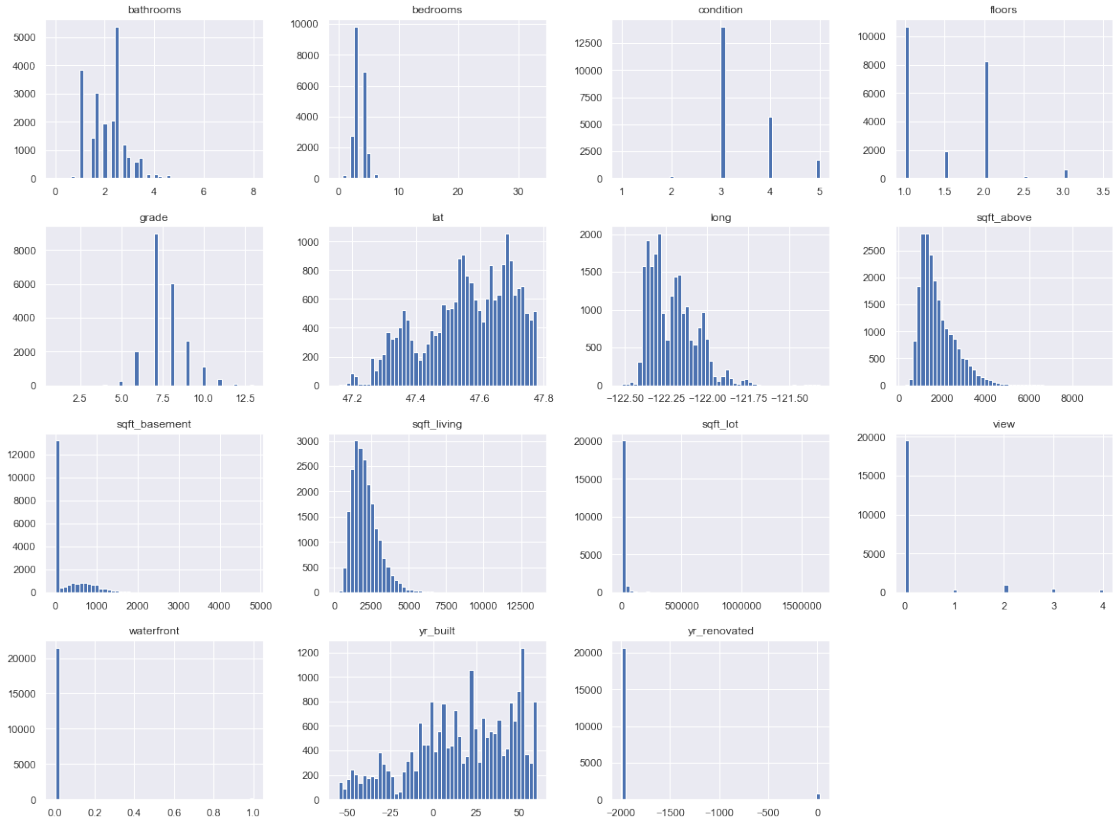
```
mean       3.37       2.11      2079.90  1.51e+04      1.49    7.54e-03
std        0.93       0.77       918.44  4.14e+04      0.54    8.65e-02
min        0.00       0.00       290.00  5.20e+02      1.00    0.00e+00
25%        3.00       1.75      1427.00  5.04e+03      1.00    0.00e+00
50%        3.00       2.25      1910.00  7.62e+03      1.50    0.00e+00
75%        4.00       2.50      2550.00  1.07e+04      2.00    0.00e+00
max       33.00       8.00     13540.00  1.65e+06      3.50    1.00e+00

             view  condition     grade  sqft_above  sqft_basement  yr_built  \
count   21613.00   21613.00  21613.00    21613.00       21613.00  21613.00
mean        0.23       3.41      7.66     1788.39         291.51     16.01
std         0.77       0.65      1.18      828.09         442.58     29.37
min         0.00       1.00      1.00      290.00           0.00    -55.00
25%         0.00       3.00      7.00     1190.00           0.00     -4.00
50%         0.00       3.00      7.00     1560.00           0.00     20.00
75%         0.00       4.00      8.00     2210.00         560.00     42.00
max         4.00       5.00     13.00     9410.00        4820.00     60.00

       yr_renovated       lat      long
count      21613.00  21613.00  21613.00
mean       -1906.60     47.56   -122.21
std          401.68      0.14      0.14
min        -1991.00     47.16   -122.52
25%        -1991.00     47.47   -122.33
50%        -1991.00     47.57   -122.23
75%        -1991.00     47.68   -122.12
max           24.00     47.78   -121.31
```

1.0.3 For Plotting Histigram

```
In [8]: X.hist(bins=50, figsize=(20, 15))
        plt.show()
```




```
In [9]: y.head()
```

```
Out[9]: 0    221900.0
        1    538000.0
        2    180000.0
        3    604000.0
        4    510000.0
        Name: price, dtype: float64
```

```
In [10]: y.describe()
```

```
Out[10]: count    2.16e+04
         mean     5.40e+05
         std      3.67e+05
         min      7.50e+04
         25%      3.22e+05
         50%      4.50e+05
         75%      6.45e+05
         max      7.70e+06
         Name: price, dtype: float64
```

1.0.4 For Missing Values

```
In [11]: print(df.isnull().sum())
```

```
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
lat              0
long             0
dtype: int64
```

There is no missing value in the dataset.

1.0.5 Looking For Correlations

```
In [12]: corr_matrix = df.corr()
         corr_matrix['price'].sort_values(ascending=False)
```

```
Out[12]: price            1.00
         sqft_living      0.70
         grade            0.67
         sqft_above       0.61
         bathrooms        0.53
         view             0.40
         sqft_basement    0.32
         bedrooms         0.31
         lat              0.31
         waterfront       0.27
         floors           0.26
         yr_renovated     0.13
         sqft_lot         0.09
         yr_built         0.05
         condition        0.04
         long             0.02
         Name: price, dtype: float64
```

1.0.6 Stepwise selection

Initial Iteration

```
In [13]: X = df.iloc[:, 1:]
         y = df.iloc[:, 0]

         X = sm.add_constant(X)
         mreg = sm.OLS(y, X).fit()
         display(mreg.summary())
```

```
C:\ProgramData\Anaconda3\lib\site-packages\numpy\core\fromnumeric.py:2389: FutureWarning: Metho
  return ptp(axis=axis, out=out, **kwargs)
```

```
<class 'statsmodels.iolib.summary.Summary'>
"""
                            OLS Regression Results
==============================================================================
Dep. Variable:                  price   R-squared:                       0.694
Model:                            OLS   Adj. R-squared:                  0.694
Method:                 Least Squares   F-statistic:                     3502.
Date:                Sat, 23 Nov 2019   Prob (F-statistic):               0.00
Time:                        14:56:43   Log-Likelihood:            -2.9481e+05
No. Observations:               21613   AIC:                         5.897e+05
Df Residuals:                   21598   BIC:                         5.898e+05
Df Model:                          14
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const      -4.006e+07    1.5e+06    -26.657      0.000    -4.3e+07   -3.71e+07
bedrooms   -3.385e+04   1906.033    -17.759      0.000   -3.76e+04   -3.01e+04
bathrooms   4.192e+04   3282.441     12.772      0.000    3.55e+04    4.84e+04
sqft_living  114.1817      2.150     53.107      0.000     109.967     118.396
sqft_lot      -0.0617      0.035     -1.762      0.078      -0.130       0.007
floors     -1982.5427   3585.539     -0.553      0.580   -9010.465    5045.379
waterfront  5.832e+05   1.75e+04     33.289      0.000    5.49e+05    6.18e+05
view        5.192e+04   2127.451     24.403      0.000    4.77e+04    5.61e+04
condition   3.034e+04   2358.297     12.866      0.000    2.57e+04     3.5e+04
grade       1.024e+05   2078.681     49.283      0.000    9.84e+04    1.07e+05
sqft_above    75.8210      2.158     35.127      0.000      71.590      80.052
sqft_basement 38.3609      2.670     14.369      0.000      33.128      43.594
yr_built   -2472.9041     72.752    -33.991      0.000   -2615.503   -2330.305
yr_renovated  19.8380      3.685      5.384      0.000      12.615      27.061
lat         5.648e+05   1.06e+04     53.444      0.000    5.44e+05    5.85e+05
long       -1.027e+05   1.17e+04     -8.784      0.000   -1.26e+05   -7.98e+04
==============================================================================
Omnibus:                    18197.968   Durbin-Watson:                   1.993
```

```
Prob(Omnibus):                  0.000   Jarque-Bera (JB):          1726367.901
Skew:                           3.529   Prob(JB):                         0.00
Kurtosis:                      46.211   Cond. No.                     3.34e+16
==============================================================================

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
[2] The smallest eigenvalue is 3.77e-20. This might indicate that there are
strong multicollinearity problems or that the design matrix is singular.
"""
```

Other Iterations

```
In [14]: (F, pval) = f_regression(X, y)
         F,pval

C:\ProgramData\Anaconda3\lib\site-packages\sklearn\feature_selection\univariate_selection.py:29
  corr /= X_norms
C:\ProgramData\Anaconda3\lib\site-packages\sklearn\feature_selection\univariate_selection.py:30
  F = corr ** 2 / (1 - corr ** 2) * degrees_of_freedom
C:\ProgramData\Anaconda3\lib\site-packages\scipy\stats\_distn_infrastructure.py:877: RuntimeWar
  return (self.a < x) & (x < self.b)
C:\ProgramData\Anaconda3\lib\site-packages\scipy\stats\_distn_infrastructure.py:877: RuntimeWar
  return (self.a < x) & (x < self.b)
C:\ProgramData\Anaconda3\lib\site-packages\scipy\stats\_distn_infrastructure.py:1831: RuntimeWa
  cond2 = cond0 & (x <= self.a)


Out[14]: (array([           nan, 2.27047248e+03, 8.22879468e+03, 2.10029321e+04,
                 1.75118043e+02, 1.52560205e+03, 1.64994390e+03, 4.05174203e+03,
                 2.86589572e+01, 1.73633079e+04, 1.25139440e+04, 2.53187904e+03,
                 6.31593119e+01, 3.51122447e+02, 2.24744477e+03, 1.00602586e+01]),
          array([            nan, 0.00000000e+000, 0.00000000e+000, 0.00000000e+000,
                 8.06152545e-040, 1.63041663e-322, 0.00000000e+000, 0.00000000e+000,
                 8.71940693e-008, 0.00000000e+000, 0.00000000e+000, 0.00000000e+000,
                 1.99921450e-015, 9.97635576e-078, 0.00000000e+000, 1.51713739e-003]))

In [15]: index = list()
         for i in range(1,len(df.columns)+1):
             if max(F[1:len(df.columns)+1]) == F[i] and max(F[1:len(df.columns)+1]) > stats.f.p
                 index.append(i)
                 break

         modeled_X = df.iloc[:,index]
         modeled_X.head()

Out[15]:    sqft_living
         0         1180
```

```
1         2570
2          770
3         1960
4         1680
```

```
In [16]: for j in range(len(df.columns)-2):
             #f test for adding column or model significance
             fvalue1 = []
             for i in range(len(df.columns)-1):
                 if i+1 not in index:
                     index1 = index + [i+1]
                     X = df.iloc[:,index1]
                     X = sm.add_constant(X)
                     mreg = sm.OLS(y, X).fit()
                     #display(mreg.summary())
                     fvalue1.append(mreg.fvalue)
                 else:
                     fvalue1.append(0)

             for i in range(len(df.columns)-1):
                 if max(fvalue1) == fvalue1[i] and max(fvalue1) > stats.f.ppf(q = 1-0.05, dfn =
                     index.append(i+1)
                     break

             modeled_X = df.iloc[:,index]

             #partial f test for removing insignificanct columns
             cols=list(modeled_X.columns)
             X = modeled_X
             X = sm.add_constant(X)
             mreg = sm.OLS(y, X).fit()
             for i in range(len(index)):
                 X = modeled_X.drop([cols[i]],axis = 1)
                 X = sm.add_constant(X)
                 mreg1 = sm.OLS(y, X).fit()
                 res = anova_lm(mreg1,mreg)
                 if res.F[1] == np.nan or res.F[1]>=stats.f.ppf(q = 0.95, dfn = len(df) - res.
                     continue
                 elif res.F[1]<stats.f.ppf(q = 0.95, dfn = len(df) - res.df_resid[1], dfd = res
                     modeled_X = modeled_X.drop([cols[i]],axis = 1)
```

```
C:\ProgramData\Anaconda3\lib\site-packages\numpy\core\fromnumeric.py:2389: FutureWarning: Metho
  return ptp(axis=axis, out=out, **kwargs)
```

```
In [17]: modeled_X.head()
```

```
Out[17]:    sqft_living    lat  view  grade  yr_built  waterfront  bedrooms  bathrooms  \
         0         1180  47.51     0      7         0           0         3       1.00
```

```
1          2570  47.72     0      7        -4           0         3       2.25
2           770  47.74     0      6       -22           0         2       1.00
3          1960  47.52     0      7        10           0         4       3.00
4          1680  47.62     0      8        32           0         3       2.00

   condition  sqft_above    long  yr_renovated  sqft_lot
0          3        1180 -122.26         -1991      5650
1          3        2170 -122.32             0      7242
2          3         770 -122.23         -1991     10000
3          5        1050 -122.39         -1991      5000
4          3        1680 -122.05         -1991      8080
```

In [18]:
```
mreg = sm.OLS(y, modeled_X).fit()
mreg.summary()
```

Out[18]:
```
<class 'statsmodels.iolib.summary.Summary'>
"""
                            OLS Regression Results
==============================================================================
Dep. Variable:                  price   R-squared:                       0.900
Model:                            OLS   Adj. R-squared:                  0.900
Method:                 Least Squares   F-statistic:                 1.496e+04
Date:                Sat, 23 Nov 2019   Prob (F-statistic):               0.00
Time:                        14:57:03   Log-Likelihood:            -2.9518e+05
No. Observations:               21613   AIC:                         5.904e+05
Df Residuals:                   21600   BIC:                         5.905e+05
Df Model:                          13
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
sqft_living    155.8494      4.154     37.515      0.000     147.707     163.992
lat           4.794e+05   1.02e+04     46.993      0.000    4.59e+05    4.99e+05
view          5.415e+04   2161.323     25.056      0.000    4.99e+04    5.84e+04
grade         1.117e+05   2081.616     53.646      0.000    1.08e+05    1.16e+05
yr_built     -3177.2175     67.414    -47.130      0.000   -3309.354   -3045.081
waterfront    5.897e+05   1.78e+04     33.107      0.000    5.55e+05    6.25e+05
bedrooms     -3.541e+04   1936.291    -18.289      0.000   -3.92e+04   -3.16e+04
bathrooms     4.889e+04   3204.794     15.256      0.000    4.26e+04    5.52e+04
condition     2.417e+04   2381.224     10.149      0.000    1.95e+04    2.88e+04
sqft_above      14.0307      3.902      3.595      0.000       6.382      21.680
long           1.92e+05   3957.427     48.514      0.000    1.84e+05       2e+05
yr_renovated    15.2691      3.737      4.086      0.000       7.944      22.594
sqft_lot        -0.2605      0.035     -7.490      0.000      -0.329      -0.192
==============================================================================
Omnibus:                    18249.706   Durbin-Watson:                   1.986
Prob(Omnibus):                  0.000   Jarque-Bera (JB):          1697167.889
Skew:                           3.553   Prob(JB):                         0.00
```

```
Kurtosis:                       45.826   Cond. No.                         5.60e+05
==============================================================================

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly spec
[2] The condition number is large, 5.6e+05. This might indicate that there are
strong multicollinearity or other numerical problems.
"""
```

1.0.7 Splitting the dataset into Training set and Test set, Fitting the model and Prediction

In [19]:
```
# Splitting the dataset into Training set and Test set
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(modeled_X, y, test_size = 0.2, ra
#Fitting multiple linear regression to the Training set
from sklearn.linear_model import LinearRegression
regressor = LinearRegression()
regressor.fit(X_train, y_train)
```

Out[19]:
```
LinearRegression(copy_X=True, fit_intercept=True, n_jobs=None,
         normalize=False)
```

In [20]:
```
# Predicting y_test results using model y_test ~ X_test
regressor.predict(X_test)
```

Out[20]:
```
array([ 456486.6867909 ,  770585.89921819, 1206524.01493281, ...,
        380303.38313419,  598542.66338376,  400157.366076  ])
```

In [21]:
```
y = df.iloc[:,0].values.reshape(-1,1)
X = df.iloc[:,3].values.reshape(-1,1)
reg = LinearRegression()
reg.fit(X,y)
```

Out[21]:
```
LinearRegression(copy_X=True, fit_intercept=True, n_jobs=None,
         normalize=False)
```

In [22]:
```
#Visualising the results
plt.scatter(X, y, color = 'red')
plt.plot(X, reg.predict(X), color = 'blue')
plt.title('sqft_living vs price (Training set)')
plt.xlabel('sqft_living')
plt.ylabel('price')
plt.show()
```


sqft_living vs price (Training set)
price
sqft_living
8000000
7000000
6000000
5000000
4000000
3000000
2000000
1000000
0
0
2000
4000
6000
8000
10000
12000
14000

In [ ]: