GikonyoJohn / dsc-phase-2-project-v2-3-group2 Public

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README.md

Multiple Linear Regression

The project aims to help the real estate agencies and homeowners in making informed decisions about home selling and buying by utilizing the King County House Sales dataset. By analyzing and modeling the dataset, we can determine the influence of various factors on house prices, ultimately providing valuable insights to real estate agencies and homeowners regarding the potential change in the estimated value of their homes through different choices.

OBJECTIVES

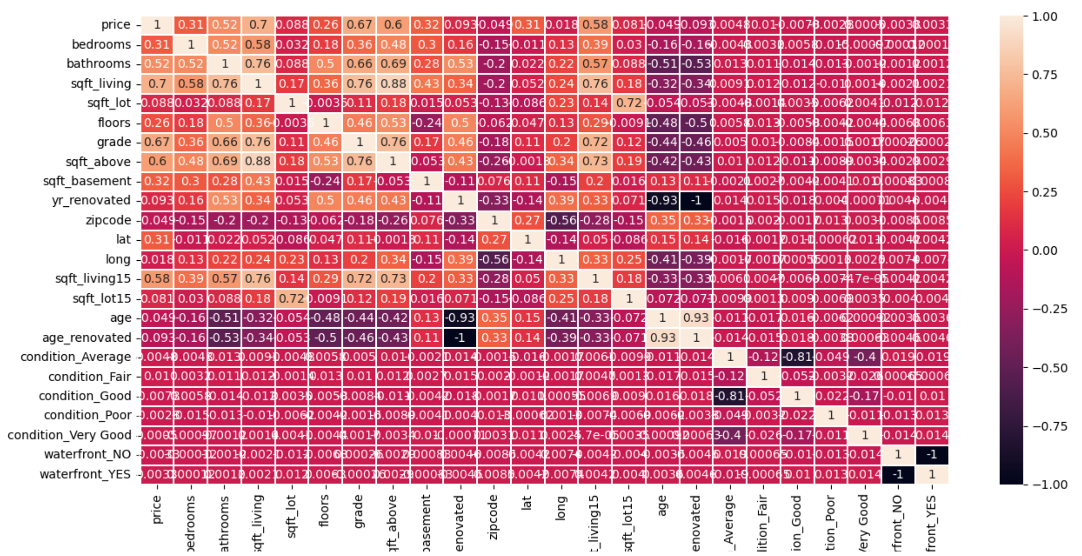
To understand which factors determines the price of a home. To understand how square feet living affect the value of a home. To explore how condition affect the price of a home. To explore features which decrease and increase value of the house.

DATA PREPARATION AND CLEANING

Data was cleaned through the following steps:

1. Checking for missing values where we found that the view, waterfront and year renovated column had missing values. We decided to drop the view column and replace Nans with mode in the waterfront column.
2. Checking for duplicates and outliers
3. Feature engineering using the date column to create a new column named age which shows the age of the house.

EXPLORATORY DATA ANALYSIS



According to this heatmap, there are some variables which are highly correlated which will be considered in linear regression

MODELLING

Below is a list of all models built and general description of changes between each model:

1. Model 1: Baseline model

Our first model has an adjusted r-squared of .660. All features with p_values that are significant, let's check our residuals.

```
Dep. Variable:                  price   R-squared:                       0.660
Model:                            OLS   Adj. R-squared:                  0.660
Method:                 Least Squares   F-statistic:                     1964.
Date:                Fri, 02 Jun 2023   Prob (F-statistic):               0.00
Time:                        22:59:57   Log-Likelihood:            -2.9085e+05
No. Observations:               21244   AIC:                         5.818e+05
Df Residuals:                   21222   BIC:                         5.819e+05
Df Model:                          21
Covariance Type:            nonrobust
=========================================================================================
                            coef    std err          t      P>|t|      [0.025      0.975]
-----------------------------------------------------------------------------------------
const                 -3.371e+07   4.13e+06     -8.159      0.000   -4.18e+07   -2.56e+07
bedrooms               -4.55e+04   2024.056    -22.479      0.000   -4.95e+04   -4.15e+04
bathrooms              4.745e+04   3497.152     13.569      0.000    4.06e+04    5.43e+04
sqft_living             109.1784     22.653      4.820      0.000      64.777     153.580
sqft_lot                  0.1422      0.051      2.792      0.005       0.042       0.242
floors                 9096.6499   3867.668      2.352      0.019    1515.728    1.67e+04
grade                  1.033e+05   2309.367     44.711      0.000    9.87e+04    1.08e+05
sqft_above               76.7000     22.666      3.384      0.001      32.272     121.128
sqft_basement            74.6117     22.657      3.293      0.001      30.202     119.021
yr_renovated           2.549e+04   3143.506      8.108      0.000    1.93e+04    3.17e+04
zipcode                -522.2306     34.950    -14.942      0.000    -590.736    -453.725
lat                    5.477e+05   1.14e+04     48.031      0.000    5.25e+05     5.7e+05
long                  -2.482e+05   1.41e+04    -17.635      0.000   -2.76e+05   -2.21e+05
sqft_living15            38.0384      3.657     10.401      0.000      30.870      45.207
sqft_lot15               -0.3115      0.078     -3.992      0.000      -0.464      -0.159
age                    3854.6952    135.390     28.471      0.000    3589.321    4120.069
age_renovated          2.487e+04   3144.132      7.909      0.000    1.87e+04     3.1e+04
condition_Average     -6.755e+06   8.26e+05     -8.176      0.000   -8.37e+06   -5.14e+06
condition_Fair        -6.735e+06   8.26e+05     -8.150      0.000   -8.35e+06   -5.11e+06
condition_Good        -6.757e+06   8.26e+05     -8.179      0.000   -8.38e+06   -5.14e+06
condition_Poor        -6.703e+06   8.27e+05     -8.102      0.000   -8.32e+06   -5.08e+06
condition_Very Good   -6.758e+06   8.26e+05     -8.180      0.000   -8.38e+06   -5.14e+06
waterfront_NO         -1.685e+07   2.07e+06     -8.159      0.000   -2.09e+07   -1.28e+07
waterfront_YES        -1.685e+07   2.07e+06     -8.159      0.000   -2.09e+07   -1.28e+07
==============================================================================
Omnibus:                    19043.086   Durbin-Watson:                   1.309
Prob(Omnibus):                  0.000   Jarque-Bera (JB):          1873733.100
Skew:                           3.914   Prob(JB):                         0.00
Kurtosis:                      48.338   Cond. No.                     6.88e+20
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
[2] The smallest eigenvalue is 4.55e-28. This might indicate that there are
strong multicollinearity problems or that the design matrix is singular.
```

2. Model 2: with log transformed y variables

After log transformation of the dependent variables our residuals are much closer to a normal distribution.

3. Model 3: Dealing with Multicollinearity

Conclusion: There are several features that seem to have multicollinearity. Rather than just dropping some of these features, let's first look at the variance inflation factor to understand the severity of the multicollinearity.

4. Model 4: Dropping Insignificant Features

Conclusion: Our adjusted R squared still stays the same at .740 and all features are significant. Next, we will further refine our data by removing additional, potential outliers.

model4

5. Model 5: Standardizing Features

Interpretation: Since the p-value (0.0024) is less than the significance level (e.g., 0.05), we can reject the null hypothesis. This suggests that there is significant evidence of heteroscedasticity in the data. It implies that the variance of the errors is not constant across the range of the predictors.

In summary,F statistic and p-value, there is evidence of heteroscedasticity in the data, indicating that the assumption of constant error variance may not hold.

```
                            OLS Regression Results
==============================================================================
Dep. Variable:                  price   R-squared:                       0.740
Model:                            OLS   Adj. R-squared:                  0.740
Method:                 Least Squares   F-statistic:                     4654.
Date:                Fri, 02 Jun 2023   Prob (F-statistic):               0.00
Time:                        23:00:29   Log-Likelihood:                -2145.4
No. Observations:               21244   AIC:                             4319.
Df Residuals:                   21230   BIC:                             4430.
Df Model:                          13
Covariance Type:            nonrobust
==================================================================================
                     coef    std err          t      P>|t|      [0.025      0.975]
----------------------------------------------------------------------------------
const            -19.1124      2.512     -7.609      0.000     -24.036     -14.189
bedrooms          -0.0198      0.003     -7.819      0.000      -0.025      -0.015
bathrooms          0.0725      0.004     16.586      0.000       0.064       0.081
sqft_living        0.0002   5.77e-06     35.087      0.000       0.000       0.000
sqft_lot        4.287e-07   4.63e-08      9.256      0.000    3.38e-07    5.19e-07
floors             0.0657      0.005     13.593      0.000       0.056       0.075
grade              0.1609      0.003     55.785      0.000       0.155       0.167
sqft_above     -5.477e-05   5.75e-06     -9.523      0.000    -6.6e-05   -4.35e-05
zipcode           -0.0006   4.37e-05    -12.865      0.000      -0.001      -0.000
lat                1.3575      0.014     95.255      0.000       1.330       1.385
long              -0.2469      0.017    -14.131      0.000      -0.281      -0.213
sqft_living15      0.0001   4.57e-06     24.031      0.000       0.000       0.000
age_renovated      0.0037   8.93e-05     41.553      0.000       0.004       0.004
waterfront_NO     -9.5608      1.256     -7.614      0.000     -12.022      -7.099
waterfront_YES    -9.5516      1.256     -7.605      0.000     -12.013      -7.090
==============================================================================
Omnibus:                      426.976   Durbin-Watson:                   1.143
Prob(Omnibus):                  0.000   Jarque-Bera (JB):              873.336
Skew:                           0.089   Prob(JB):                    2.28e-190
Kurtosis:                       3.977   Cond. No.                     9.00e+20
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
[2] The smallest eigenvalue is 2.6e-28. This might indicate that there are
strong multicollinearity problems or that the design matrix is singular.
```

Conclusion

Analyzing the models the following conclusion can be made: An increase with one bedroom decreases the house sale by $ 0.002. An increase with one bathroom increases the house price by $ 0.0725. An increase in Square footage of the home by one square foot increases the price of the house by $ 0.0002. An increase in Square footage of the by one square feet decreases the house price by $ 4.287e-07. An increase in floors by one increases price by $0.0657. An increase in grade rating by one increases the price by $ 0.1609. An increase in one square foot from basement decrease price by $ -5.477e-05. An increase in Square footage of interior housing living space for the nearest 15 neighbors by one foot increase prices by $ 0.0001. There is no significant increase/decrease in the house price with the condition of the house. Presence of waterfront decreases the house price by $ -9.5516.

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Contributors 7

- GikonyoJohn
- Wambui-T
- Phelix-hub
- Categakii

Languages

- **Jupyter Notebook** 100.0%