

## EXERCISE 8.2.3

Ramsey King

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Housing Data - Complete the following:

1. Explain any transformations or modifications you made to the dataset
  - Modifications made: added a variable called `price_per_sqft` and a `row_id`.

```
##
## Attaching package: 'dplyr'
## The following objects are masked from 'package:stats':
##
##   filter, lag
## The following objects are masked from 'package:base':
##
##   intersect, setdiff, setequal, union
```

2. Create two variables; one that will contain the variables Sale Price and Square Foot of Lot (same variables used from previous assignment on simple regression) and one that will contain Sale Price and several additional predictors of your choice. Explain the basis for your additional predictor selections.
  - My additional predictors chosen were the `square_feet_total_living` and the year built. The reason I chose these additional predictors is because I believe the larger the square footage on the home, the more expensive it will be. I also believe that newer homes will be more expensive than older homes.
3. Execute a `summary()` function on two variables defined in the previous step to compare the model results. What are the R2 and Adjusted R2 statistics? Explain what these results tell you about the overall model. Did the inclusion of the additional predictors help explain any large variations found in Sale Price?

```
##
## Call:
## lm(formula = Sale_Price ~ sq_ft_lot, data = housing_data_row_id)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2016064  -194842   -63293    91565   3735109
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  6.418e+05  3.800e+03  168.90  <2e-16 ***
## sq_ft_lot    8.510e-01  6.217e-02  13.69  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 401500 on 12863 degrees of freedom
## Multiple R-squared:  0.01435,    Adjusted R-squared:  0.01428
```

```
## F-statistic: 187.3 on 1 and 12863 DF, p-value: < 2.2e-16
```

```
##
```

```
## Call:
```

```
## lm(formula = Sale_Price ~ sq_ft_lot + square_feet_total_living +  
##     year_built, data = housing_data_row_id)
```

```
##
```

```
## Residuals:
```

```
##      Min       1Q   Median       3Q      Max  
## -2158828 -119944  -41323   46104  3761175
```

```
##
```

```
## Coefficients:
```

```
##              Estimate Std. Error t value Pr(>|t|)  
## (Intercept)    -5.547e+06  3.901e+05 -14.219 < 2e-16 ***  
## sq_ft_lot       2.924e-01  5.837e-02   5.009 5.55e-07 ***  
## square_feet_total_living 1.663e+02  3.495e+00  47.592 < 2e-16 ***  
## year_built      2.900e+03  1.971e+02  14.711 < 2e-16 ***
```

```
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
##
```

```
## Residual standard error: 357200 on 12861 degrees of freedom
```

```
## Multiple R-squared:  0.22, Adjusted R-squared:  0.2198
```

```
## F-statistic: 1209 on 3 and 12861 DF, p-value: < 2.2e-16
```

- r squared and adjusted r squared for the first variable : 0.01435 and 0.01428. r squared and adjusted r squared for the second variable: 0.22 and 0.2198. The overall model improved when adding the additional variables (square\_feet\_total\_living and year\_built).

4. Considering the parameters of the multiple regression model you have created, what are the standardized betas for each parameter and what do the values indicate?

```
## Warning: package 'QuantPsyc' was built under R version 4.0.5
```

```
## Loading required package: boot
```

```
## Loading required package: MASS
```

```
##
```

```
## Attaching package: 'MASS'
```

```
## The following object is masked from 'package:dplyr':
```

```
##
```

```
##      select
```

```
##
```

```
## Attaching package: 'QuantPsyc'
```

```
## The following object is masked from 'package:base':
```

```
##
```

```
##      norm
```

```
## sq_ft_lot
```

```
## 0.1198122
```

```
##              sq_ft_lot square_feet_total_living      year_built  
##              0.04116294              0.40711553      0.12347342
```

Square\_feet\_total\_living has the highest impact on the sale price.

5. Calculate the confidence intervals for the parameters in your model and explain what the results indicate.

```
##                2.5 %          97.5 %
## (Intercept) 6.343730e+05 6.492698e+05
## sq_ft_lot   7.291208e-01 9.728641e-01

##                2.5 %          97.5 %
## (Intercept)      -6.311551e+06 -4.782253e+06
## sq_ft_lot        1.779547e-01  4.067827e-01
## square_feet_total_living 1.594730e+02 1.731737e+02
## year_built       2.513176e+03  3.285875e+03
```

It seems that these confidence intervals are close to each other, which would suggest that the model is representative of the true population values.

6. Assess the improvement of the new model compared to your original model (simple regression model) by testing whether this change is significant by performing an analysis of variance.

```
## Analysis of Variance Table
##
## Model 1: Sale_Price ~ sq_ft_lot
## Model 2: Sale_Price ~ sq_ft_lot + square_feet_total_living + year_built
##   Res.Df      RSS Df Sum of Sq   F    Pr(>F)
## 1  12863 2.0734e+15
## 2  12861 1.6409e+15  2 4.3252e+14 1695 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

7. Perform casewise diagnostics to identify outliers and/or influential cases, storing each function's output in a dataframe assigned to a unique variable name.
8. Calculate the standardized residuals using the appropriate command, specifying those that are  $\pm 2$ , storing the results of large residuals in a variable you create.
9. Use the appropriate function to show the sum of large residuals.

```
## [1] 334
```

10. Which specific variables have large residuals (only cases that evaluate as TRUE)?
11. Investigate further by calculating the leverage, cooks distance, and covariance ratios. Comment on all cases that are problematic.

```
##      cooks_distance      leverage covariance_ratios
## 6      0.0003786119 3.206527e-04      0.9991633
## 25      0.0008996870 6.219188e-04      0.9991345
## 115     0.0040741281 1.735686e-03      0.9991324
## 160     0.0014918590 1.334527e-03      1.0002574
## 178     0.0013674027 9.234733e-04      0.9993943
## 239     0.0001783162 1.573739e-04      0.9990592
## 246     0.0051550064 1.596054e-03      0.9978968
## 287     0.0008192822 4.950746e-04      0.9987487
## 295     0.0010288656 6.526365e-04      0.9990039
## 300     0.0089655448 2.676565e-03      0.9988337
## 341     0.0004153141 3.885293e-04      0.9993703
## 344     0.0103999269 8.403722e-03      1.0072495
## 359     0.0025140509 1.266065e-03      0.9991103
## 385     0.0034436518 1.273529e-03      0.9982258
## 396     0.0019727976 9.956501e-04      0.9988445
## 475     0.0007174399 5.259101e-04      0.9991408
## 482     0.0016488903 1.368855e-03      1.0001840
```

## 508	0.0037460466	2.244823e-03	1.0004866
## 528	0.0013766838	1.016638e-03	0.9996449
## 576	0.0012653507	1.221090e-03	1.0002451
## 661	0.0043654857	2.721463e-03	1.0010461
## 670	0.0026620678	5.532028e-04	0.9948897
## 679	0.0110155133	2.968427e-03	0.9986792
## 784	0.0022094263	1.413021e-03	0.9997821
## 802	0.0012580374	1.206275e-03	1.0002220
## 811	0.0050272267	7.379854e-04	0.9925994
## 853	0.0007886185	7.034817e-04	0.9996209
## 877	0.0021996661	1.229049e-03	0.9993166
## 916	0.0056933033	2.243517e-03	0.9994060
## 1009	0.0003070119	2.615081e-04	0.9991125
## 1119	0.0027951267	1.263876e-03	0.9988276
## 1142	0.0020380856	1.029285e-03	0.9988799
## 1155	0.0195775221	6.981544e-03	1.0038587
## 1305	0.0018071616	1.433052e-03	1.0001782
## 1368	0.0011232454	1.094906e-03	1.0001315
## 1380	0.0002658155	2.074826e-04	0.9989253
## 1442	0.0010899082	6.843401e-04	0.9990156
## 1492	0.0006205572	5.128773e-04	0.9993195
## 1504	0.0084924616	3.019928e-03	0.9998461
## 1550	0.0012901280	7.732854e-04	0.9990106
## 1633	0.0002581482	2.006823e-04	0.9989120
## 1650	0.0180781135	4.075723e-03	0.9988962
## 1716	0.0012360741	5.309096e-04	0.9979482
## 1745	0.0015802035	7.162464e-04	0.9982853
## 1870	0.0090535902	5.660062e-03	1.0040160
## 1962	0.0034523123	1.057159e-03	0.9973119
## 1963	0.0003313060	2.121601e-04	0.9985814
## 1964	0.0013690239	4.055014e-04	0.9965220
## 1976	0.0014186714	2.483554e-04	0.9934698
## 1977	0.0010989366	1.748296e-04	0.9926865
## 1978	0.0011303787	1.845172e-04	0.9928937
## 1979	0.0010854651	1.734164e-04	0.9927179
## 1980	0.0010861113	1.727814e-04	0.9926841
## 1981	0.0016516685	3.025577e-04	0.9938376
## 1982	0.0013259343	2.257156e-04	0.9932465
## 2022	0.0022503071	8.641750e-04	0.9979396
## 2099	0.0008212073	5.675052e-04	0.9990795
## 2137	0.0006314130	2.470687e-04	0.9973817
## 2157	0.0008458614	4.289362e-04	0.9982885
## 2257	0.0002424133	2.077547e-04	0.9990677
## 2264	0.0029822023	8.795848e-04	0.9969791
## 2302	0.0020485512	1.322888e-03	0.9997104
## 2360	0.0006568707	3.769444e-04	0.9985214
## 2361	0.0022719723	5.624629e-04	0.9958567
## 2469	0.0003484108	1.726631e-04	0.9979750
## 2604	0.0001736068	1.548624e-04	0.9990717
## 2684	0.0010750288	1.799420e-04	0.9930770
## 2685	0.0012827808	2.268448e-04	0.9935193
## 2686	0.0020716549	4.314632e-04	0.9947810
## 2687	0.0011775318	2.010374e-04	0.9932430
## 2688	0.0010261141	1.685239e-04	0.9929239

## 2689	0.0018898151	3.805644e-04	0.9945264
## 2690	0.0019433263	3.969598e-04	0.9946299
## 2699	0.0610004015	2.504189e-02	1.0229761
## 2708	0.0016526131	5.956223e-04	0.9974588
## 2709	0.0019542860	8.011953e-04	0.9980811
## 2710	0.0020945930	8.143143e-04	0.9979291
## 2717	0.0044039902	1.190442e-03	0.9969074
## 2742	0.0006129755	3.396996e-04	0.9984073
## 2852	0.0448084144	7.459410e-03	1.0003742
## 2867	0.0008756189	8.643949e-04	0.9999165
## 2934	0.0012349398	5.309096e-04	0.9979509
## 2937	0.0011933361	5.309096e-04	0.9980482
## 3097	0.0037436999	1.062350e-03	0.9969966
## 3102	0.0010527025	5.305816e-04	0.9983753
## 3110	0.0006043130	3.882771e-04	0.9987642
## 3111	0.0004289112	3.539678e-04	0.9991582
## 3168	0.0048353662	3.422295e-04	0.9831861
## 3169	0.0048353662	3.422295e-04	0.9831861
## 3170	0.0037900061	2.797401e-04	0.9838369
## 3171	0.0031633555	2.370321e-04	0.9840432
## 3172	0.0032591200	2.433284e-04	0.9839902
## 3173	0.0031680599	2.374391e-04	0.9840474
## 3174	0.0032584052	2.432677e-04	0.9839897
## 3175	0.0041317843	2.988310e-04	0.9835142
## 3176	0.0030827320	2.339303e-04	0.9842462
## 3177	0.0028845637	2.189748e-04	0.9842373
## 3178	0.0028861594	2.191171e-04	0.9842390
## 3179	0.0036231322	2.667836e-04	0.9837840
## 3180	0.0028884200	2.193161e-04	0.9842412
## 3181	0.0036216846	2.666649e-04	0.9837832
## 3182	0.0048370220	3.423599e-04	0.9831869
## 3183	0.0048340335	3.421243e-04	0.9831854
## 3184	0.0048340335	3.421243e-04	0.9831854
## 3185	0.0048372178	3.423753e-04	0.9831870
## 3186	0.0048353662	3.422295e-04	0.9831861
## 3187	0.0048353662	3.422295e-04	0.9831861
## 3188	0.0048480604	3.432253e-04	0.9831920
## 3189	0.0041297057	2.986639e-04	0.9835131
## 3190	0.0032550812	2.429833e-04	0.9839869
## 3191	0.0041288784	2.985973e-04	0.9835127
## 3192	0.0031637968	2.370706e-04	0.9840436
## 3193	0.0032543520	2.429204e-04	0.9839863
## 3194	0.0032538755	2.428792e-04	0.9839859
## 3195	0.0028853418	2.190444e-04	0.9842382
## 3196	0.0028870095	2.191922e-04	0.9842399
## 3197	0.0030945613	2.349509e-04	0.9842557
## 3198	0.0048404537	3.426297e-04	0.9831885
## 3199	0.0048401663	3.426072e-04	0.9831884
## 3200	0.0048340335	3.421243e-04	0.9831854
## 3201	0.0048340335	3.421243e-04	0.9831854
## 3202	0.0048340335	3.421243e-04	0.9831854
## 3424	0.0006578619	3.551590e-04	0.9983634
## 3464	0.0040509577	2.985521e-04	0.9838307
## 3465	0.0037005325	2.782561e-04	0.9841418

## 3466	0.0028284732	2.189086e-04	0.9845474
## 3467	0.0028320388	2.192327e-04	0.9845512
## 3468	0.0040531208	2.987298e-04	0.9838319
## 3469	0.0035460814	2.660647e-04	0.9840941
## 3470	0.0028276297	2.188305e-04	0.9845464
## 3471	0.0037021298	2.783914e-04	0.9841428
## 3472	0.0031033652	2.370624e-04	0.9843564
## 3473	0.0031949437	2.431432e-04	0.9843019
## 3474	0.0040582632	2.991506e-04	0.9838347
## 3475	0.0031080513	2.374757e-04	0.9843605
## 3476	0.0028553700	2.207114e-04	0.9845291
## 3477	0.0031064222	2.373330e-04	0.9843592
## 3478	0.0047444125	3.421243e-04	0.9835072
## 3479	0.0047444125	3.421243e-04	0.9835072
## 3480	0.0047444125	3.421243e-04	0.9835072
## 3481	0.0047444125	3.421243e-04	0.9835072
## 3482	0.0047444125	3.421243e-04	0.9835072
## 3483	0.0047444214	3.421251e-04	0.9835072
## 3484	0.0047443858	3.421222e-04	0.9835072
## 3485	0.0031159380	2.422344e-04	0.9846414
## 3486	0.0035453360	2.660015e-04	0.9840936
## 3487	0.0029685404	2.302604e-04	0.9845940
## 3488	0.0031919770	2.428828e-04	0.9842993
## 3489	0.0031015990	2.369040e-04	0.9843546
## 3490	0.0031950517	2.431526e-04	0.9843020
## 3491	0.0028273493	2.188044e-04	0.9845460
## 3492	0.0037007925	2.782782e-04	0.9841420
## 3493	0.0028291972	2.189752e-04	0.9845482
## 3494	0.0040536602	2.987741e-04	0.9838322
## 3495	0.0047444214	3.421251e-04	0.9835072
## 3496	0.0047444214	3.421251e-04	0.9835072
## 3497	0.0047444214	3.421251e-04	0.9835072
## 3523	0.0026508257	9.226346e-04	0.9976642
## 3837	0.0008982730	5.199545e-04	0.9986833
## 3918	0.0017526328	1.263876e-03	0.9998524
## 3919	0.0013206358	1.029285e-03	0.9997460
## 4055	0.0007882483	3.407559e-04	0.9977764
## 4056	0.0058836897	9.494907e-04	0.9935725
## 4248	0.0011810632	1.170288e-03	1.0002278
## 4285	0.0004103083	3.240811e-04	0.9990607
## 4391	0.0020970477	1.802946e-03	1.0006712
## 4435	0.0004925569	3.746697e-04	0.9990510
## 4571	0.0007270647	7.104353e-04	0.9997493
## 4648	0.1800856691	1.003828e-02	0.9883132
## 4649	1.1769957921	4.365379e-02	1.0128200
## 4671	0.0046273853	3.142908e-03	1.0016339
## 4695	0.0016467356	2.602263e-04	0.9927196
## 4696	0.0019306262	7.541541e-04	0.9978840
## 4740	0.0002836988	2.351624e-04	0.9990459
## 4750	0.0022546554	2.243517e-03	1.0013103
## 4821	0.0007627341	3.662813e-04	0.9980887
## 4834	0.0019306063	8.641750e-04	0.9983990
## 4840	0.0204438832	6.981544e-03	1.0037047
## 4934	0.0016263328	9.335410e-04	0.9990796

## 5083	0.1320504653	2.973075e-02	1.0254461
## 5491	0.0001929156	1.654051e-04	0.9990259
## 5494	0.0001911179	1.673503e-04	0.9990581
## 5495	0.0001938638	1.660483e-04	0.9990251
## 5496	0.0001930188	1.654742e-04	0.9990258
## 5497	0.0001948333	1.660888e-04	0.9990182
## 5549	0.0005138256	4.461296e-04	0.9993250
## 5935	0.0022001806	9.567101e-04	0.9984101
## 6055	0.0016298308	1.273361e-03	0.9999946
## 6230	0.0016145639	1.970646e-04	0.9903512
## 6231	0.0018602312	2.363573e-04	0.9907890
## 6232	0.0019495726	2.550420e-04	0.9910873
## 6233	0.0016180218	1.926846e-04	0.9900947
## 6234	0.0016248097	1.989621e-04	0.9903860
## 6235	0.0016134663	1.969388e-04	0.9903515
## 6236	0.0016241298	1.988838e-04	0.9903862
## 6237	0.0016764588	2.052034e-04	0.9903882
## 6238	0.0016046873	1.883606e-04	0.9899398
## 6239	0.0018608539	2.364312e-04	0.9907889
## 6429	0.0047518776	1.929573e-04	0.9702076
## 6430	0.0044575261	1.669673e-04	0.9676663
## 6431	0.0045203752	1.745775e-04	0.9686498
## 6432	0.0044307491	1.753499e-04	0.9694102
## 6433	0.0042880911	1.720489e-04	0.9698255
## 6434	0.0046572420	1.874667e-04	0.9699389
## 6435	0.0054560138	2.286800e-04	0.9711775
## 6436	0.0044421539	1.727114e-04	0.9688582
## 6437	0.0042731544	1.615057e-04	0.9679506
## 6438	0.0047499885	1.780232e-04	0.9676957
## 6439	0.0043885199	1.757414e-04	0.9697711
## 6440	0.0049617830	2.035737e-04	0.9705262
## 6441	0.0044736804	1.761038e-04	0.9692461
## 6442	0.0045447637	1.814312e-04	0.9696819
## 6443	0.0038911815	1.748394e-04	0.9730759
## 6444	0.0040840289	1.894174e-04	0.9739375
## 6445	0.0045098703	1.953908e-04	0.9720906
## 6446	0.0041026237	1.859288e-04	0.9733188
## 6447	0.0044755781	2.129193e-04	0.9746209
## 6448	0.0039017399	1.696550e-04	0.9721662
## 6449	0.0047319781	2.279179e-04	0.9749511
## 6450	0.0056553251	2.808689e-04	0.9757691
## 6451	0.0042406567	1.835807e-04	0.9720564
## 6452	0.0041075973	1.865188e-04	0.9733719
## 6453	0.0049496689	2.395539e-04	0.9750845
## 6454	0.0041813564	1.955152e-04	0.9741566
## 6455	0.0038882018	1.735664e-04	0.9728966
## 6456	0.0039983513	1.758944e-04	0.9724971
## 6457	0.0042297917	1.983749e-04	0.9742377
## 6512	0.0029029073	7.199107e-04	0.9960231
## 6527	0.0008947873	6.217587e-04	0.9991437
## 6739	0.0004613583	2.914610e-04	0.9986343
## 6766	0.0076877384	7.564572e-03	1.0066716
## 6796	0.0003264600	3.083179e-04	0.9993026
## 6821	0.0013239946	1.040755e-03	0.9997710

## 6931	0.0003315936	2.768138e-04	0.9990982
## 6938	0.0010770205	3.022898e-04	0.9961871
## 6939	0.0014447326	4.778399e-04	0.9970320
## 6940	0.0008567372	2.080121e-04	0.9954035
## 6941	0.0008520316	2.075052e-04	0.9954186
## 6942	0.0013055232	4.075967e-04	0.9967389
## 6943	0.0013019166	4.053457e-04	0.9967257
## 6944	0.0015577149	5.409615e-04	0.9972739
## 6945	0.0010770205	3.022898e-04	0.9961871
## 6946	0.0008579593	2.088057e-04	0.9954164
## 6947	0.0008386385	1.990590e-04	0.9952776
## 6948	0.0008297585	1.948163e-04	0.9952161
## 7039	0.0014192040	1.105810e-03	0.9998223
## 7147	0.0013316292	7.756072e-04	0.9989526
## 7167	0.0067486219	6.659268e-04	0.9884256
## 7210	0.0046751759	1.043304e-03	0.9957909
## 7211	0.0029470393	5.522945e-04	0.9942399
## 7446	0.0027496462	1.882051e-04	0.9824416
## 7447	0.0028905678	1.947612e-04	0.9821637
## 7448	0.0027435033	1.879167e-04	0.9824539
## 7449	0.0028916806	1.948163e-04	0.9821619
## 7450	0.0028981562	1.951341e-04	0.9821511
## 7451	0.0029046674	1.954546e-04	0.9821404
## 7452	0.0028900522	1.947369e-04	0.9821646
## 7453	0.0026134937	1.780907e-04	0.9823514
## 7454	0.0026044760	1.776953e-04	0.9823732
## 7455	0.0027166350	1.828912e-04	0.9821368
## 7456	0.0028906475	1.947650e-04	0.9821635
## 7457	0.0027593031	1.886302e-04	0.9824196
## 7458	0.0029029724	1.953748e-04	0.9821436
## 7459	0.0029966823	2.000699e-04	0.9820014
## 7460	0.0028981562	1.951341e-04	0.9821511
## 7461	0.0029525764	1.978397e-04	0.9820655
## 7462	0.0029742694	1.989330e-04	0.9820334
## 7463	0.0029525458	1.978383e-04	0.9820656
## 7507	0.0027068028	1.413021e-03	0.9993448
## 7649	0.0004269719	3.991099e-04	0.9993798
## 7650	0.0004273070	3.994994e-04	0.9993804
## 7791	0.0017592217	1.514207e-03	1.0003830
## 7871	0.0077407189	2.979407e-03	1.0000710
## 8119	0.0010738887	1.040755e-03	1.0000698
## 8154	0.0003579616	3.038300e-04	0.9991497
## 8232	0.0027270564	1.413021e-03	0.9993270
## 8262	0.0358408052	1.073599e-02	1.0070189
## 8320	0.0110337357	4.680867e-03	1.0020852
## 8377	0.6636528396	6.370680e-02	1.0554687
## 8457	0.0003209938	2.121601e-04	0.9986418
## 8458	0.0013399647	4.055014e-04	0.9966109
## 8535	0.0005038155	4.160318e-04	0.9992212
## 8541	0.0002597440	2.006823e-04	0.9989021
## 8698	0.0002953519	2.133484e-04	0.9988029
## 8710	0.0034828842	6.275339e-04	0.9940502
## 8763	0.0006188175	3.892478e-04	0.9987237
## 8887	0.0104601632	1.330079e-03	0.9918923



```
## 8911    0.0016479316 1.216828e-03    0.9998455
## 8946    0.0016479316 1.216828e-03    0.9998455
## 9215    0.0042542061 2.576135e-03    1.0008412
## 9293    0.0014100380 1.016638e-03    0.9996042
## 9369    0.0023524641 2.036880e-03    1.0009163
## 9420    0.0085285048 5.204139e-03    1.0035062
## 9453    0.0006515232 5.309096e-04    0.9993161
## 9528    0.0095261587 2.136525e-03    0.9969157
## 9546    0.0008603946 5.199545e-04    0.9987738
## 9722    0.0004952458 2.351624e-04    0.9979281
## 10125   0.0020786427 1.678259e-03    1.0004522
## 10318   0.0261844364 2.222189e-02    1.0215795
## 10371   0.0009624012 6.752997e-04    0.9992147
## 10418   0.0020804200 1.630009e-03    1.0003569
## 10623   0.0006826384 5.861345e-04    0.9994492
## 10707   0.0001214075 9.981802e-05    0.9988982
## 10723   0.0006302687 5.334653e-04    0.9993755
## 10741   0.0003508417 3.469648e-04    0.9994005
## 10787   0.0045484606 1.349635e-03    0.9974755
## 10844   0.0023988819 1.597504e-03    1.0000442
## 10958   0.0006636672 3.940425e-04    0.9986111
## 10995   0.0044475345 3.705608e-03    1.0025388
## 11165   0.0005876438 3.254236e-04    0.9983914
## 11289   0.0010351137 2.207959e-04    0.9947106
## 11413   0.0046745001 1.158445e-03    0.9964591
## 11558   0.0044728700 6.238003e-04    0.9920420
## 11586   0.0028588670 1.076254e-03    0.9980872
## 11728   0.0119150426 4.675383e-03    1.0018422
## 11758   0.0010313489 6.752997e-04    0.9990878
## 11772   0.0167299080 1.496278e-03    0.9879681
## 11822   0.0022709876 3.299199e-04    0.9921025
## 11898   0.0663281580 3.418654e-02    1.0333064
## 11899   0.1463847873 3.690804e-02    1.0337185
## 11982   0.0111575241 2.243517e-03    0.9963857
## 11992   0.1259398797 4.502498e-03    0.9704760
## 12212   0.0027848613 1.538777e-03    0.9996024
## 12255   0.0037819076 1.348070e-03    0.9981747
## 12256   0.0018448651 1.092883e-03    0.9993064
## 12392   0.0011421621 8.560378e-04    0.9995087
## 12472   0.0035237958 6.248723e-04    0.9939372
## 12487   0.0037885394 1.288023e-03    0.9979458
## 12577   0.0062196039 1.352017e-03    0.9959528
## 12582   0.0322490030 2.443888e-03    0.9864407
## 12643   0.0071298373 4.740877e-04    0.9822009
## 12686   0.0002249663 2.063750e-04    0.9991617
## 12759   0.0004195772 3.964855e-04    0.9993916
## 12764   0.0095134947 2.178446e-03    0.9970713
```

All cooks distance are less than 1, so there seems to be no issues.

12. Perform the necessary calculations to assess the assumption of independence and state if the condition is met or not.

```
## Warning: package 'car' was built under R version 4.0.5
```

```
## Loading required package: carData
```

```
##
## Attaching package: 'car'
## The following object is masked from 'package:boot':
##
##   logit
## The following object is masked from 'package:dplyr':
##
##   recode
## lag Autocorrelation D-W Statistic p-value
## 1      0.7197493      0.5604916      0
## Alternative hypothesis: rho != 0
```

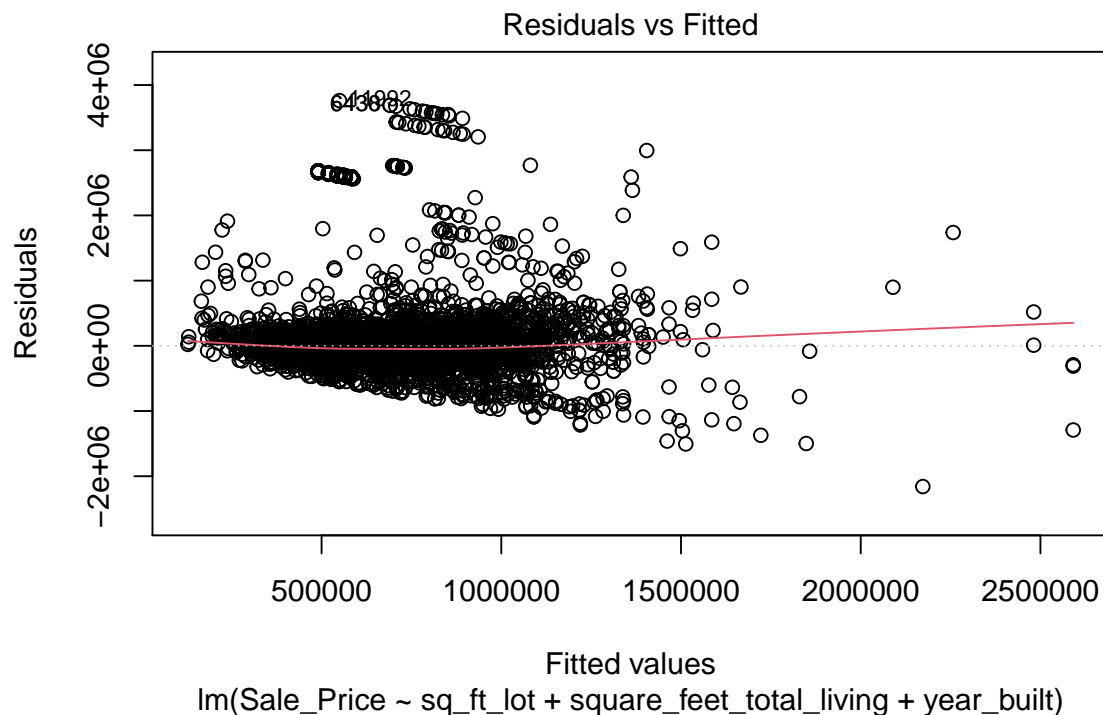
dwt is less than 1, so everything looks ok here.

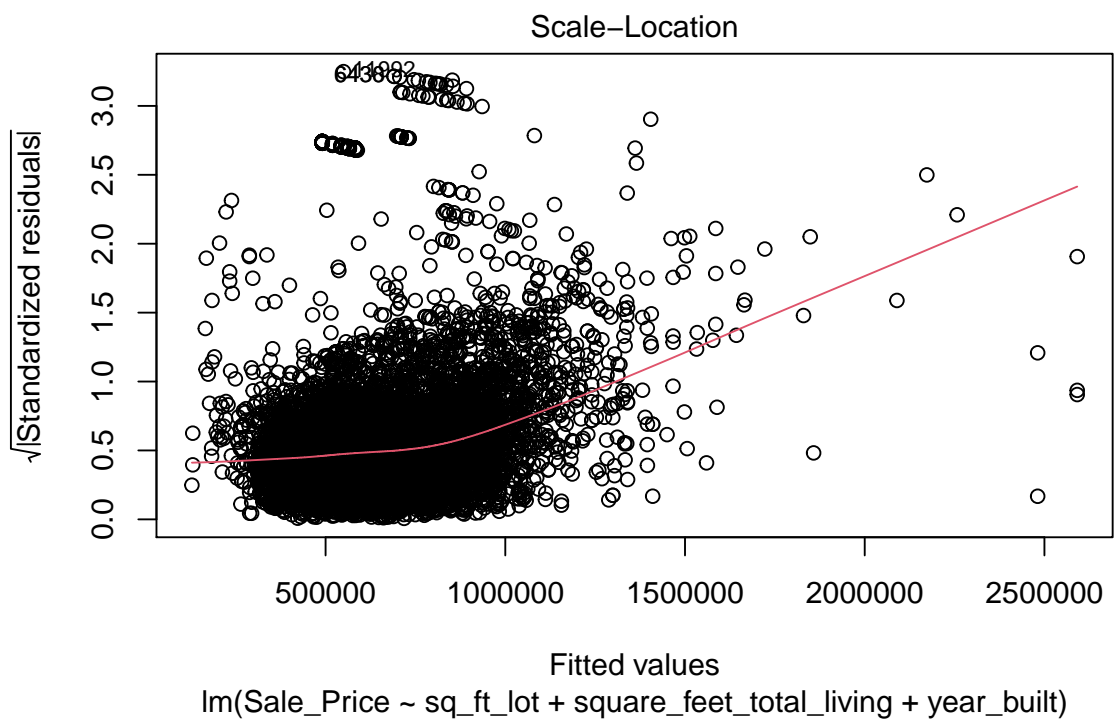
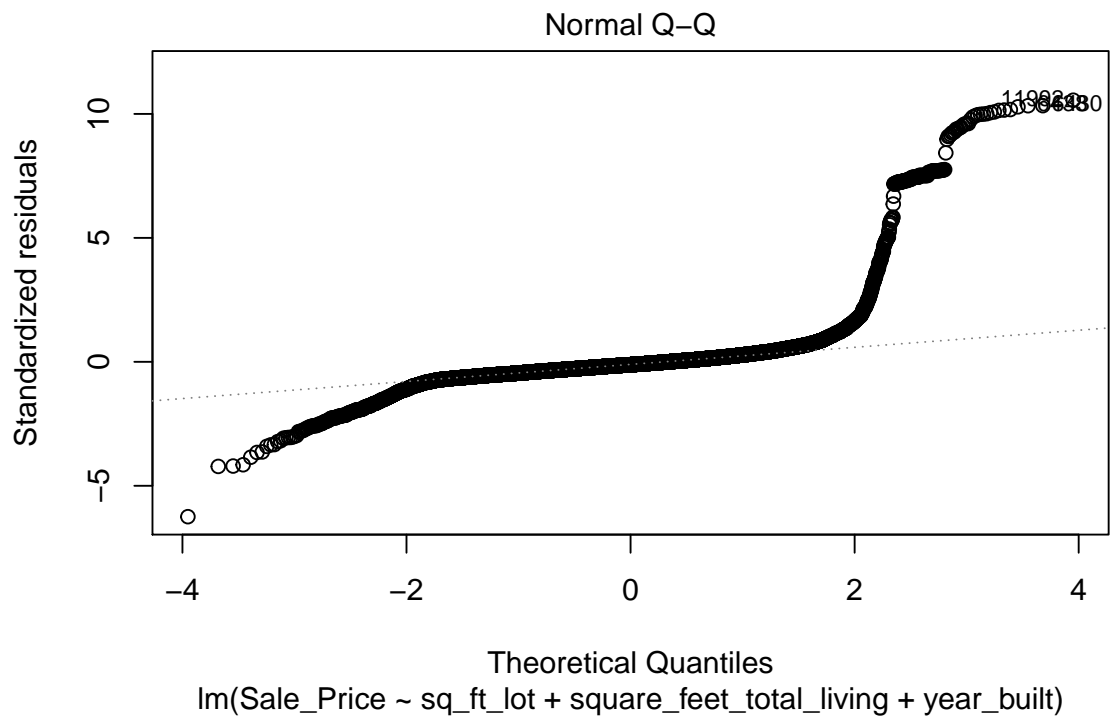
13. Perform the necessary calculations to assess the assumption of no multicollinearity and state if the condition is met or not.

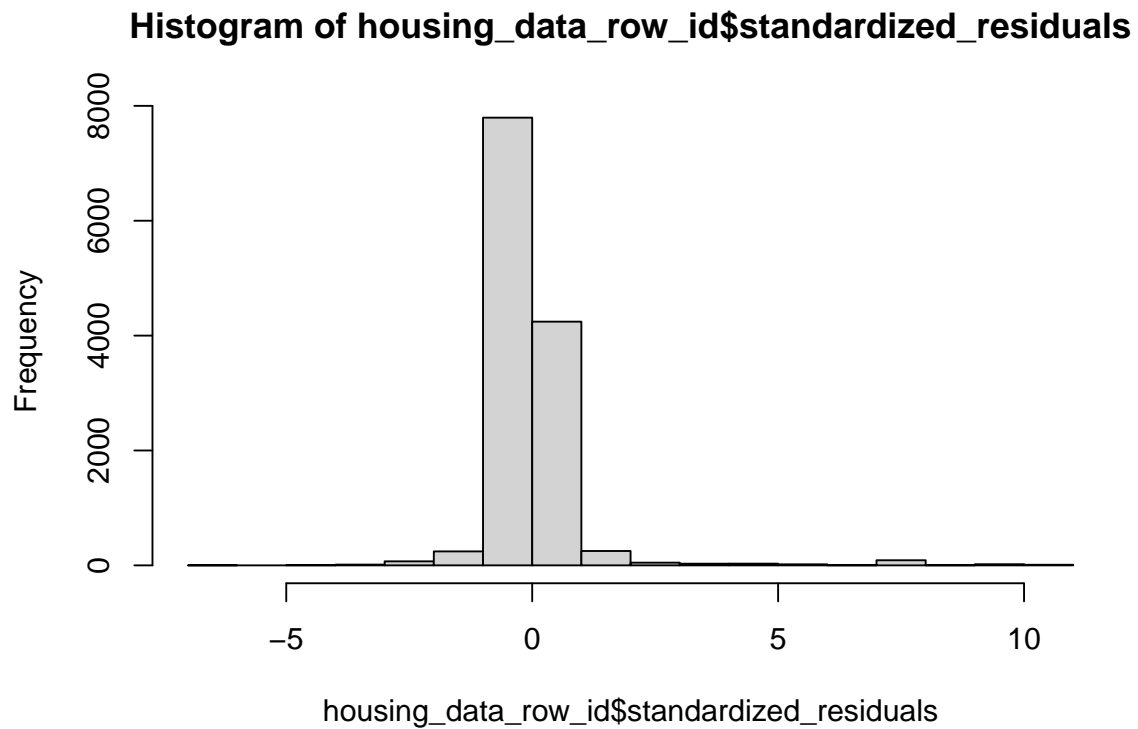
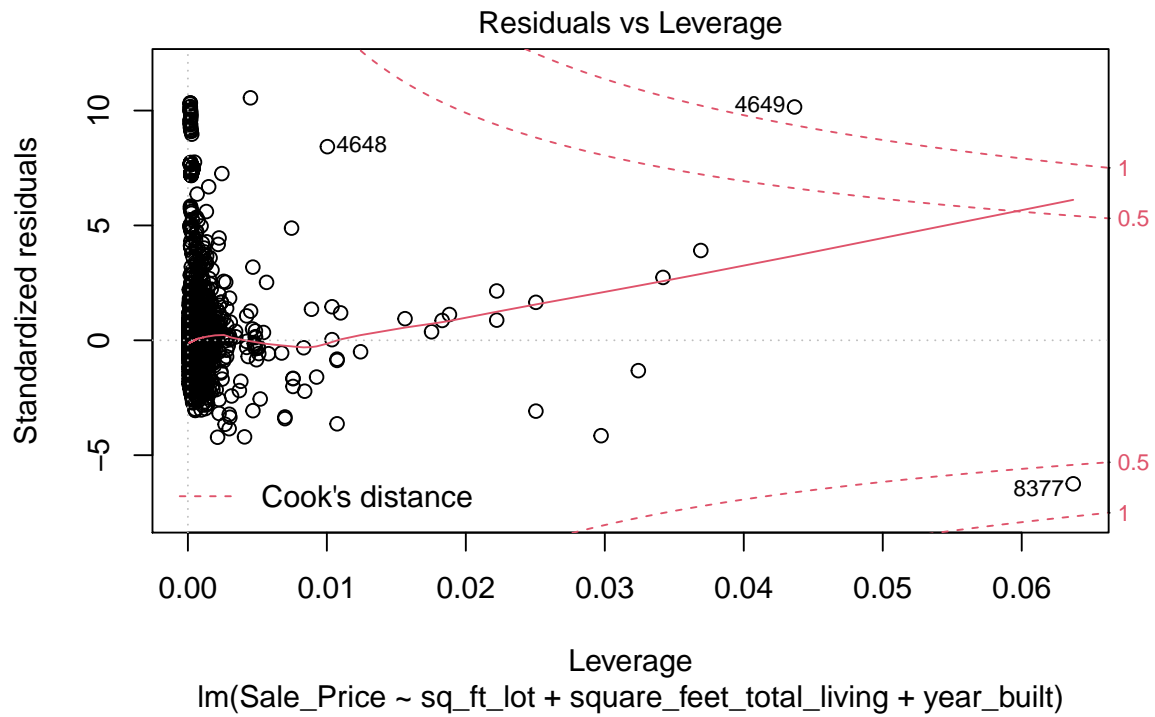
```
##              sq_ft_lot square_feet_total_living      year_built
##              1.113505           1.206527           1.161545
```

vif is less than 10, so everything looks ok here.

14. Visually check the assumptions related to the residuals using the plot() and hist() functions. Summarize what each graph is informing you of and if any anomalies are present.







15. Overall, is this regression model unbiased? If an unbiased regression model, what does this tell us about the sample vs. the entire population model?

I am not sure. The model does not follow a normal distribution, so I am not sure if this suggests bias or not. In saying that, most of the calculations and variables have not shown any metrics that have caused alarm.