6.1 Assignment Housing Data

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7/12/2020

##{r} ##setwd("/Users/Roni Kaakaty/Documents/Github/dsc520") ##

```
housing_df <- read.csv("data/week-7-cleaned-housing.csv")
```

```
library(ggplot2)
```

Explain why you chose to remove data points from your 'clean' dataset.

A. Not applicable since we received "cleaned" data set already. However, I did update the half bathroom and 3 quarter bathroom columns. I wanted a total_bath variable, so in order to weigh the bathrooms equally, every 1 half bath became 0.5 and every 1 three quarter bath became 0.75. This will enable me to provide a more accurate representation for my prediction model.

Create two variables; one that will contain variables Sale Price and Square Foot of Lot and one that will contain Sale Price and several additional predictors of your choice. Explain the basis of your additional predictor selections.

B. I've included square feet total living, bedrooms and total baths as additional predictor selections as there is an assumption that those items have a strong correlation with the sales price.

##Create two variables

```
sqfoot_lm <- lm(Sale.Price ~ sq_ft_lot, data = housing_df)

saleprice_lm <- lm(Sale.Price ~ sq_ft_lot + square_feet_total_living + bedrooms + total_bath, data = hou
```

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?

C.

Sale Price/Sq_ft_lot:

R2: .01435 Adjusted R2: .01428

Sale Price/Sq_ft_lot/Bedroom/Total Bath/Sq_ft_living:

R2: .2098 Adjusted R2: .2096

These results tell me that a linear model might not be the best fit since the numbers are very far from 1. Yes, including additional parameters is helpful because it the accounted for variance went from 1% in the original model to 21% in the model with the additional parameters. This means that the parameters helped account for an additional 20%.

```
summary(sqfoot_lm)
```

```
##
## Call:
## lm(formula = Sale.Price ~ sq_ft_lot, data = housing_df)
##
## 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
```

```
summary(saleprice_lm)
```

```
##
## Call:
## lm(formula = Sale.Price ~ sq_ft_lot + square_feet_total_living +
##     bedrooms + total_bath, data = housing_df)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1975012  -117703   -40353    44570  3787149
##
## Coefficients:
##                             Estimate Std. Error t value Pr(>|t|)
## (Intercept)               2.158e+05  1.451e+04  14.869  < 2e-16 ***
## sq_ft_lot                 9.441e-02  5.800e-02   1.628    0.104
## square_feet_total_living  1.828e+02  5.268e+00  34.698  < 2e-16 ***
## bedrooms                 -2.734e+04  4.506e+03  -6.068 1.33e-09 ***
## total_bath                2.979e+04  6.969e+03   4.275 1.92e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 359500 on 12860 degrees of freedom
## Multiple R-squared:  0.2098, Adjusted R-squared:  0.2096
## F-statistic: 853.6 on 4 and 12860 DF,  p-value: < 2.2e-16
```

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?

D. I've populated the standardized betas below. They indicate that for every 1 standard deviation in the predictor, the coefficient in question will increase by their standard beta coefficient, assuming the other variables remain constant.

##{r} ##install.packages("QuantPsyc") ##

```
library(QuantPsyc)
```

```
## Warning: package 'QuantPsyc' was built under R version 4.0.2
```

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

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

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

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

```
lm.beta(saleprice_lm)
```

```
##                sq_ft_lot square_feet_total_living                bedrooms
##               0.01329249               0.44745161              -0.05923540
##               total_bath
##               0.05121769
```

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

```
confint(saleprice_lm)
```

```
##                                 2.5 %        97.5 %
## (Intercept)               1.873207e+05  2.442088e+05
## sq_ft_lot                -1.927802e-02  2.081036e-01
## square_feet_total_living  1.724756e+02  1.931291e+02
## bedrooms                 -3.617257e+04 -1.850824e+04
## total_bath                1.613289e+04  4.345214e+04
```

E. The results indicate that the true value of the unknown quantities should fall within the ranges listed with 95% confidence. Since the confidence interval for the square_feet_total_living has the tightest confidence interval, it indicates that the estimates for the model should be representative of the true population.

Assess the improvement of the new model compared to the original model by testing whether this change is significant by performing an analysis of variance.

F. The analysis of variance provided a F value of 1060.2 which confirms that the new model improved the old model significantly.

```
anova(sqfoot_lm, saleprice_lm)
```

```
## Analysis of Variance Table
##
## Model 1: Sale.Price ~ sq_ft_lot
## Model 2: Sale.Price ~ sq_ft_lot + square_feet_total_living + bedrooms +
##     total_bath
```

```
##   Res.Df        RSS Df  Sum of Sq      F    Pr(>F)
## 1  12863 2.0734e+15
## 2  12860 1.6622e+15  3 4.1113e+14 1060.2 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

G. Perform casewise diagnostics to identify outliers and/or influential cases, storing each function's output in a dataframe assigned to a unique variable frame.

```
housing_df$residuals <- resid(saleprice_lm)
```

H. Calculate the standardized residuals using the appropriate command, specifying those that are +-2, storing the results of large residuals in a variable you create.

```
housing_df$standardized.residuals <- rstandard(saleprice_lm)
housing_df$studentized.residuals <- rstudent(saleprice_lm)
housing_df$cooks.distance <- cooks.distance(saleprice_lm)
housing_df$dfbeta <- dfbeta(saleprice_lm)
housing_df$dffit <- dffits(saleprice_lm)
housing_df$leverage <- hatvalues(saleprice_lm)
housing_df$covariance.ratios <- covratio(saleprice_lm)
```

```
write.table(housing_df, "Housing with Diagnostics.csv", sep = "\t", row.names = FALSE)
```

```
housing_df$large.residual <- housing_df$standardized.residuals > 2 | housing_df$standardized.residuals
```

I. Use the appropriate function to show the sum of the large residuals.

```
sum(housing_df$large.residual)
```

```
## [1] 322
```

J. Which specific variables have large residuals (only cases that evaluate as TRUE?)

```
housing_df[housing_df$large.residual ,c("bedrooms", "total_bath", "sq_ft_lot", "square_feet_total_livin
```

```
##       bedrooms total_bath sq_ft_lot square_feet_total_living
## 6            4       3.25      7280                      4160
## 25           4       4.50    112650                      4920
## 115          0       1.00    225640                       660
## 178          5       4.50     63162                      5800
## 239          2       2.50      8752                      3360
## 246          2       1.00     14043                       900
## 287          4       4.00     18498                      4710
## 295          4      23.50     89734                      5060
## 300          5       4.50    288367                      6880
## 341          4       3.25     55303                      4490
## 359          4       5.50    212572                      5140
## 385          4       3.75     36362                      6310
## 396          4       4.00    180774                      5080
```

```
## 475          4       3.00     10247                  3320
## 482          6       6.50     15021                  6380
## 508          4       3.75    305173                  3700
## 528          5       5.00     10454                  5830
## 661          4       4.25    176418                  8090
## 670          4       3.25     15167                  4710
## 679          7       7.75    118483                  8490
## 784          4       3.00    221720                  5150
## 811          4       4.25     18045                  5270
## 877          4       3.50    220413                  4640
## 916          5       5.50    144683                  7640
## 1009         4       3.00     35042                  4040
## 1119         4       5.25     45302                  6340
## 1142         4       4.25     55756                  5980
## 1155         6       5.75    544199                  4740
## 1207         4       4.75     37388                  8610
## 1380         3       2.00     14820                  3660
## 1442         0       0.75     29933                   340
## 1492         4       4.50    106722                  4610
## 1504         5       4.75    266152                  7780
## 1550         4       4.00    106722                  5380
## 1633         5       2.75      5930                  3130
## 1650         4       4.25     45738                  9360
## 1716         4       3.50     95989                  4610
## 1745         4       4.25     46609                  5360
## 1870         5       5.25    207781                 10630
## 1962         4       3.50    179031                  5300
## 1963         3       3.00     17715                  3090
## 1964         1       1.00     17715                   550
## 1976         5       3.75      9480                  3830
## 1977         4       2.50      7399                  3330
## 1978         4       3.00     10309                  3480
## 1979         4       2.50      7457                  3370
## 1980         4       3.50      5788                  3350
## 1981         6       3.50      8371                  4080
## 1982         5       3.50      6731                  3690
## 2022         1       1.75     18102                   900
## 2099         4       4.25     59677                  5020
## 2137         3       2.25     17995                  2820
## 2157         4       3.25     13634                  3130
## 2257         3       2.50     23522                  2940
## 2264         3       1.75     28183                  1540
## 2302        10       8.25     17328                  6340
## 2360         3       2.50     19556                  3200
## 2361         0       0.00     19556                   310
## 2469         3       2.50     19110                  2980
## 2604         3       3.75     41583                  3060
## 2684         5       3.75      5794                  3410
## 2685         4       3.50      5833                  3660
## 2686         5       4.00      5169                  4500
## 2687         4       3.50      5035                  3480
## 2688         4       3.25      5650                  3310
## 2689         5       3.25      5086                  4340
## 2690         5       4.25      5476                  4390
```

```
## 2699        4       3.75   1008414                  5270
## 2708        5       4.25    108542                  4710
## 2709        4       3.50    131301                  5100
## 2710        4       3.50    146779                  4910
## 2717        4       3.50    193842                  5390
## 2742        4       4.25     78844                  3950
## 2852        7       7.50    139392                 11810
## 2934        4       3.50     95989                  4610
## 2937        4       3.50     95989                  4610
## 3097        4       3.50    178160                  5320
## 3102        4       3.50      7701                  4790
## 3110        2       1.25     18792                  1290
## 3111        5       2.00     18792                  1920
## 3168        2       1.00      2628                  1290
## 3169        2       2.00      2628                  1290
## 3170        3       2.50      6451                  1600
## 3171        3       2.50      3833                  1740
## 3172        3       2.50      4846                  1710
## 3173        3       2.00      4862                  1740
## 3174        3       2.50      4710                  1710
## 3175        3       2.00      4350                  1460
## 3176        3       2.50      4622                  1820
## 3177        3       2.50      4697                  1840
## 3178        3       2.00      5125                  1840
## 3179        3       2.50      5481                  1600
## 3180        3       2.50      5680                  1840
## 3181        3       2.50      5277                  1600
## 3182        2       1.00      2807                  1290
## 3183        2       1.00      2482                  1290
## 3184        2       1.00      2482                  1290
## 3185        2       1.00      2828                  1290
## 3186        2       1.00      2628                  1290
## 3187        2       1.00      2628                  1290
## 3188        2       2.00      3940                  1290
## 3189        3       2.00      4093                  1460
## 3190        3       2.50      4041                  1710
## 3191        3       2.00      3989                  1460
## 3192        3       2.50      3937                  1740
## 3193        3       2.50      3885                  1710
## 3194        3       2.50      3781                  1710
## 3195        3       2.50      4910                  1840
## 3196        3       2.50      5340                  1840
## 3197        3       2.50      6952                  1820
## 3198        2       1.00      3170                  1290
## 3199        2       1.00      3140                  1290
## 3200        2       1.00      2482                  1290
## 3201        2       1.00      2482                  1290
## 3202        2       1.00      2482                  1290
## 3424        4       3.50     10922                  4290
## 3464        3       2.00      3918                  1460
## 3465        3       2.50      4036                  1600
## 3466        3       2.50      4487                  1840
## 3467        3       2.50      5453                  1840
## 3468        3       2.00      4195                  1460
```

```
## 3469         3       2.50      4179                  1600
## 3470         3       2.50      4229                  1840
## 3471         3       2.50      4279                  1600
## 3472         3       2.50      3915                  1740
## 3473         3       2.50      4424                  1710
## 3474         3       2.00      4827                  1460
## 3475         3       2.50      4948                  1740
## 3476         3       1.50      4646                  1830
## 3477         3       2.50      4607                  1740
## 3478         2       1.00      2482                  1290
## 3479         2       1.00      2482                  1290
## 3480         2       1.00      2482                  1290
## 3481         2       1.00      2482                  1290
## 3482         2       1.00      2482                  1290
## 3483         2       1.00      2483                  1290
## 3484         2       2.00      2479                  1290
## 3485         3       2.50      4408                  1840
## 3486         3       2.50      4056                  1600
## 3487         3       2.50      4424                  1840
## 3488         3       2.50      3790                  1710
## 3489         3       2.50      3476                  1740
## 3490         3       2.00      4446                  1710
## 3491         4       2.25      4140                  1840
## 3492         3       2.00      4076                  1600
## 3493         3       2.50      4698                  1840
## 3494         3       2.00      4263                  1460
## 3495         2       1.00      2483                  1290
## 3496         2       1.00      2483                  1290
## 3497         2       1.00      2483                  1290
## 3523         4       4.25     22545                  3980
## 3810         5       2.75     16418                  3430
## 3837         4       2.50    104688                  4480
## 3918         4       5.25     45302                  6340
## 3919         4       4.25     55756                  5980
## 4055         4       4.50     14388                  4110
## 4056         1       1.00     14388                   900
## 4285         5       3.00      8561                  4180
## 4435         4       4.00     11325                  4330
## 4571         3       1.50    105660                  3430
## 4648         3       3.25    657816                  5790
## 4649         3       1.75   1327090                  2410
## 4671         5       7.00    277286                  7810
## 4695         2       1.75     16105                  1430
## 4696         4       3.50     16105                  5330
## 4821         1       1.00      7599                   890
## 4834         1       1.75     18102                   900
## 4840         6       5.75    544199                  4740
## 4934         4       2.75     15353                  4210
## 5083         4       4.75   1127205                  5830
## 5491         4       2.50      7743                  2960
## 5494         4       2.50      6932                  3010
## 5495         4       2.75      6396                  2960
## 5496         4       2.50      7588                  2960
## 5497         5       3.00      5815                  2950
```

```
## 5498        4       2.50      5062                  3480
## 5549        3       2.75    104544                  4130
## 5935        3       3.50    127591                  5640
## 6055        4       2.75    223027                  3500
## 6230        4       3.25      5000                  3320
## 6231        4       3.25      5037                  3530
## 6232        4       3.50      6237                  3720
## 6233        4       2.75      5163                  3150
## 6234        5       3.50      5013                  3340
## 6235        5       2.75      5143                  3320
## 6236        5       3.50      5100                  3340
## 6237        5       2.75      5100                  3320
## 6238        4       2.75      5103                  3060
## 6239        4       3.25      4963                  3530
## 6429        4       2.50      6712                  3290
## 6430        4       2.50      4749                  2450
## 6431        4       2.50      5816                  2750
## 6432        4       2.75      8908                  3010
## 6433        5       2.50      4584                  3200
## 6434        5       2.50      4681                  3200
## 6435        5       3.75      9901                  3620
## 6436        4       2.50     13289                  2810
## 6437        4       2.50      4368                  2550
## 6438        3       2.50      4244                  2440
## 6439        4       2.50      5778                  3160
## 6440        4       3.75      6740                  3400
## 6441        4       3.75      4451                  2960
## 6442        4       2.75      5310                  3110
## 6443        5       3.50      4647                  2900
## 6444        5       3.50      4080                  3220
## 6445        4       3.50      5032                  2510
## 6446        4       3.50      4383                  2970
## 6447        5       3.50      5326                  3470
## 6448        4       2.50      5913                  2580
## 6449        5       3.25      6254                  3590
## 6450        5       3.25      5441                  3890
## 6451        4       3.50      4442                  2520
## 6452        4       3.50      4234                  2990
## 6453        5       3.00      6168                  3620
## 6454        5       3.50      4676                  3300
## 6455        5       3.00      6695                  2830
## 6456        4       2.50      7271                  2680
## 6457        5       3.25      4596                  3330
## 6512        4       4.25     17417                  5040
## 6527        5       3.75     15681                  5050
## 6634        5       2.50      5898                  2670
## 6739        3       4.50     62726                  3850
## 6821        5       2.50     16000                  4200
## 6931        4       2.50      7761                  4000
## 6938        4       2.75      6260                  3970
## 6939        4       3.75      6260                  4610
## 6940        4       2.50      6200                  3360
## 6941        4       2.50      8108                  3370
## 6942        5       3.75      6858                  4390
```

```
## 6943         5       4.00      6475                 4380
## 6944         5       3.50      6438                 4790
## 6945         4       3.50      6260                 3970
## 6946         4       2.50      6418                 3370
## 6947         4       2.50      6594                 3260
## 6948         4       2.50      7617                 3210
## 7039         4       3.50    151153                 5320
## 7147         5       3.50     11718                 5370
## 7167         4       2.75     20119                 4460
## 7210         4       3.00    202387                 4460
## 7211         5       3.00    155074                 3640
## 7389         3       4.25     79863                 7040
## 7446         4       2.50      4644                 2650
## 7447         4       2.50      4887                 2520
## 7448         4       2.50      5078                 2655
## 7449         3       2.50      4409                 2520
## 7450         3       2.50      4400                 2515
## 7451         3       2.50      4408                 2510
## 7452         4       2.50      5140                 2520
## 7453         4       2.50      5021                 2630
## 7454         4       2.50      5099                 2640
## 7455         4       2.50      5127                 2530
## 7456         4       2.50      4850                 2520
## 7457         4       2.50      4499                 2640
## 7458         3       2.50      5232                 2510
## 7459         4       2.50      4400                 2445
## 7460         3       2.50      4400                 2515
## 7461         4       2.50      4400                 2475
## 7462         4       2.50      4403                 2460
## 7463         4       2.50      4416                 2475
## 7507         4       3.00    221720                 5150
## 7649         4       4.50      8038                 4350
## 7650         4       4.50      7796                 4350
## 7791         3       4.00    218439                 5620
## 7871         4       4.25    319294                 6650
## 8119         5       2.50     16000                 4200
## 8154         4       3.50     54014                 3960
## 8232         4       3.00    221720                 5150
## 8262         7       8.00    307752                13540
## 8320         3       3.25    436507                 5820
## 8377         5       5.25   1631322                 8750
## 8457         3       3.00     17715                 3090
## 8458         1       1.00     17715                  550
## 8535         5       3.25     10000                 4420
## 8541         5       2.75      5930                 3130
## 8698         4       3.25     16190                 3380
## 8710         5       4.25     14444                 4950
## 8763         5       2.50     10861                 3460
## 8887         4       5.50     21010                 6360
## 8911         5       5.00     83813                 6280
## 8946         5       5.00     83813                 6280
## 9215         4       1.00    316245                 1650
## 9293         5       5.00     10454                 5830
## 9420         4       0.50    464350                 4800
```

```
## 9453         4       3.50     95989                    4610
## 9528         4       4.00    209088                    7110
## 9546         4       2.50    104688                    4480
## 9722         3       2.75     15188                    2900
## 10125        4       3.50    167270                    6680
## 10318        4       3.75    963702                    5150
## 10371        4       2.25    111950                    4930
## 10418        3       3.00    261795                    4770
## 10623        4       3.50    112384                    4570
## 10707        4       2.50      9705                    2630
## 10723        4       3.50      6451                    4790
## 10787        5       4.25     19173                    4640
## 10958        5       3.25    117454                    4010
## 10995        6       6.00    186525                    9070
## 11165        4       4.50     14041                    4140
## 11289        4       3.25     10532                    3310
## 11413        3       2.25    192099                    2610
## 11558        2       1.00     13260                     730
## 11586        4       2.50     13170                    2770
## 11728        2       1.75    439956                    2280
## 11758        4       2.25    111950                    4930
## 11772        4       3.25     41217                    6600
## 11822        3       3.25     15368                    4240
## 11898        4       4.00   1166246                    3690
## 11899        1       1.00   1166246                    1230
## 11982        5       5.50    144683                    7640
## 11992        3       1.50    425145                    1670
## 12212        2       1.00    167838                     820
## 12255        2       1.75    227383                    1650
## 12256        4       3.25    227383                    3260
## 12392        3       2.25    188614                    2140
## 12472        3       3.00     30894                    3150
## 12487        4       2.50      9600                    5000
## 12577        3       3.00    227818                    5030
## 12582        5       4.75     29494                    7070
## 12643        3       3.25     77418                    4690
## 12686        3       3.50     19290                    3720
## 12764        5       6.00    226512                    6990
## 12816        4       3.75   1008414                    5270
##       standardized.residuals
## 6                  -2.169095
## 25                 -2.464169
## 115                 2.791772
## 178                -2.474876
## 239                 2.052786
## 246                 3.041611
## 287                -2.574517
## 295                -4.430179
## 300                -3.615300
## 341                -2.028765
## 359                -2.904703
## 385                 3.131682
## 396                 2.776649
## 475                 2.031579
```

```
## 482              -2.389959
## 508              -2.390140
## 528              -2.392852
## 661               2.341984
## 670               4.221666
## 679              -4.093951
## 784              -2.319091
## 811               5.014196
## 877              -2.567943
## 916              -3.350770
## 1009             -2.121478
## 1119             -3.193074
## 1142             -2.928763
## 1155             -3.099174
## 1207             -2.281290
## 1380             -2.180859
## 1442              2.176322
## 1492             -2.249218
## 1504             -3.385120
## 1550             -2.623192
## 1633             -2.027268
## 1650             -4.459701
## 1716             -2.953151
## 1745              2.832130
## 1870              2.204127
## 1962              3.608411
## 1963              2.254210
## 1964              3.560400
## 1976              4.821815
## 1977              5.103647
## 1978              4.985045
## 1979              5.083321
## 1980              5.011166
## 1981              4.792488
## 1982              4.914306
## 2022              2.721711
## 2099              2.277989
## 2137              2.973717
## 2157              2.507200
## 2257             -2.024753
## 2264              3.285043
## 2302             -2.510455
## 2360              2.350515
## 2361              3.801963
## 2469              2.657148
## 2604             -2.138436
## 2684              4.939193
## 2685              4.756145
## 2686              4.364336
## 2687              4.847880
## 2688              4.954693
## 2689              4.507731
## 2690              4.399695
## 2699             -2.524554
```

```
## 2708              3.403173
## 2709              3.185061
## 2710              3.277592
## 2717              3.851219
## 2742             -2.648810
## 2852              4.396888
## 2934             -2.951760
## 2937             -2.900290
## 3097              3.754328
## 3102              2.762757
## 3110              2.264796
## 3111              2.110718
## 3168              7.645600
## 3169              7.562029
## 3170              7.437659
## 3171              7.366998
## 3172              7.382018
## 3173              7.407897
## 3174              7.382054
## 3175              7.550566
## 3176              7.326036
## 3177              7.315829
## 3178              7.356953
## 3179              7.437913
## 3180              7.315571
## 3181              7.437967
## 3182              7.645552
## 3183              7.645639
## 3184              7.645639
## 3185              7.645547
## 3186              7.645600
## 3187              7.645600
## 3188              7.561683
## 3189              7.550634
## 3190              7.382230
## 3191              7.550661
## 3192              7.366971
## 3193              7.382271
## 3194              7.382298
## 3195              7.315773
## 3196              7.315660
## 3197              7.325423
## 3198              7.645455
## 3199              7.645463
## 3200              7.645639
## 3201              7.645639
## 3202              7.645639
## 3424             -2.714626
## 3464              7.481137
## 3465              7.368747
## 3466              7.246342
## 3467              7.246088
## 3468              7.481064
## 3469              7.368710
```

```
## 3470              7.246410
## 3471              7.368683
## 3472              7.297433
## 3473              7.312585
## 3474              7.480898
## 3475              7.297162
## 3476              7.334545
## 3477              7.297251
## 3478              7.576084
## 3479              7.576084
## 3480              7.576084
## 3481              7.576084
## 3482              7.576084
## 3483              7.576084
## 3484              7.492520
## 3485              7.246363
## 3486              7.368742
## 3487              7.246358
## 3488              7.312752
## 3489              7.297549
## 3490              7.353731
## 3491              7.343404
## 3492              7.409813
## 3493              7.246286
## 3494              7.481046
## 3495              7.576084
## 3496              7.576084
## 3497              7.576084
## 3523              2.886146
## 3810             -2.114331
## 3837             -2.447865
## 3918             -2.578212
## 3919             -2.383669
## 4055              2.801724
## 4056              4.496306
## 4285             -2.165407
## 4435             -2.307624
## 4571             -2.266753
## 4648              8.523399
## 4649             10.377699
## 4671             -2.625073
## 4695              5.073738
## 4696              3.098521
## 4821              2.917134
## 4834              2.485338
## 4840             -3.171840
## 4934              2.283064
## 5083             -4.009708
## 5491              2.301231
## 5494              2.276028
## 5495              2.280842
## 5496              2.301271
## 5497              2.341703
## 5498              2.037649
```

```
## 5549              -2.057601
## 5935              -3.064996
## 6055              -2.001481
## 6230               5.770388
## 6231               5.663625
## 6232               5.546179
## 6233               5.898064
## 6234               5.816190
## 6235               5.888332
## 6236               5.816167
## 6237               5.888344
## 6238               5.943818
## 6239               5.663645
## 6429              10.007608
## 6430              10.434894
## 6431              10.282021
## 6432              10.128252
## 6433              10.131055
## 6434              10.131028
## 6435               9.812642
## 6436              10.249534
## 6437              10.384111
## 6438              10.364011
## 6439              10.073809
## 6440               9.848995
## 6441              10.073883
## 6442              10.078406
## 6443               9.532674
## 6444               9.369598
## 6445               9.654582
## 6446               9.420092
## 6447               9.241900
## 6448               9.699904
## 6449               9.201090
## 6450               9.048833
## 6451               9.649630
## 6452               9.409939
## 6453               9.206615
## 6454               9.328668
## 6455               9.608477
## 6456               9.648686
## 6457               9.333821
## 6512               3.739823
## 6527              -2.338321
## 6634               2.094367
## 6739              -2.581460
## 6821              -2.512063
## 6931              -2.123275
## 6938               3.854013
## 6939               3.445945
## 6940               4.184658
## 6941               4.179072
## 6942               3.633586
## 6943               3.618164
```

```
## 6944               3.451195
## 6945               3.791733
## 6946               4.179521
## 6947               4.235346
## 6948               4.260474
## 7039               2.010750
## 7147              -2.538052
## 7167               6.105715
## 7210               4.090300
## 7211               4.595294
## 7389              -2.005088
## 7446               7.778132
## 7447               7.844188
## 7448               7.775474
## 7449               7.768260
## 7450               7.770804
## 7451               7.773343
## 7452               7.844120
## 7453               7.788202
## 7454               7.783096
## 7455               7.839037
## 7456               7.844197
## 7457               7.783256
## 7458               7.773123
## 7459               7.882476
## 7460               7.770804
## 7461               7.867211
## 7462               7.874843
## 7463               7.867207
## 7507              -2.584398
## 7649              -2.104840
## 7650              -2.104777
## 7791              -2.159119
## 7871              -3.153005
## 8119              -2.289467
## 8154              -2.079921
## 8232              -2.594661
## 8262              -4.102206
## 8320              -2.880790
## 8377              -5.674254
## 8457               2.215265
## 8458               3.521445
## 8535              -2.058259
## 8541              -2.034223
## 8698               2.440589
## 8710               4.557777
## 8763               2.400755
## 8887               5.304683
## 8911               2.160610
## 8946               2.160610
## 9215               2.600894
## 9293              -2.420684
## 9420              -2.017462
## 9453              -2.122675
```

```
## 9528              -4.280905
## 9546              -2.392214
## 9722               2.650307
## 10125              2.095178
## 10318              2.501370
## 10371             -2.188329
## 10418             -2.212801
## 10623             -2.046851
## 10707              2.169470
## 10723              2.123158
## 10787              3.183820
## 10958             -2.509562
## 10995             -2.385652
## 11165              2.480460
## 11289              4.146703
## 11413              3.697991
## 11558              5.075753
## 11586              2.813639
## 11728              3.257622
## 11758             -2.271830
## 11772              6.506286
## 11822              5.127549
## 11898              3.268641
## 11899              4.562752
## 11982              4.238087
## 11992             10.557864
## 12212              2.347121
## 12255              3.322548
## 12256              2.530938
## 12392              2.338030
## 12472              4.306578
## 12487              3.073246
## 12577              4.275691
## 12582              6.777127
## 12643              7.665506
## 12686             -2.146865
## 12764              3.986220
## 12816              2.177011
```

Investigate further by calculating the leverage, cooks distance, and covariance rations.Comment on all cases that are problematics.

K. Based on the data, line 295 is the only problematic case since the leverage exceeds the average leverage amount.The covariance ratio also falls outside of the average boundry.

```
housing_df[housing_df$large.residual , c("cooks.distance", "leverage", "covariance.ratios")]
```

```
##       cooks.distance     leverage covariance.ratios
## 6       0.0003219879 0.0003420612         0.9989019
## 25      0.0011898691 0.0009788202         0.9990072
## 115     0.0037880501 0.0024242182         0.9997848
## 178     0.0011844718 0.0009659797         0.9989738
## 239     0.0006233065 0.0007390322         0.9994896
## 246     0.0008614624 0.0004653684         0.9972598
```

```
## 287     0.0008033656 0.0006056595         0.9984182
## 295     0.6830692450 0.1482237082         1.1655389
## 300     0.0070533441 0.0026909534         0.9980010
## 341     0.0003517824 0.0004271644         0.9992159
## 359     0.0044454247 0.0026274674         0.9997383
## 385     0.0033264346 0.0016930038         0.9982701
## 396     0.0016896828 0.0010946056         0.9984867
## 475     0.0001178536 0.0001427523         0.9989272
## 482     0.0031317813 0.0027339556         1.0009056
## 508     0.0026772302 0.0023377214         1.0005078
## 528     0.0014287234 0.0012460774         0.9994092
## 661     0.0040402732 0.0036695793         1.0019340
## 670     0.0021012086 0.0005891360         0.9940616
## 679     0.0156268687 0.0046402008         0.9985202
## 784     0.0016050049 0.0014899211         0.9997884
## 811     0.0045431943 0.0009026856         0.9915430
## 877     0.0015613197 0.0011824346         0.9990079
## 916     0.0055593886 0.0024696423         0.9984954
## 1009    0.0002607830 0.0002896318         0.9989289
## 1119    0.0038310064 0.0018752094         0.9983015
## 1142    0.0021696267 0.0012630999         0.9983180
## 1155    0.0185235733 0.0095506991         1.0062692
## 1207    0.0045867821 0.0043874045         1.0027658
## 1380    0.0006927134 0.0007276999         0.9992675
## 1442    0.0012764748 0.0013457086         0.9998936
## 1492    0.0009571485 0.0009450952         0.9993672
## 1504    0.0072558839 0.0031560179         0.9990930
## 1550    0.0012358643 0.0008972029         0.9986113
## 1633    0.0002862613 0.0003481441         0.9991392
## 1650    0.0249069302 0.0062225412         0.9988926
## 1716    0.0008819944 0.0005054114         0.9975055
## 1745    0.0014477690 0.0009016774         0.9981730
## 1870    0.0066909754 0.0068392101         1.0053767
## 1962    0.0029744138 0.0011408895         0.9964716
## 1963    0.0002357643 0.0002319309         0.9986456
## 1964    0.0018930113 0.0007461076         0.9962113
## 1976    0.0019736051 0.0004242529         0.9917992
## 1977    0.0011081664 0.0002126774         0.9905093
## 1978    0.0008115818 0.0001632650         0.9909222
## 1979    0.0011593927 0.0002242890         0.9906008
## 1980    0.0013513758 0.0002689997         0.9909262
## 1981    0.0033687873 0.0007328297         0.9922144
## 1982    0.0017513891 0.0003624690         0.9913901
## 2022    0.0010934821 0.0007375261         0.9982472
## 2099    0.0007955582 0.0007659595         0.9991374
## 2137    0.0003268155 0.0001847538         0.9971383
## 2157    0.0002351864 0.0001870351         0.9981330
## 2257    0.0001385184 0.0001689118         0.9989641
## 2264    0.0003892849 0.0001803338         0.9963782
## 2302    0.0107245886 0.0084365774         1.0064308
## 2360    0.0002708650 0.0002450702         0.9984865
## 2361    0.0049731284 0.0017172659         0.9964905
## 2469    0.0002562921 0.0001814659         0.9978268
## 2604    0.0005762901 0.0006297165         0.9992407
```

```
## 2684    0.0024344026 0.0004986936         0.9914305
## 2685    0.0012136644 0.0002681896         0.9918873
## 2686    0.0020010364 0.0005250016         0.9935238
## 2687    0.0012436596 0.0002645166         0.9915434
## 2688    0.0009143186 0.0001861886         0.9910614
## 2689    0.0018327631 0.0004507799         0.9929580
## 2690    0.0024165596 0.0006238085         0.9935022
## 2699    0.0311338112 0.0238425591         1.0222863
## 2708    0.0016972244 0.0007321887         0.9966220
## 2709    0.0016634813 0.0008192124         0.9972663
## 2710    0.0016976100 0.0007895052         0.9970046
## 2717    0.0037993554 0.0012791681         0.9959072
## 2742    0.0010161724 0.0007236379         0.9983854
## 2852    0.0278656415 0.0071553285         1.0000476
## 2934    0.0008811637 0.0005054114         0.9975087
## 2937    0.0008507018 0.0005054114         0.9976256
## 3097    0.0032374787 0.0011471339         0.9960612
## 3102    0.0009313523 0.0006097246         0.9980321
## 3110    0.0004050927 0.0003947253         0.9987897
## 3111    0.0005985973 0.0006713558         0.9993282
## 3168    0.0060525798 0.0005174431         0.9783645
## 3169    0.0038543534 0.0003368981         0.9786735
## 3170    0.0027294014 0.0002466367         0.9792983
## 3171    0.0022190483 0.0002043934         0.9796570
## 3172    0.0023177687 0.0002126168         0.9795803
## 3173    0.0014464610 0.0001317740         0.9793548
## 3174    0.0023178191 0.0002126194         0.9795801
## 3175    0.0019779541 0.0001734410         0.9785797
## 3176    0.0019764616 0.0001840943         0.9798673
## 3177    0.0019212439 0.0001794516         0.9799200
## 3178    0.0013524890 0.0001249262         0.9796357
## 3179    0.0027276367 0.0002464605         0.9792967
## 3180    0.0019194083 0.0001792929         0.9799213
## 3181    0.0027273345 0.0002464296         0.9792963
## 3182    0.0060503319 0.0005172575         0.9783646
## 3183    0.0060544277 0.0005175957         0.9783645
## 3184    0.0060544277 0.0005175957         0.9783645
## 3185    0.0060500694 0.0005172358         0.9783646
## 3186    0.0060525798 0.0005174431         0.9783645
## 3187    0.0060525798 0.0005174431         0.9783645
## 3188    0.0038496484 0.0003365178         0.9786751
## 3189    0.0019782572 0.0001734645         0.9785793
## 3190    0.0023182201 0.0002126460         0.9795792
## 3191    0.0019783910 0.0001734750         0.9785792
## 3192    0.0022189152 0.0002043826         0.9796571
## 3193    0.0023183501 0.0002126556         0.9795789
## 3194    0.0023184445 0.0002126626         0.9795788
## 3195    0.0019208004 0.0001794130         0.9799202
## 3196    0.0019199822 0.0001793421         0.9799208
## 3197    0.0019735017 0.0001838494         0.9798705
## 3198    0.0060458335 0.0005168862         0.9783648
## 3199    0.0060462022 0.0005169166         0.9783648
## 3200    0.0060544277 0.0005175957         0.9783645
## 3201    0.0060544277 0.0005175957         0.9783645
```

```
## 3202    0.0060544277 0.0005175957         0.9783645
## 3424    0.0005655748 0.0003835955         0.9979087
## 3464    0.0019422097 0.0001734825         0.9789787
## 3465    0.0026752771 0.0002462887         0.9796882
## 3466    0.0018853452 0.0001794921         0.9803072
## 3467    0.0018834587 0.0001793251         0.9803085
## 3468    0.0019418620 0.0001734548         0.9789790
## 3469    0.0026753819 0.0002463009         0.9796884
## 3470    0.0018859354 0.0001795449         0.9803069
## 3471    0.0026754620 0.0002463100         0.9796886
## 3472    0.0021772473 0.0002043849         0.9800473
## 3473    0.0022744921 0.0002126279         0.9799706
## 3474    0.0019412363 0.0001734066         0.9789799
## 3475    0.0021762626 0.0002043076         0.9800487
## 3476    0.0027702504 0.0002574132         0.9798915
## 3477    0.0021765222 0.0002043270         0.9800482
## 3478    0.0059447711 0.0005175957         0.9787691
## 3479    0.0059447711 0.0005175957         0.9787691
## 3480    0.0059447711 0.0005175957         0.9787691
## 3481    0.0059447711 0.0005175957         0.9787691
## 3482    0.0059447711 0.0005175957         0.9787691
## 3483    0.0059447587 0.0005175947         0.9787691
## 3484    0.0037843708 0.0003369469         0.9790736
## 3485    0.0018855220 0.0001795079         0.9803071
## 3486    0.0026752910 0.0002462903         0.9796882
## 3487    0.0018854859 0.0001795047         0.9803071
## 3488    0.0022749608 0.0002126620         0.9799697
## 3489    0.0021778451 0.0002044345         0.9800467
## 3490    0.0014579459 0.0001347837         0.9796635
## 3491    0.0025229094 0.0002338704         0.9798187
## 3492    0.0016318200 0.0001485810         0.9793604
## 3493    0.0018848895 0.0001794515         0.9803075
## 3494    0.0019417835 0.0001734486         0.9789791
## 3495    0.0059447587 0.0005175947         0.9787691
## 3496    0.0059447587 0.0005175947         0.9787691
## 3497    0.0059447587 0.0005175947         0.9787691
## 3523    0.0010919963 0.0006550435         0.9978068
## 3810    0.0003154425 0.0003526884         0.9990037
## 3837    0.0009313964 0.0007765908         0.9988361
## 3918    0.0024976527 0.0018752094         0.9996807
## 3919    0.0014371717 0.0012630999         0.9994433
## 4055    0.0013437944 0.0008552251         0.9981931
## 4056    0.0031260006 0.0007725234         0.9933176
## 4285    0.0004287551 0.0004569849         0.9990230
## 4435    0.0005603310 0.0005258430         0.9988446
## 4571    0.0010183176 0.0009899537         0.9993813
## 4648    0.1477412726 0.0100658982         0.9823376
## 4649    0.9882328762 0.0438677257         1.0032039
## 4671    0.0067388895 0.0048658344         1.0025899
## 4695    0.0015582268 0.0003025612         0.9907159
## 4696    0.0018093677 0.0009414104         0.9975993
## 4821    0.0013186234 0.0007741797         0.9978559
## 4834    0.0009117984 0.0007375261         0.9987253
## 4840    0.0194023950 0.0095506991         1.0060908
```

```
## 4934    0.0004947700 0.0004743852         0.9988370
## 5083    0.1013904460 0.0305674475         1.0254979
## 5491    0.0001447041 0.0001366065         0.9984672
## 5494    0.0001495460 0.0001443202         0.9985197
## 5495    0.0001198809 0.0001152072         0.9984821
## 5496    0.0001448868 0.0001367740         0.9984673
## 5497    0.0003993209 0.0003639738         0.9986213
## 5498    0.0002195736 0.0002643484         0.9990391
## 5549    0.0005463996 0.0006448787         0.9993877
## 5935    0.0029661752 0.0015762385         0.9983139
## 6055    0.0008511138 0.0010611908         0.9998928
## 6230    0.0012454654 0.0001869865         0.9876893
## 6231    0.0012737730 0.0001985120         0.9881708
## 6232    0.0016752806 0.0002722397         0.9887509
## 6233    0.0009131483 0.0001312307         0.9870608
## 6234    0.0027550030 0.0004070410         0.9877024
## 6235    0.0024535747 0.0003536967         0.9873247
## 6236    0.0027546193 0.0004069875         0.9877025
## 6237    0.0024539196 0.0003537451         0.9873246
## 6238    0.0008646876 0.0001223616         0.9868436
## 6239    0.0012744471 0.0001986157         0.9881708
## 6429    0.0040611931 0.0002027099         0.9622314
## 6430    0.0028399546 0.0001303913         0.9588731
## 6431    0.0025703674 0.0001215501         0.9600560
## 6432    0.0023615627 0.0001150934         0.9612316
## 6433    0.0084892631 0.0004133816         0.9614970
## 6434    0.0084868729 0.0004132674         0.9614971
## 6435    0.0086901806 0.0004510565         0.9639288
## 6436    0.0024923415 0.0001186090         0.9603042
## 6437    0.0026693437 0.0001237605         0.9592643
## 6438    0.0025965552 0.0001208535         0.9594184
## 6439    0.0035088048 0.0001728489         0.9617015
## 6440    0.0075722501 0.0003901590         0.9636002
## 6441    0.0100280980 0.0004938331         0.9620098
## 6442    0.0025731926 0.0001266495         0.9616222
## 6443    0.0097385388 0.0005355520         0.9660573
## 6444    0.0076285830 0.0004342935         0.9671259
## 6445    0.0089226026 0.0004783952         0.9651176
## 6446    0.0058042720 0.0003269380         0.9666630
## 6447    0.0065750256 0.0003847493         0.9679781
## 6448    0.0022848771 0.0001214074         0.9644416
## 6449    0.0055596713 0.0003282449         0.9682086
## 6450    0.0057091361 0.0003485009         0.9692816
## 6451    0.0088334952 0.0004741058         0.9651496
## 6452    0.0057131500 0.0003225016         0.9667310
## 6453    0.0057063012 0.0003364950         0.9681780
## 6454    0.0072343482 0.0004154795         0.9673975
## 6455    0.0071843237 0.0003889357         0.9653670
## 6456    0.0022135914 0.0001188720         0.9648136
## 6457    0.0060000655 0.0003442370         0.9672922
## 6512    0.0022613219 0.0008077545         0.9957650
## 6527    0.0006873714 0.0006281744         0.9988915
## 6634    0.0003656347 0.0004166112         0.9991002
## 6739    0.0016507933 0.0012370698         0.9990355
```

```
## 6821    0.0008969290 0.0007101639         0.9986460
## 6931    0.0004497079 0.0004985074         0.9991347
## 6938    0.0011007655 0.0003704056         0.9949935
## 6939    0.0012753414 0.0005367186         0.9963135
## 6940    0.0007823969 0.0002233470         0.9938183
## 6941    0.0007799793 0.0002232525         0.9938363
## 6942    0.0011860062 0.0004489430         0.9957111
## 6943    0.0013408590 0.0005118635         0.9958171
## 6944    0.0013554086 0.0005686619         0.9963313
## 6945    0.0008857915 0.0003079585         0.9951158
## 6946    0.0007897116 0.0002259890         0.9938375
## 6947    0.0006999035 0.0001950498         0.9936250
## 6948    0.0006585838 0.0001813788         0.9935289
## 7039    0.0008229204 0.0010166469         0.9998338
## 7147    0.0011228731 0.0008708060         0.9987556
## 7167    0.0046049858 0.0006172443         0.9865816
## 7210    0.0033953923 0.0010136992         0.9949069
## 7211    0.0030560496 0.0007230853         0.9929204
## 7389    0.0023376148 0.0028987810         1.0017299
## 7446    0.0014637780 0.0001209601         0.9771960
## 7447    0.0015386249 0.0001250122         0.9768061
## 7448    0.0014581478 0.0001205773         0.9772114
## 7449    0.0015032122 0.0001245342         0.9772581
## 7450    0.0015004397 0.0001242232         0.9772427
## 7451    0.0014975740 0.0001239050         0.9772273
## 7452    0.0015365304 0.0001248442         0.9768064
## 7453    0.0014659942 0.0001208302         0.9771361
## 7454    0.0014619179 0.0001206524         0.9771662
## 7455    0.0015274146 0.0001242646         0.9768362
## 7456    0.0015389347 0.0001250371         0.9768061
## 7457    0.0014679886 0.0001211483         0.9771658
## 7458    0.0014872726 0.0001230597         0.9772278
## 7459    0.0016288070 0.0001310561         0.9765823
## 7460    0.0015004397 0.0001242232         0.9772427
## 7461    0.0015906297 0.0001284818         0.9766715
## 7462    0.0016090630 0.0001297188         0.9766268
## 7463    0.0015905014 0.0001284716         0.9766715
## 7507    0.0019932400 0.0014899211         0.9992826
## 7649    0.0007513199 0.0008472052         0.9995137
## 7650    0.0007515725 0.0008475406         0.9995141
## 7791    0.0018467971 0.0019768625         1.0005549
## 7871    0.0062464964 0.0031318071         0.9996588
## 8119    0.0007450164 0.0007101639         0.9990613
## 8154    0.0002460322 0.0002842790         0.9989914
## 8232    0.0020091021 0.0014899211         0.9992619
## 8262    0.0364288334 0.0107079122         1.0046180
## 8320    0.0081084346 0.0048614669         1.0020365
## 8377    0.4309358879 0.0627238474         1.0540418
## 8457    0.0002276883 0.0002319309         0.9987132
## 8458    0.0018518144 0.0007461076         0.9963183
## 8535    0.0003967284 0.0004680153         0.9992098
## 8541    0.0002882288 0.0003481441         0.9991283
## 8698    0.0002121660 0.0001780652         0.9982520
## 8710    0.0027579977 0.0006633908         0.9929938
```

```
## 8763    0.0005156776 0.0004471553         0.9985956
## 8887    0.0119755803 0.0021233645         0.9915972
## 8911    0.0012676105 0.0013558568         0.9999302
## 8946    0.0012676105 0.0013558568         0.9999302
## 9215    0.0041687533 0.0030718123         1.0008349
## 9293    0.0014621525 0.0012460774         0.9993571
## 9420    0.0061700417 0.0075226038         1.0063774
## 9453    0.0004556817 0.0005054114         0.9991426
## 9528    0.0097687444 0.0026581628         0.9959285
## 9546    0.0008895283 0.0007765908         0.9989408
## 9722    0.0002386507 0.0001698504         0.9978293
## 10125   0.0019947489 0.0022668926         1.0009517
## 10318   0.0278515700 0.0217722761         1.0201690
## 10371   0.0013015228 0.0013570841         0.9998846
## 10418   0.0018453822 0.0018808495         1.0003674
## 10623   0.0004481403 0.0005345388         0.9992946
## 10707   0.0001107521 0.0001176424         0.9986771
## 10723   0.0005530879 0.0006131027         0.9992494
## 10787   0.0012454092 0.0006139295         0.9970645
## 10958   0.0006456080 0.0005122955         0.9984532
## 10995   0.0042389855 0.0037102518         1.0018945
## 11165   0.0010495342 0.0008521811         0.9988493
## 11289   0.0006242666 0.0001814912         0.9938990
## 11413   0.0022295657 0.0008145254         0.9958924
## 11558   0.0024055027 0.0004666295         0.9908706
## 11586   0.0001850899 0.0001168867         0.9974301
## 11728   0.0099609648 0.0046712882         1.0009438
## 11758   0.0014027427 0.0013570841         0.9997398
## 11772   0.0201404015 0.0023732306         0.9863727
## 11822   0.0032857839 0.0006244793         0.9908231
## 11898   0.0760698716 0.0343760691         1.0317062
## 11899   0.1490091795 0.0345508547         1.0278300
## 11982   0.0088936020 0.0024696423         0.9958817
## 11992   0.1019543278 0.0045524161         0.9621581
## 12212   0.0012160382 0.0011024709         0.9993497
## 12255   0.0031314656 0.0014163140         0.9975153
## 12256   0.0015887144 0.0012385528         0.9991374
## 12392   0.0009307557 0.0008506209         0.9991144
## 12472   0.0008656718 0.0002333228         0.9934277
## 12487   0.0024170684 0.0012779354         0.9979961
## 12577   0.0063660162 0.0017380796         0.9950278
## 12582   0.0174415408 0.0018951331         0.9845174
## 12643   0.0098110068 0.0008341412         0.9785581
## 12686   0.0004411970 0.0004783937         0.9990754
## 12764   0.0094720864 0.0029716702         0.9971870
## 12816   0.0231517743 0.0238425591         1.0229363
```

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

L. The condition is not met since the values are below the statistic value is below 1 and the p-value isn't above 0.05.

##{r} ##install.packages("car") ##library(car) ##

```
library(car)
```

```
## Warning: package 'car' was built under R version 4.0.2
```

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

```
##
## Attaching package: 'car'
```

```
## The following object is masked from 'package:boot':
##
##     logit
```

```
durbinWatsonTest(saleprice_lm)
```

```
##  lag Autocorrelation D-W Statistic p-value
##    1       0.7309992     0.5379977       0
##  Alternative hypothesis: rho != 0
```

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

M. Based on our data, there is no multicollinearity.

```
vif(saleprice_lm)
```

```
##                sq_ft_lot square_feet_total_living                bedrooms
##                 1.085244                 2.706329                1.551002
##               total_bath
##                 2.335764
```

```
1/vif(saleprice_lm)
```

```
##                sq_ft_lot square_feet_total_living                bedrooms
##                0.9214520                0.3695042               0.6447445
##               total_bath
##                0.4281254
```

```
mean(vif(saleprice_lm))
```

```
## [1] 1.919585
```

N. 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.

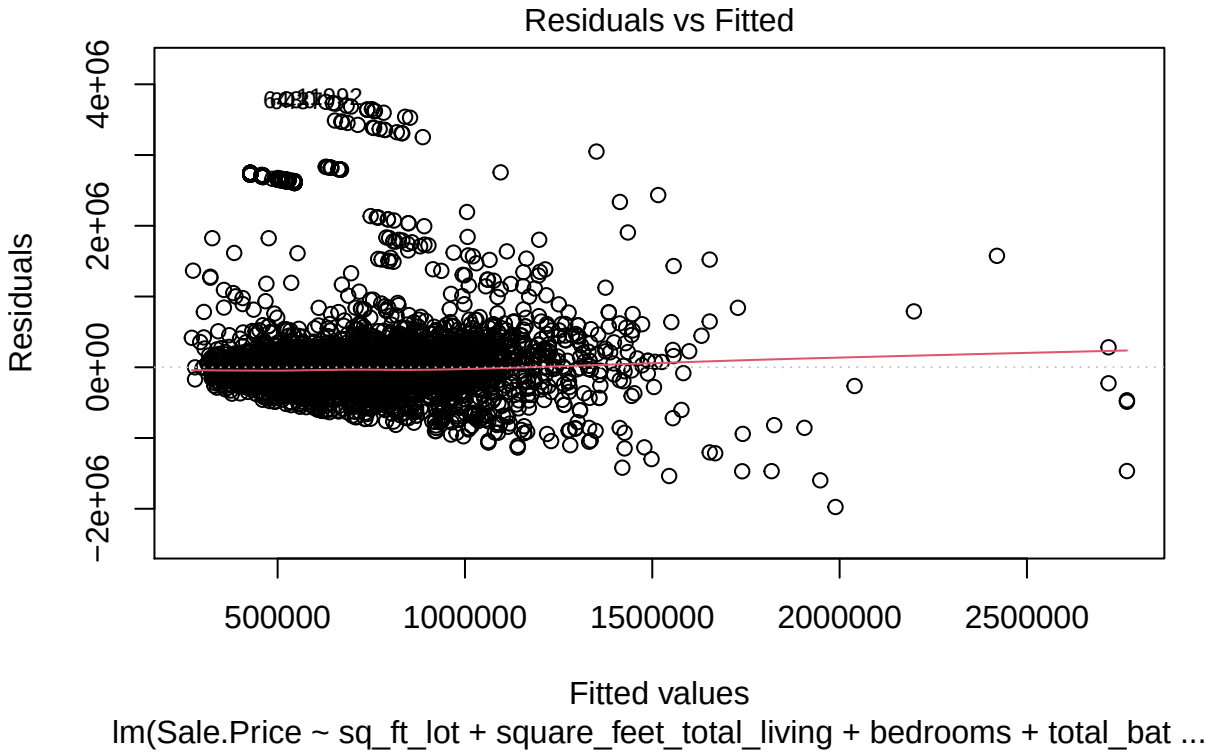
The first plot is the residuals vs. the fitted values. This plot is used to show how far away from the average the residuals are.

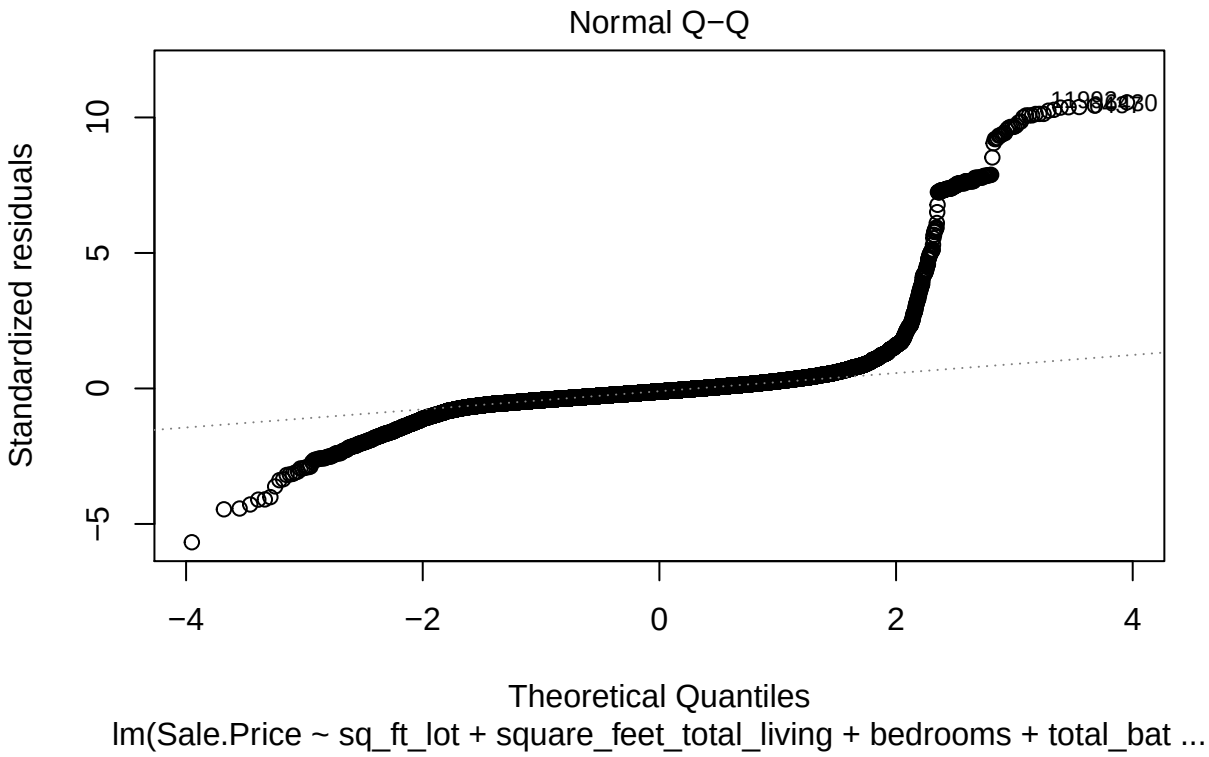
The second plot is the Q-Q plot. This plot illustrates probability distributions. My regression model doesn't appear to provide a normal Q-Q plot since the line tails off at the end.

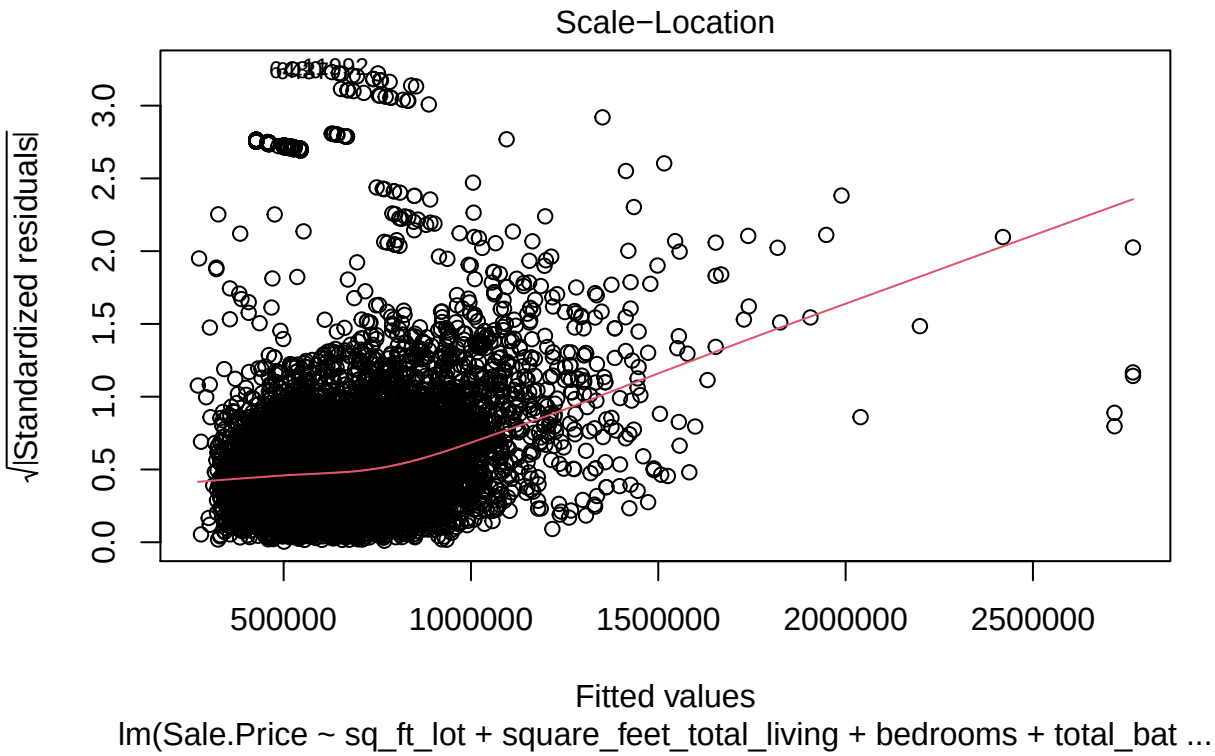
The third plot is a Scale-Location plot. This plot shows if residuals are spread equally. Mine appear to be fairly concentrated to the left.

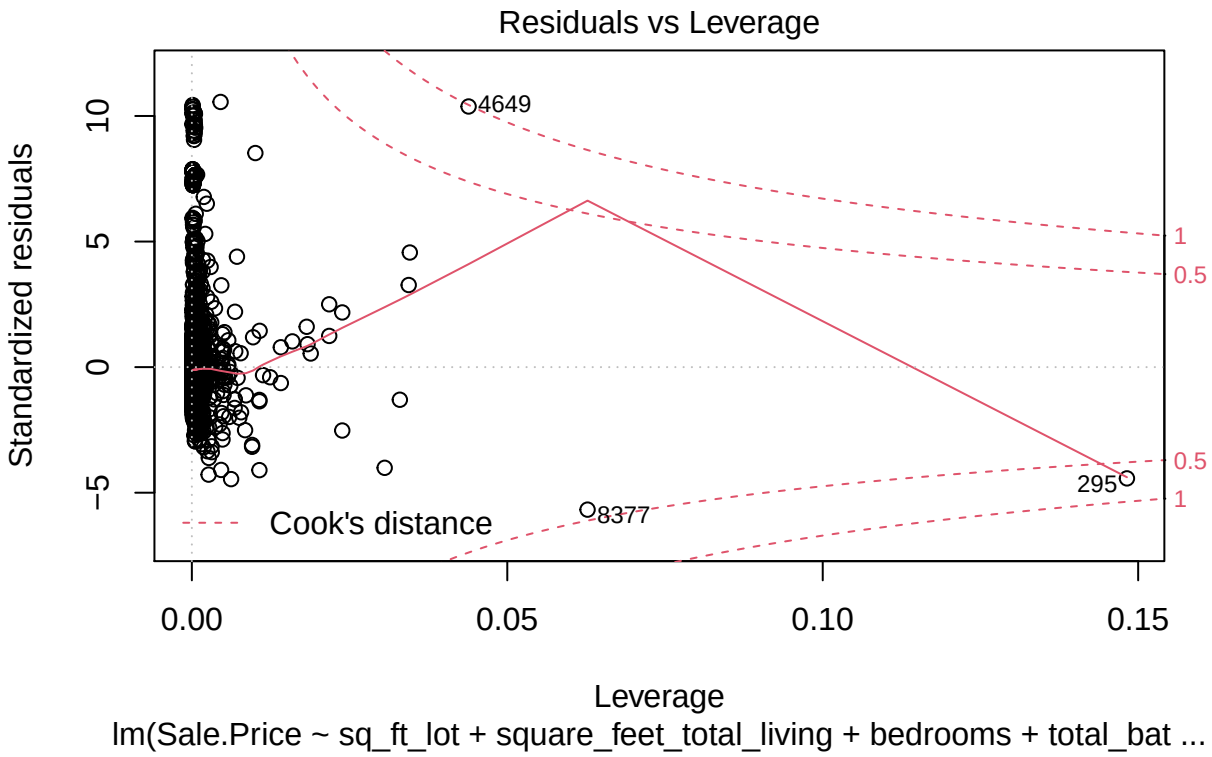
The fourth plot is the Residuals vs. Leverage plot. This plot is used to identify outliers using the Cook's distance lines. There are 3 cases identified to be anomolies that are impacting the data (8377, 295, and 4649).

```
plot(saleprice_lm)
```

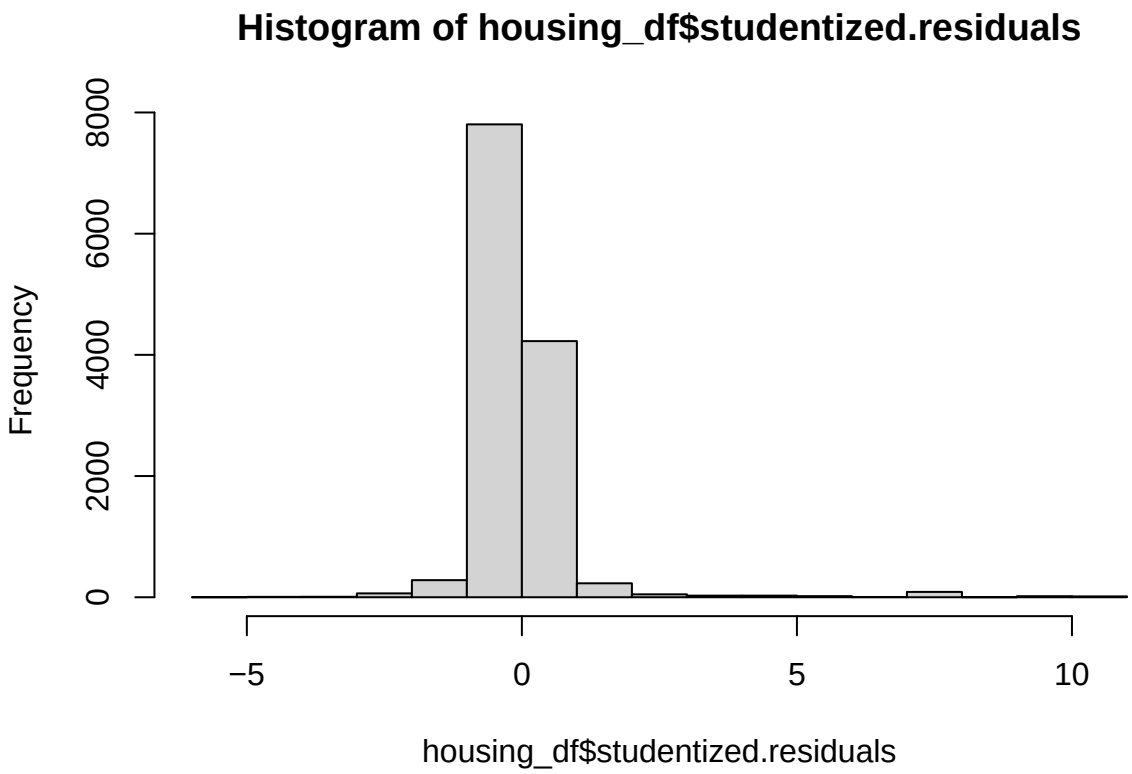



Normal Q−Q
Standardized residuals
10
5
0
−5
−4
−2
0
2
4
Theoretical Quantiles
lm(Sale.Price ~ sq_ft_lot + square_feet_total_living + bedrooms + total_bat ...


Scale−Location
√|Standardized residuals|
0.0
0.5
1.0
1.5
2.0
2.5
3.0
500000
1000000
1500000
2000000
2500000
Fitted values
lm(Sale.Price ~ sq_ft_lot + square_feet_total_living + bedrooms + total_bat ...




```
hist(housing_df$studentized.residuals)
```



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

O. Yes, the regression model is unbiased. This tells us that the sample is an accurate representation of the true population.