

ASSIGNMENT 8

Raghuvanshi, Prashant

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Question no 1 : Complete assignment06

```
library(ggplot2)
theme_set(theme_minimal())
library(readxl)
### Set the working directory to the root of your DSC 520 directory

setwd("D:/MS_DataScience/DSC 520-Datastatiics.pdf/dsc520")

### Load the `data/r4ds/heights.csv` to
heights_df <- read.csv("data/r4ds/heights.csv")

### Fit a linear model using the `age` variable as the predictor and `earn` as the outcome
age_lm <- lm(heights_df$earn ~ heights_df$age, data = heights_df)

### View the summary of your model using `summary()`
summary(age_lm)

##
## Call:
## lm(formula = heights_df$earn ~ heights_df$age, data = heights_df)
##
## Residuals:
##      Min       1Q   Median       3Q      Max 
## -25098 -12622  -3667   6883  177579 
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 19041.53    1571.26 12.119 < 2e-16 ***
## heights_df$age     99.41      35.46   2.804  0.00514 ** 
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 19420 on 1190 degrees of freedom
## Multiple R-squared:  0.006561, Adjusted R-squared:  0.005727 
## F-statistic:  7.86 on 1 and 1190 DF,  p-value: 0.005137

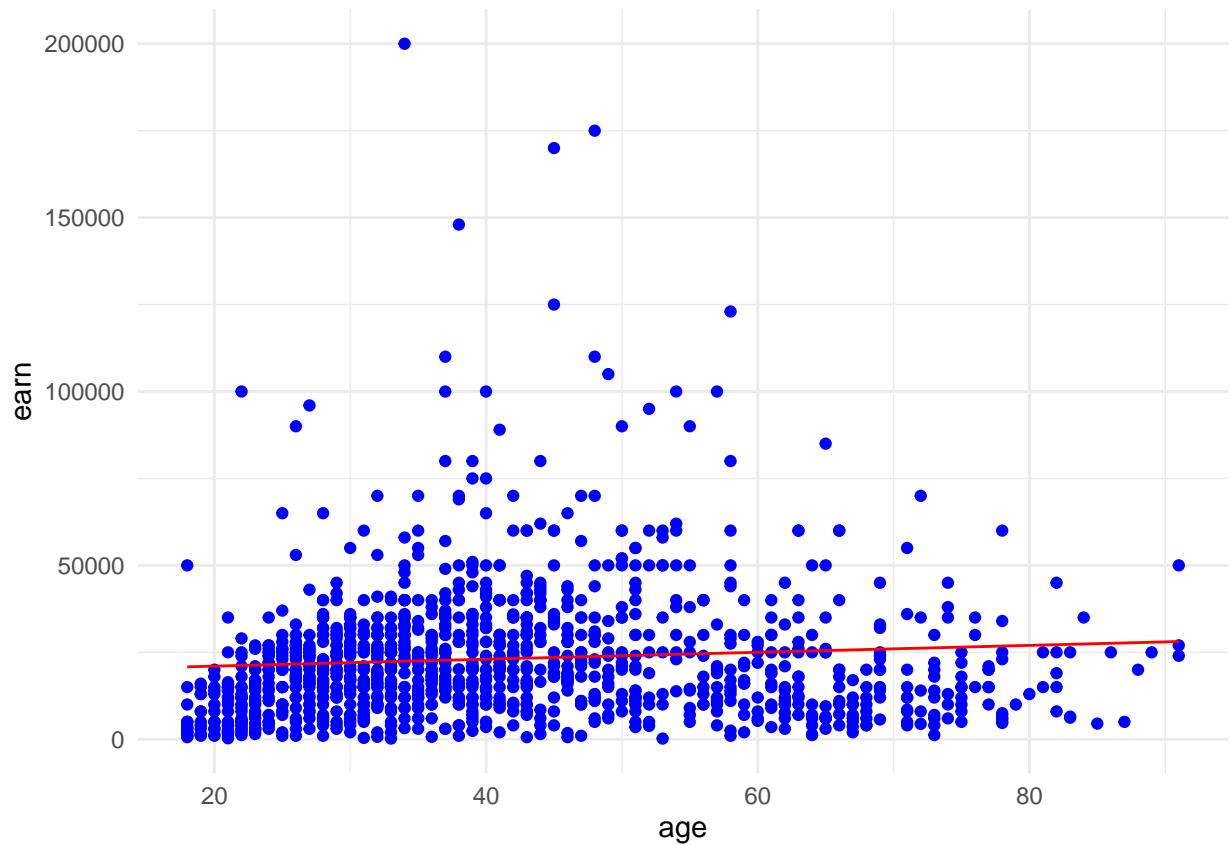
### Creating predictions using `predict()`
age_predict_df <- data.frame(earn = predict(age_lm, newdata= as.list(heights_df$age)), age=heights_df$age)

### Plot the predictions against the original data
ggplot(data = heights_df, aes(y = earn, x = age)) +
```

```

geom_point(color='blue') +
geom_line(color='red', data = age_predict_df, aes(y=earn, x=age))

```



```

mean_earn <- mean(heights_df$earn)
### Corrected Sum of Squares Total
sst <- sum((mean_earn - heights_df$earn)^2)
### Corrected Sum of Squares for Model
ssm <- sum((mean_earn - age_predict_df$earn)^2)
## Residuals
residuals <- heights_df$earn - age_predict_df$earn
### Sum of Squares for Error
sse <- sum(residuals^2)
### R Squared  $R^2 = SSM \backslash SST$ 
r_squared <- ssm/sst

### Number of observations
n <- length(heights_df)
### Number of regression parameters
p <- 2
### Corrected Degrees of Freedom for Model ( $p-1$ )
dfm <- p-1
### Degrees of Freedom for Error ( $n-p$ )
dfe <- n-p
### Corrected Degrees of Freedom Total:  $DFT = n - 1$ 
dft <- n-1

```

```

### Mean of Squares for Model: MSM = SSM / DFM
msm <- ssm/dfm
### Mean of Squares for Error: MSE = SSE / DFE
mse <- sse/dfe
### Mean of Squares Total: MST = SST / DFT
mst <- sst/dft
### F Statistic F = MSM/MSE
f_score <- msm/mse

### Adjusted R Squared R2 = 1 - (1 - R2)(n - 1) / (n - p)
adjusted_r_squared <- (1 - (1 - r_squared)*(n - 1)/(n-p))
adjusted_r_squared

## [1] -0.2417981

### Calculate the p-value from the F distribution
p_value <- pf(f_score, dfm, dft, lower.tail=F)

```

Question no 2 : Complete assignment07

```

## Fit a linear model
earn_lm <- lm(heights_df$earn ~ heights_df$age + heights_df$ed + heights_df$race + heights_df$height +
## View the summary of your model
summary(earn_lm)

##
## Call:
## lm(formula = heights_df$earn ~ heights_df$age + heights_df$ed +
##     heights_df$race + heights_df$height + heights_df$sex, data = heights_df)
##
## Residuals:
##      Min       1Q   Median       3Q      Max 
## -39423  -9827  -2208   6157  158723 
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) -41478.4    12409.4  -3.342 0.000856 ***
## heights_df$age        178.3      32.2   5.537 3.78e-08 ***
## heights_df$ed        2768.4     209.9  13.190 < 2e-16 ***
## heights_df$racehispanic -1414.3    2685.2  -0.527 0.598507  
## heights_df$raceother      371.0     3837.0   0.097 0.922983  
## heights_df$racewhite      2432.5    1723.9   1.411 0.158489  
## heights_df$height         202.5      185.6   1.091 0.275420  
## heights_df$sexmale        10325.6    1424.5   7.249 7.57e-13 ***
## ---                        
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 17250 on 1184 degrees of freedom
## Multiple R-squared:  0.2199, Adjusted R-squared:  0.2153 
## F-statistic: 47.68 on 7 and 1184 DF,  p-value: < 2.2e-16

predicted_df <- data.frame(
  earn = predict(earn_lm, newdata= as.list(heights_df$earn)),

```

```

  ed=heights_df$ed, race=heights_df$race, height=heights_df$height,
  age=heights_df$age, sex=heights_df$sex
)
## Compute deviation (i.e. residuals)
mean_earn <- mean(heights_df$earn)
## Corrected Sum of Squares Total
sst <- sum((mean_earn - heights_df$earn)^2)
## Corrected Sum of Squares for Model
ssm <- sum((mean_earn - predicted_df$earn)^2)
## Residuals
residuals <- heights_df$earn - predicted_df$earn
## Sum of Squares for Error
sse <- sum(residuals^2)
## R Squared  $R^2 = SSM/SST$ 
r_squared <- ssm/sst

## Number of observations
n <- length(heights_df)
## Number of regression parameters
p <- 8
## Corrected Degrees of Freedom for Model (p-1)
dfm <- p-1
## Degrees of Freedom for Error (n-p)
dfe <- n-p
## Corrected Degrees of Freedom Total: DFT = n - 1
dft <- n-1

## Mean of Squares for Model: MSM = SSM / DFM
msm <- ssm/dfm
## Mean of Squares for Error: MSE = SSE / DFE
mse <- sse/dfe
## Mean of Squares Total: MST = SST / DFT
mst <- sst/dft
## F Statistic  $F = MSM/MSE$ 
f_score <- msm/mse

## Adjusted R Squared  $R^2 = 1 - (1 - R^2)(n - 1) / (n - p)$ 
adjusted_r_squared <- (1 - (1 - r_squared)*(n - 1)/(n-p))
adjusted_r_squared

## [1] 2.950262
## Calculate the p-value from the F distribution
p_value <- pf(f_score, dfm, dft, lower.tail=F)

```

Question no 3 : Housing Data

Work individually on this assignment. You are encouraged to collaborate on ideas and strategies pertinent to this assignment. Data for this assignment is focused on real estate transactions recorded from 1964 to 2016 and can be found in **Housing.xlsx**.

Using your skills in statistical correlation, multiple regression, and R programming, you are interested in the following variables: Sale Price and several other possible predictors.

If you worked with the Housing dataset in previous week ??? you are in luck, you likely have already found any issues in the dataset and made the necessary transformations. If not, you will want to take some time looking at the data with all your new skills and identifying if you have any clean up that needs to happen.

Complete the following:

```
library(readxl)
library(dplyr)

## 
## 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

## Set the working directory to the root of your DSC 520 directory

setwd("D:/MS_DataScience/DSC 520-Datastatiics.pdf/dsc520")

## Load the `data/r4ds/heights.csv` to
housing_df <- read_excel("data/week-7-housing.xlsx", sheet = "Sheet2")
summary(housing_df)

##      Sale Date              Sale_Price       sale_reason
##  Min.   :2006-01-03 00:00:00  Min.   : 698   Min.   : 0.00
##  1st Qu.:2008-07-07 00:00:00  1st Qu.: 460000  1st Qu.: 1.00
##  Median :2011-11-17 00:00:00  Median : 593000  Median : 1.00
##  Mean   :2011-07-28 15:07:32  Mean   : 660738   Mean  : 1.55
##  3rd Qu.:2014-06-05 00:00:00  3rd Qu.: 750000  3rd Qu.: 1.00
##  Max.   :2016-12-16 00:00:00  Max.   :4400000  Max.  :19.00
##      sale_instrument    sale_warning      sitetype        addr_full
##  Min.   : 0.000  Length:12865   Length:12865   Length:12865
##  1st Qu.: 3.000  Class :character  Class :character  Class :character
##  Median : 3.000  Mode  :character  Mode  :character  Mode  :character
##  Mean   : 3.678
##  3rd Qu.: 3.000
##  Max.   :27.000
##      zip5          ctyname        postalctyn           lon
```

```

## Min. :98052 Length:12865      Length:12865      Min.   :-122.2
## 1st Qu.:98052 Class :character  Class :character  1st Qu.:-122.1
## Median :98052 Mode  :character  Mode  :character  Median :-122.1
## Mean   :98053                           Mean   :-122.1
## 3rd Qu.:98053                           3rd Qu.:-122.0
## Max.  :98074                           Max.  :-121.9
##       lat    building_grade  square_feet_total_living   bedrooms
## Min.  :47.46  Min.    : 2.00  Min.    : 240          Min.   : 0.000
## 1st Qu.:47.67 1st Qu. : 8.00  1st Qu. : 1820        1st Qu.: 3.000
## Median :47.69 Median  : 8.00  Median  : 2420        Median : 4.000
## Mean   :47.68 Mean   : 8.24  Mean   : 2540        Mean   : 3.479
## 3rd Qu.:47.70 3rd Qu. : 9.00  3rd Qu. : 3110        3rd Qu.: 4.000
## Max.   :47.73 Max.   :13.00  Max.   :13540       Max.   :11.000
## bath_full_count bath_half_count bath_3qtr_count year_built
## Min.   : 0.000  Min.   :0.0000  Min.   :0.000  Min.   :1900
## 1st Qu.: 1.000  1st Qu.:0.0000  1st Qu.:0.000  1st Qu.:1979
## Median : 2.000  Median :1.0000  Median :0.000  Median :1998
## Mean   : 1.798  Mean   :0.6134  Mean   :0.494  Mean   :1993
## 3rd Qu.: 2.000  3rd Qu.:1.0000  3rd Qu.:1.000  3rd Qu.:2007
## Max.   :23.000  Max.   :8.0000  Max.   :8.000  Max.   :2016
## year_renovated current_zoning      sq_ft_lot      prop_type
## Min.   : 0.00  Length:12865      Min.   :    785  Length:12865
## 1st Qu.: 0.00  Class :character  1st Qu.: 5355  Class :character
## Median : 0.00  Mode   :character  Median : 7965  Mode   :character
## Mean   : 26.24                           Mean   : 22229
## 3rd Qu.: 0.00                           3rd Qu.: 12632
## Max.   :2016.00                         Max.   :1631322
##       present_use
## Min.   : 0.000
## 1st Qu.: 2.000
## Median : 2.000
## Mean   : 6.598
## 3rd Qu.: 2.000
## Max.   :300.000

### Explain any transformations or modifications you made to the dataset
### ANS , havent made any transformation to dataset

### Create two variables; one that will contain the variables Sale Price and Square Foot of Lot (same v
### Explain the basis for your additional predictor selections.
given_variable <- select(housing_df, Sale_Price, sq_ft_lot)
new_variable <- select(housing_df, Sale_Price, sq_ft_lot, building_grade, year_built, square_feet_total_living)
### ANS Here i have used year build , building grades, square_feet_total_living --i believe sales price

### Execute a summary() function on two variables defined in the previous step to compare the model results
summary(given_variable)

##       Sale_Price      sq_ft_lot
## Min.   : 698  Min.   :    785
## 1st Qu.:460000 1st Qu.: 5355
## Median :593000  Median : 7965
## Mean   :660738  Mean   : 22229
## 3rd Qu.:750000  3rd Qu.: 12632
## Max.   :4400000 Max.   :1631322

```

```

summary(new_variable)

##      Sale_Price      sq_ft_lot      building_grade      year_built
##  Min.   : 698   Min.   : 785   Min.   : 2.00   Min.   :1900
##  1st Qu.: 460000  1st Qu.: 5355   1st Qu.: 8.00   1st Qu.:1979
##  Median : 593000  Median : 7965   Median : 8.00   Median :1998
##  Mean   : 660738  Mean   : 22229  Mean   : 8.24   Mean   :1993
##  3rd Qu.: 750000  3rd Qu.: 12632  3rd Qu.: 9.00   3rd Qu.:2007
##  Max.   :4400000  Max.   :1631322 Max.   :13.00   Max.   :2016
##      square_feet_total_living
##  Min.   : 240
##  1st Qu.: 1820
##  Median : 2420
##  Mean   : 2540
##  3rd Qu.: 3110
##  Max.   :13540

##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?
given_variable_lm <- lm(formula = Sale_Price ~ sq_ft_lot, data = given_variable)
summary(given_variable_lm)

## 
## Call:
## lm(formula = Sale_Price ~ sq_ft_lot, data = given_variable)
## 
## 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

new_variable_lm <- lm(Sale_Price ~ sq_ft_lot + building_grade + year_built + square_feet_total_living,
summary(new_variable_lm)

## 
## Call:
## lm(formula = Sale_Price ~ sq_ft_lot + building_grade + year_built +
##     square_feet_total_living, data = new_variable)
## 
## Residuals:
##      Min      1Q      Median      3Q      Max
## -2129819 -118825  -42246   42655  3736710
## 
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
```

```

## (Intercept) -5.149e+06 3.930e+05 -13.103 < 2e-16 ***
## sq_ft_lot 2.962e-01 5.825e-02 5.086 3.72e-07 ***
## building_grade 3.263e+04 4.412e+03 7.395 1.50e-13 ***
## year_built 2.597e+03 2.009e+02 12.928 < 2e-16 ***
## square_feet_total_living 1.410e+02 4.884e+00 28.881 < 2e-16 ***
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 356400 on 12860 degrees of freedom
## Multiple R-squared: 0.2233, Adjusted R-squared: 0.223
## F-statistic: 924.1 on 4 and 12860 DF, p-value: < 2.2e-16
### ANS Both R2 and the adjusted R2 give us an idea of how many data points fall within the line of the
### R2 assumes that every single variable explains the variation in the dependent variable.
### The adjusted R2 tells us the percentage of variation explained by only the independent variables that
### here i have got below r-squared values by using 1 variable and 3 variable
### Multiple R-squared: 0.01435, Adjusted R-squared: 0.01428
### Multiple R-squared: 0.2233, Adjusted R-squared: 0.223
### conclusion , increasing independent variables counts increases r-squared value, r_sq & R adj Sq va

### 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?
library(QuantPsyc)

## 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
lm.beta(new_variable_lm)

##          sq_ft_lot      building_grade      year_built
## 0.04170810       0.08816384      0.11059981
## square_feet_total_living
## 0.34523475

### ANS The higher the absolute value of the beta coefficient, the stronger the effect. here square feet
### highest beta value and sq ft lot is having lowest

### Calculate the confidence intervals for the parameters in your model and explain what the results indicate
confint(new_variable_lm, level=0.95)

##                   2.5 %      97.5 %
## (Intercept) -5.919468e+06 -4.378856e+06
## sq_ft_lot    1.820603e-01   4.104214e-01
## building_grade 2.398101e+04   4.127804e+04

```

```

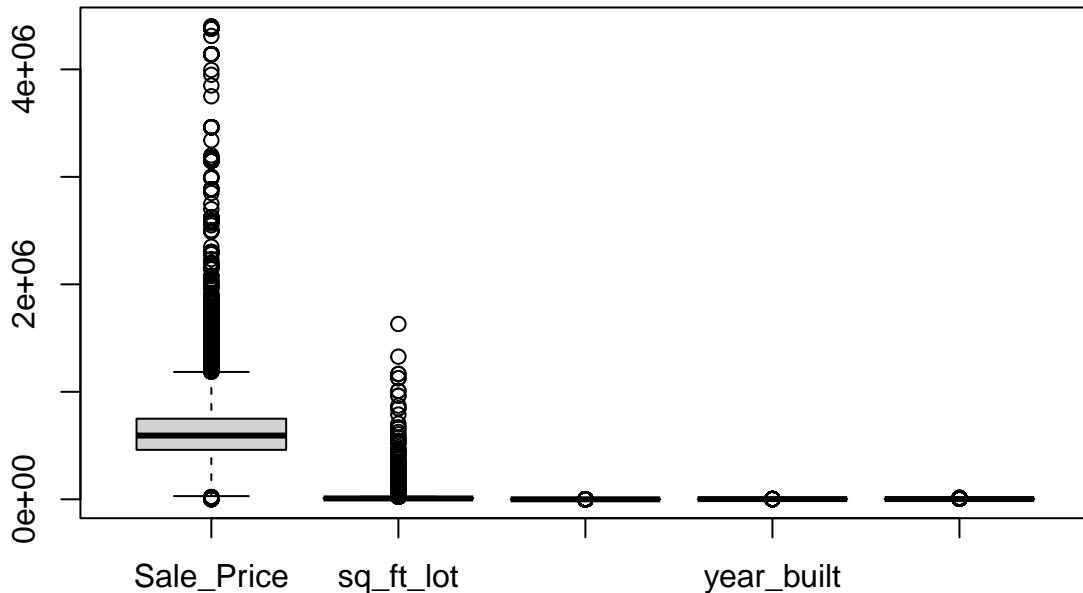
## year_built           2.203431e+03  2.990998e+03
## square_feet_total_living 1.314701e+02  1.506150e+02
### ANS here we got the upper limit & lower limit of parameters for confidence interval== 95%

### 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.
new_variable_aov <- anova(given_variable_lm, new_variable_lm, test="Chisq")
new_variable_aov

## Analysis of Variance Table
##
## Model 1: Sale_Price ~ sq_ft_lot
## Model 2: Sale_Price ~ sq_ft_lot + building_grade + year_built + square_feet_total_living
##   Res.Df      RSS Df Sum of Sq Pr(>Chi)
## 1 12863 2.0734e+15
## 2 12860 1.6339e+15  3 4.3946e+14 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## ANS seems residual is value is decreasing and Pr value is less than .0001 seems new variable model is significant

### Perform casewise diagnostics to identify outliers and/or influential cases,
### storing each function's output in a dataframe assigned to a unique variable name.
OutVals = boxplot(new_variable)$out

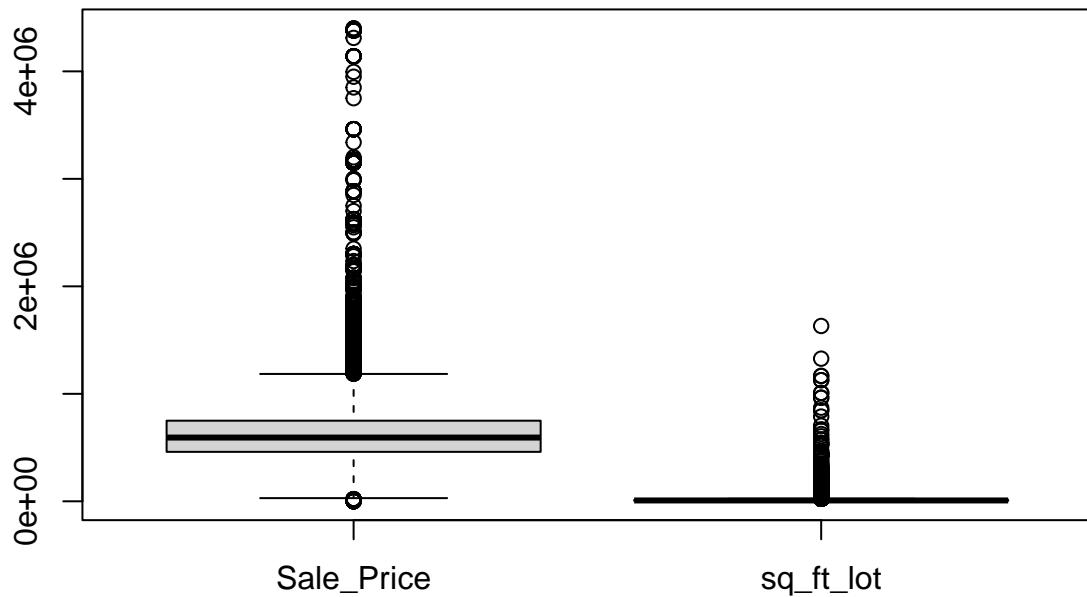
```



```

### ANS seems we have outliers on sales price and sq_ft_lot variables
OutVals1 = boxplot(given_variable)$out

```

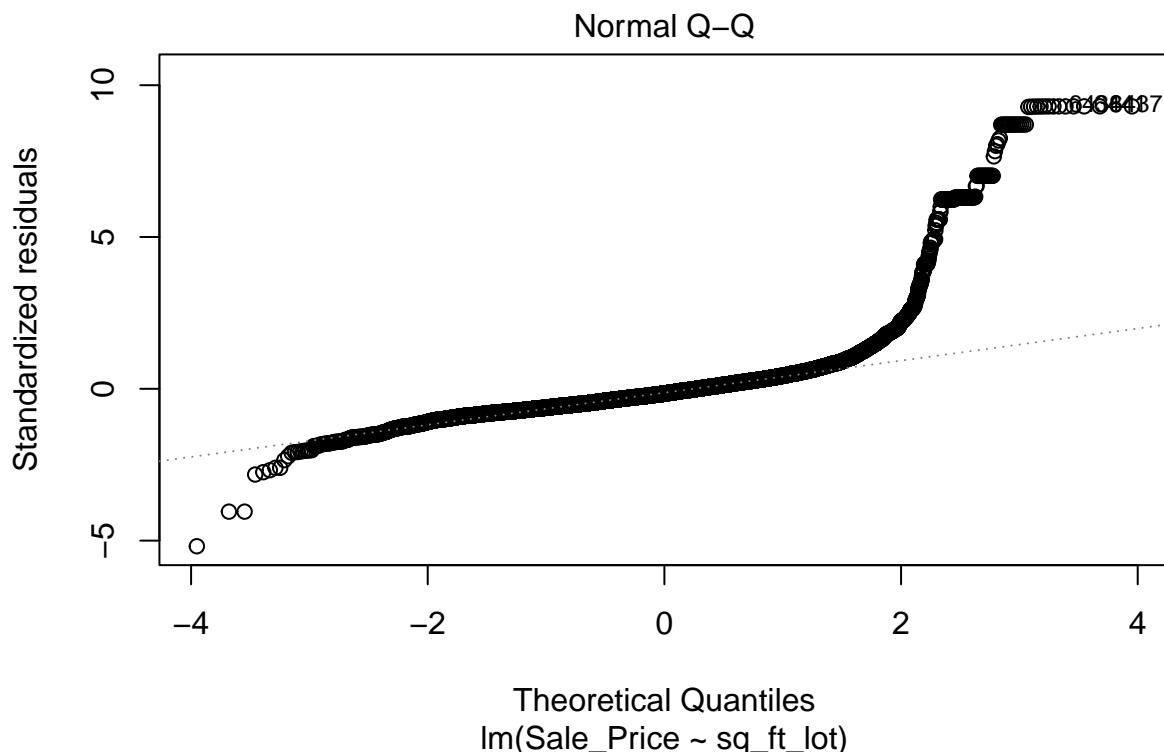


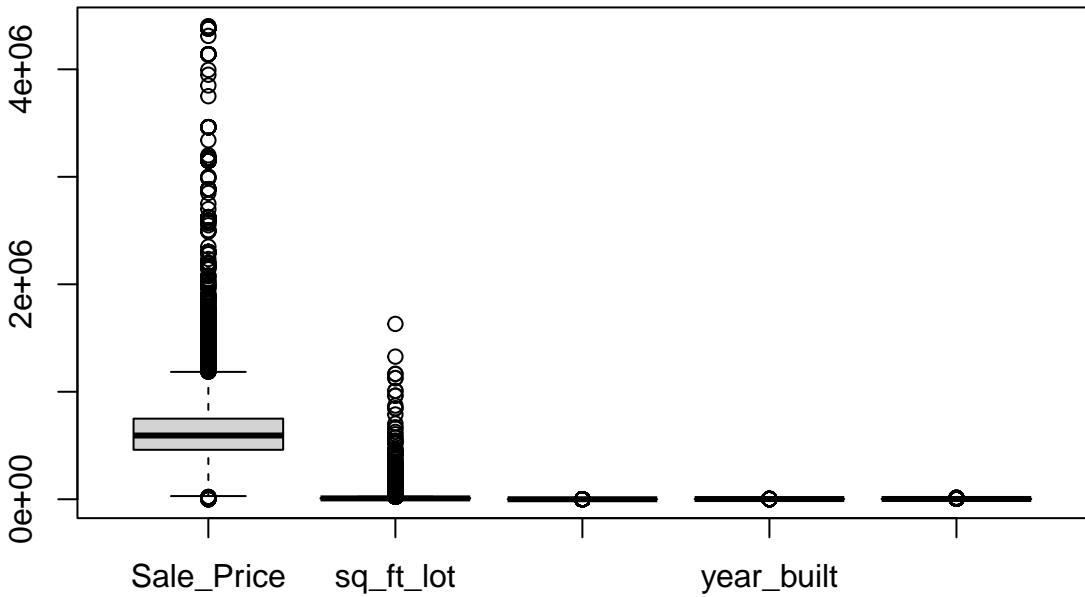
```

class(OutVals1)
## [1] "numeric"
library(car)

## 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
### Calculate the standardized residuals using the appropriate command, specifying those that are +-2, 
given_variable_residuals = rstandard(given_variable_lm)
plot(given_variable_lm, which = 2)

```





```

### Ans sales_price & sq_ft_lot variable is having large residual

### Investigate further by calculating the leverage, cooks distance, and covariance ratios. Comment on
new_variable_leverage <- as.data.frame(hatvalues(new_variable_lm))
### Ans leverage by observations
### sort observations by leverage, descending
new_variable_leverage[order(-new_variable_leverage['hatvalues(new_variable_lm)']), ]

## Warning in xtfrm.data.frame(x): cannot xtfrm data frames
## [1] 6.382790e-02 4.397498e-02 3.743491e-02 3.476820e-02 3.259318e-02
## [6] 3.010538e-02 2.536082e-02 2.536082e-02 2.232284e-02 2.232284e-02
## [11] 1.898341e-02 1.861948e-02 1.754363e-02 1.562611e-02 1.424432e-02
## [16] 1.424432e-02 1.424432e-02 1.367806e-02 1.367806e-02 1.242474e-02
## [21] 1.106370e-02 1.004872e-02 9.548547e-03 8.898499e-03 8.700525e-03
## [26] 8.397206e-03 8.330069e-03 7.853515e-03 7.853515e-03 7.853515e-03
## [31] 7.602463e-03 7.602463e-03 7.225145e-03 6.679494e-03 6.139722e-03
## [36] 6.008186e-03 5.449926e-03 5.404367e-03 5.311760e-03 5.100931e-03
## [41] 5.085632e-03 5.067365e-03 5.019759e-03 4.871086e-03 4.859129e-03
## [46] 4.859129e-03 4.859129e-03 4.832763e-03 4.817987e-03 4.781727e-03
## [51] 4.740612e-03 4.677642e-03 4.588635e-03 4.582138e-03 4.535692e-03
## [56] 4.424430e-03 4.418527e-03 4.418527e-03 4.418527e-03 3.917007e-03
## [61] 3.568079e-03 3.516383e-03 3.516383e-03 3.469689e-03 3.451040e-03
## [66] 3.438814e-03 3.322340e-03 3.228817e-03 3.228817e-03 3.169682e-03
## [71] 3.169682e-03 3.169682e-03 3.143659e-03 3.124981e-03 3.045769e-03
## [76] 3.023207e-03 3.004699e-03 3.000278e-03 2.979602e-03 2.964180e-03
## [81] 2.943861e-03 2.909548e-03 2.909116e-03 2.902247e-03 2.839803e-03

```

```

## [86] 2.784807e-03 2.780914e-03 2.774595e-03 2.739026e-03 2.687949e-03
## [91] 2.646342e-03 2.584640e-03 2.584640e-03 2.579816e-03 2.579816e-03
## [96] 2.579816e-03 2.486154e-03 2.484416e-03 2.471739e-03 2.465924e-03
## [101] 2.429223e-03 2.414529e-03 2.414529e-03 2.414529e-03 2.370699e-03
## [106] 2.342972e-03 2.321286e-03 2.313301e-03 2.288472e-03 2.263700e-03
## [111] 2.263138e-03 2.263138e-03 2.257991e-03 2.257991e-03 2.257991e-03
## [116] 2.255458e-03 2.255128e-03 2.235356e-03 2.234904e-03 2.225916e-03
## [121] 2.185544e-03 2.185544e-03 2.177048e-03 2.157407e-03 2.146257e-03
## [126] 2.137105e-03 2.130000e-03 2.121798e-03 2.111757e-03 2.083947e-03
## [131] 2.053518e-03 2.050039e-03 2.023259e-03 2.023259e-03 2.007172e-03
## [136] 2.004281e-03 1.999867e-03 1.965602e-03 1.963505e-03 1.952213e-03
## [141] 1.952213e-03 1.951963e-03 1.949018e-03 1.944250e-03 1.937153e-03
## [146] 1.937153e-03 1.937153e-03 1.933600e-03 1.933600e-03 1.921924e-03
## [151] 1.921924e-03 1.914598e-03 1.914598e-03 1.914598e-03 1.897723e-03
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## [12686] 1.047456e-04 1.047362e-04 1.044900e-04 1.044217e-04 1.043881e-04
## [12691] 1.043881e-04 1.042737e-04 1.041071e-04 1.039740e-04 1.038816e-04
## [12696] 1.038816e-04 1.038816e-04 1.036150e-04 1.036018e-04 1.035562e-04
## [12701] 1.034995e-04 1.034918e-04 1.033955e-04 1.033955e-04 1.033955e-04
## [12706] 1.030770e-04 1.030286e-04 1.029725e-04 1.029646e-04 1.029646e-04
## [12711] 1.028896e-04 1.028326e-04 1.023932e-04 1.023180e-04 1.023180e-04
## [12716] 1.022948e-04 1.021487e-04 1.018738e-04 1.016801e-04 1.016463e-04
## [12721] 1.016120e-04 1.014297e-04 1.013803e-04 1.013048e-04 1.012013e-04
## [12726] 1.012013e-04 1.012013e-04 1.009989e-04 1.009967e-04 1.009401e-04
## [12731] 1.009401e-04 1.009401e-04 1.008901e-04 1.007564e-04 1.006688e-04
## [12736] 1.004510e-04 1.002198e-04 1.001873e-04 1.001873e-04 1.001687e-04
## [12741] 1.001578e-04 1.001578e-04 9.974261e-05 9.974261e-05 9.971247e-05
## [12746] 9.965662e-05 9.965662e-05 9.963827e-05 9.962423e-05 9.941182e-05
## [12751] 9.941182e-05 9.927732e-05 9.927732e-05 9.909685e-05 9.892509e-05
## [12756] 9.888701e-05 9.871988e-05 9.871988e-05 9.866055e-05 9.862210e-05
## [12761] 9.833805e-05 9.814890e-05 9.814890e-05 9.809474e-05 9.769153e-05
## [12766] 9.769153e-05 9.769153e-05 9.769153e-05 9.762230e-05 9.762230e-05
## [12771] 9.728714e-05 9.715907e-05 9.646020e-05 9.634972e-05 9.627960e-05

```

```

## [12776] 9.625248e-05 9.617709e-05 9.603107e-05 9.576304e-05 9.576304e-05
## [12781] 9.565388e-05 9.562935e-05 9.546267e-05 9.540854e-05 9.518736e-05
## [12786] 9.507746e-05 9.478677e-05 9.470206e-05 9.443657e-05 9.393993e-05
## [12791] 9.381815e-05 9.370191e-05 9.350986e-05 9.332909e-05 9.332326e-05
## [12796] 9.322820e-05 9.322820e-05 9.320790e-05 9.308516e-05 9.297599e-05
## [12801] 9.287457e-05 9.273996e-05 9.273996e-05 9.270144e-05 9.269783e-05
## [12806] 9.251050e-05 9.240523e-05 9.229170e-05 9.229170e-05 9.226979e-05
## [12811] 9.216086e-05 9.214808e-05 9.208948e-05 9.202874e-05 9.192615e-05
## [12816] 9.183058e-05 9.179960e-05 9.179105e-05 9.177422e-05 9.176454e-05
## [12821] 9.176454e-05 9.165214e-05 9.140285e-05 9.121885e-05 9.097287e-05
## [12826] 9.085092e-05 9.076639e-05 9.076639e-05 9.069060e-05 9.054772e-05
## [12831] 9.031164e-05 9.029152e-05 9.029152e-05 9.023944e-05 9.010770e-05
## [12836] 9.010770e-05 8.976849e-05 8.955251e-05 8.955251e-05 8.955251e-05
## [12841] 8.933771e-05 8.917726e-05 8.917726e-05 8.852539e-05 8.849537e-05
## [12846] 8.849537e-05 8.840893e-05 8.840893e-05 8.840893e-05 8.834162e-05
## [12851] 8.831791e-05 8.824873e-05 8.821811e-05 8.816390e-05 8.812648e-05
## [12856] 8.804441e-05 8.763483e-05 8.763483e-05 8.726037e-05 8.671990e-05
## [12861] 8.626332e-05 8.598367e-05 8.570362e-05 8.557498e-05 8.341096e-05

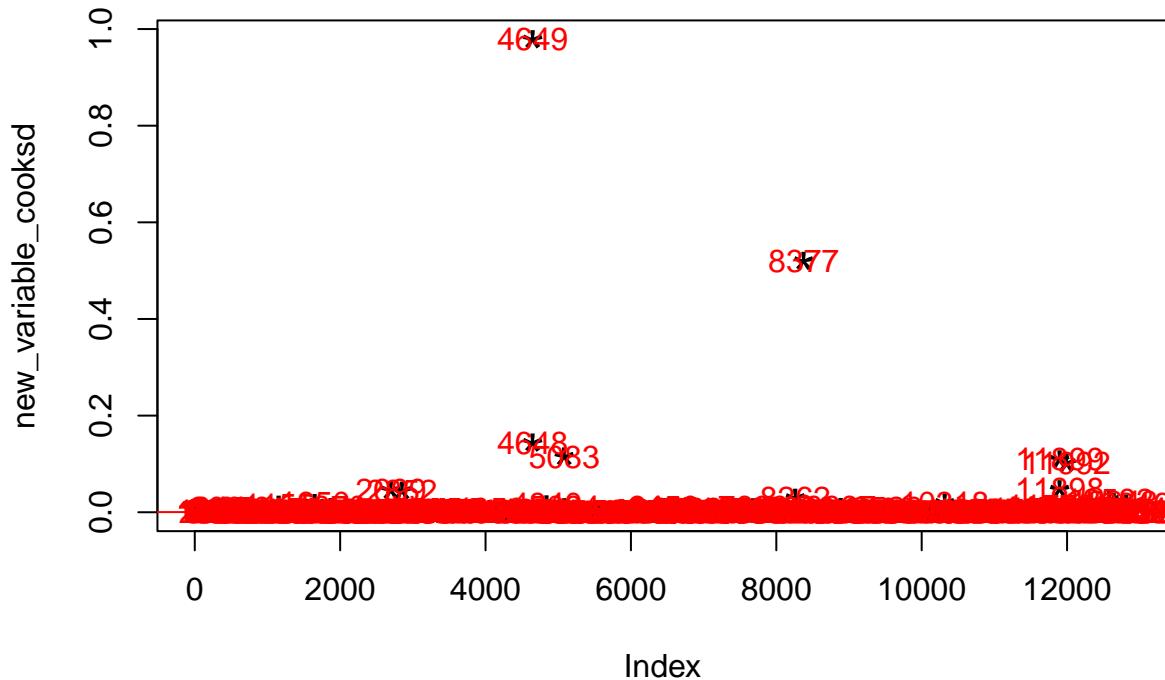
#### We can see that the largest leverage value is 0.0621723410. Since this isn't greater than 2, we know it's not an outlier.

new_variable_cooksd <- cooks.distance(new_variable_lm)

# Plot the Cook's Distance using the traditional 4/n criterion
sample_size <- nrow(new_variable)
plot(new_variable_cooksd, pch="*", cex=2, main="Influential Obs by Cooks distance") # plot cook's distance
abline(h = 4/sample_size, col="red") # add cutoff line
text(x=1:length(new_variable_cooksd)+1, y=new_variable_cooksd, labels=ifelse(new_variable_cooksd>4/sample_size, "Outlier", ""))

```

Influential Obs by Cooks distance



```
### Removing Outliers
### influential row numbers
new_variable_influential <- as.numeric(names(new_variable_cooksd))[(new_variable_cooksd > (4/sample_size))

new_variable_screen <- new_variable[- new_variable_influential, ]

plot3 <- ggplot(data = new_variable, aes(x = Sale_Price, y = sq_ft_lot)) +
  geom_point() +
  geom_smooth(method = lm) +
  xlim(0, 400000) + ylim(0, 75000) +
  ggtitle("Before")
plot4 <- ggplot(data = new_variable_screen, aes(x = Sale_Price, y = sq_ft_lot)) +
  geom_point() +
  geom_smooth(method = lm) +
  xlim(0, 400000) + ylim(0, 75000) +
  ggtitle("After")
library(gridExtra)

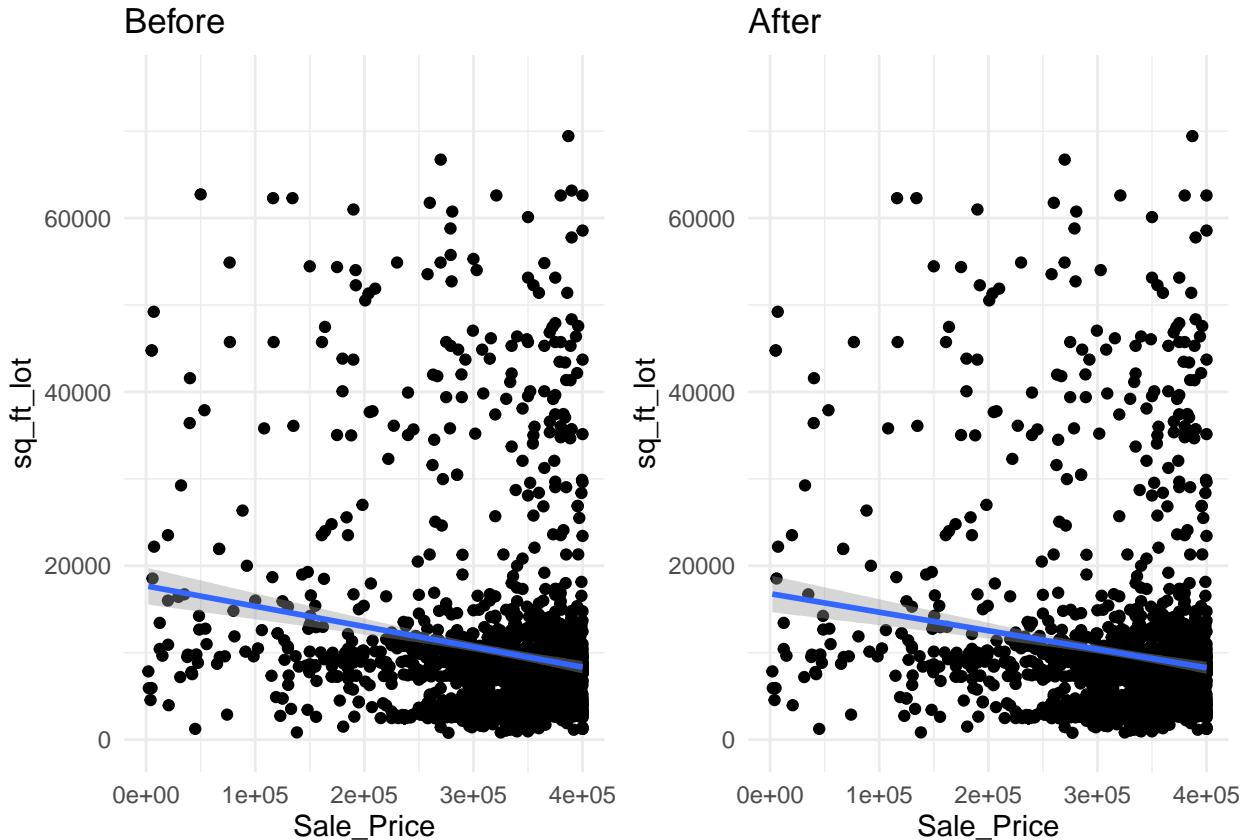
##
## Attaching package: 'gridExtra'
## The following object is masked from 'package:dplyr':
##     combine
gridExtra::grid.arrange(plot3, plot4, ncol=2)

## `geom_smooth()` using formula 'y ~ x'
```

```

## Warning: Removed 11055 rows containing non-finite values (stat_smooth).
## Warning: Removed 11055 rows containing missing values (geom_point).
## `geom_smooth()` using formula 'y ~ x'
## Warning: Removed 10604 rows containing non-finite values (stat_smooth).
## Warning: Removed 10604 rows containing missing values (geom_point).

```

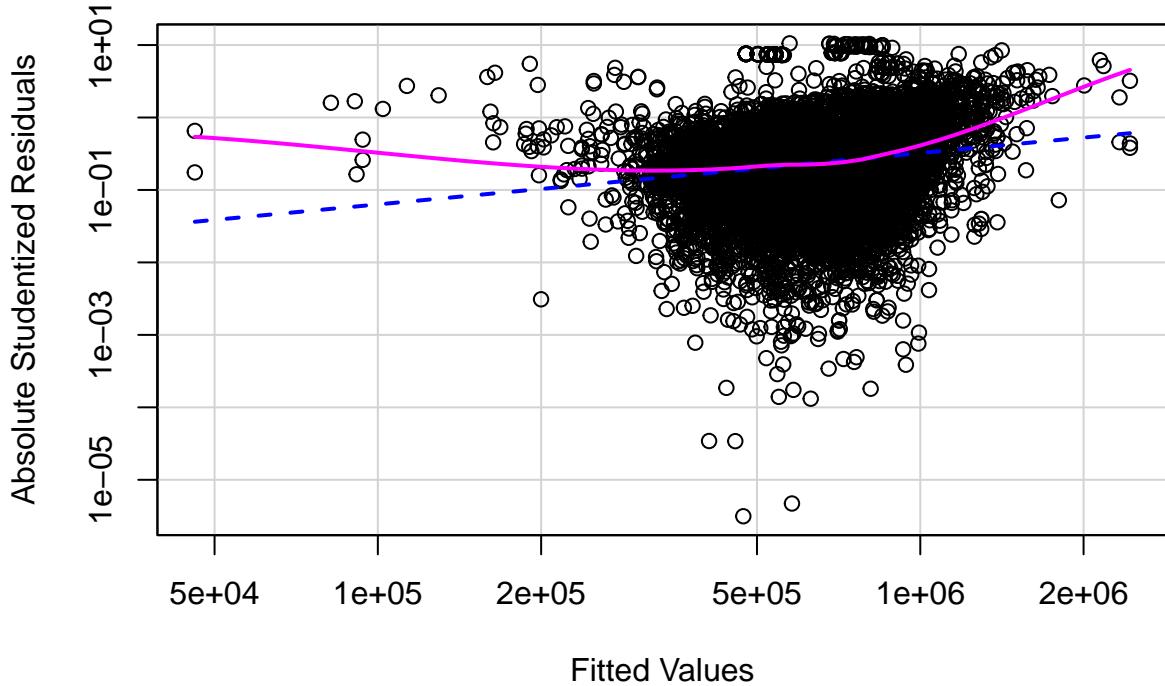


```

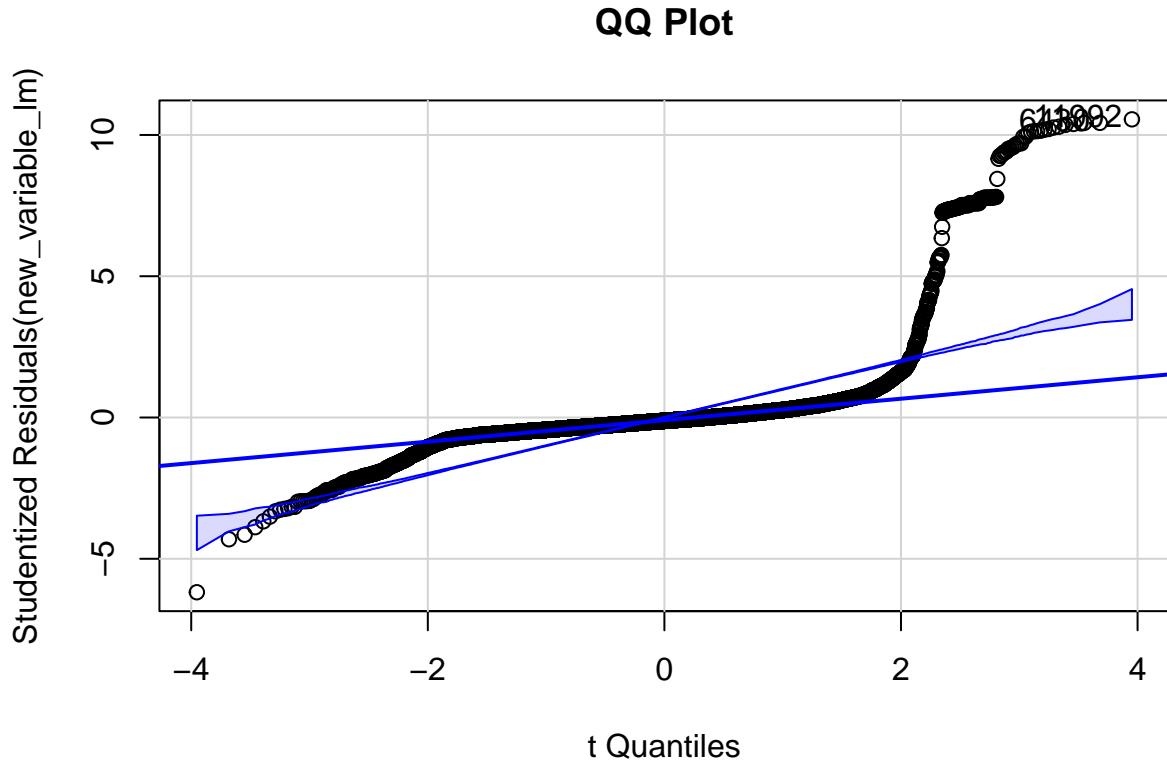
### Perform the necessary calculations to assess the assumption of independence and state if the condition holds
### Checking the assumption of constant variance of residuals (Homoscedasticity)
spreadLevelPlot(new_variable_lm)

```

Spread-Level Plot for new_variable_lm



```
##  
## Suggested power transformation: 0.2911658  
### Checking the assumption of normality of residuals  
qqPlot(new_variable_lm, main="QQ Plot")
```



```

## [1] 6430 11992
### Perform the necessary calculations to assess the assumption of no multicollinearity and state if there is any
### Checking for multicollinearity
vif(new_variable_lm) # variance inflation factors

##          sq_ft_lot      building_grade      year_built
##            1.113594        2.353068        1.211716
## square_feet_total_living
##                  2.365744

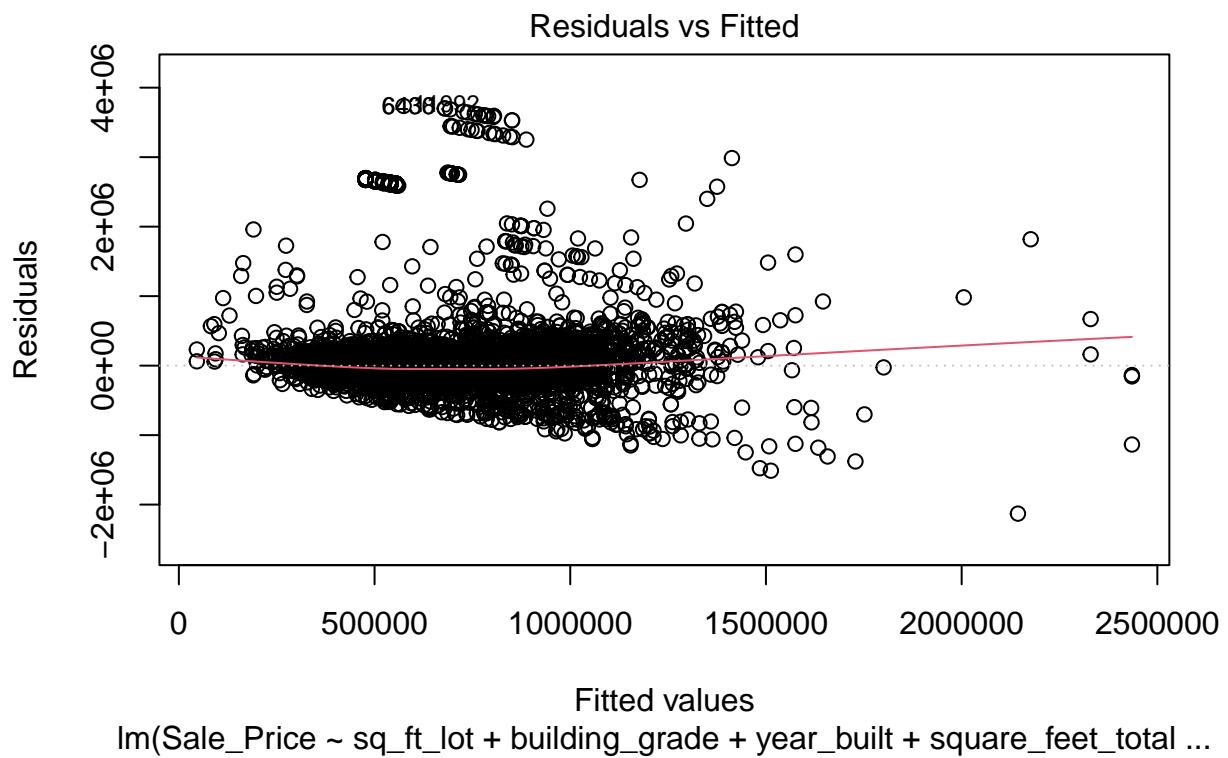
sqrt(vif(new_variable_lm)) > 2 #checks if the VIF's in your model are > 2, usually indicating a problem

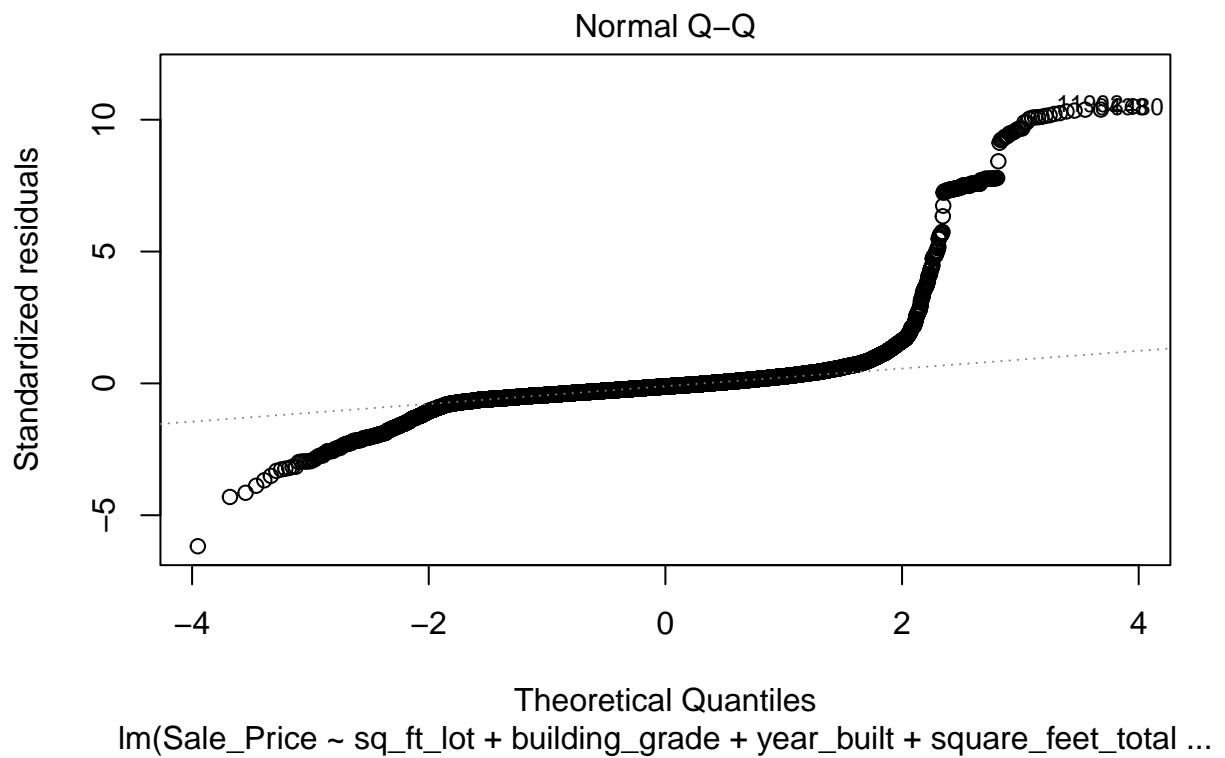
##          sq_ft_lot      building_grade      year_built
##            FALSE           FALSE           FALSE
## square_feet_total_living
##                  FALSE

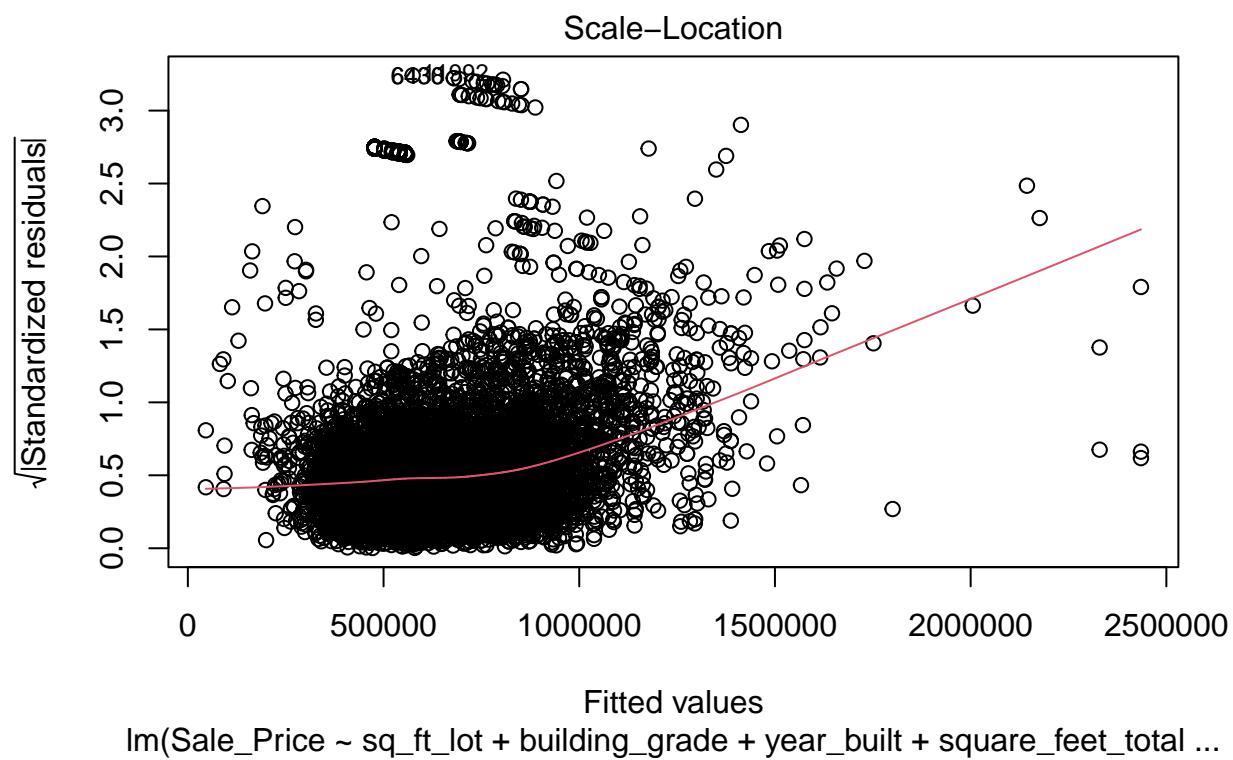
### ANS It appears that the VIF for both of our predictors is less than 2, so we have met the assumption of no multicollinearity

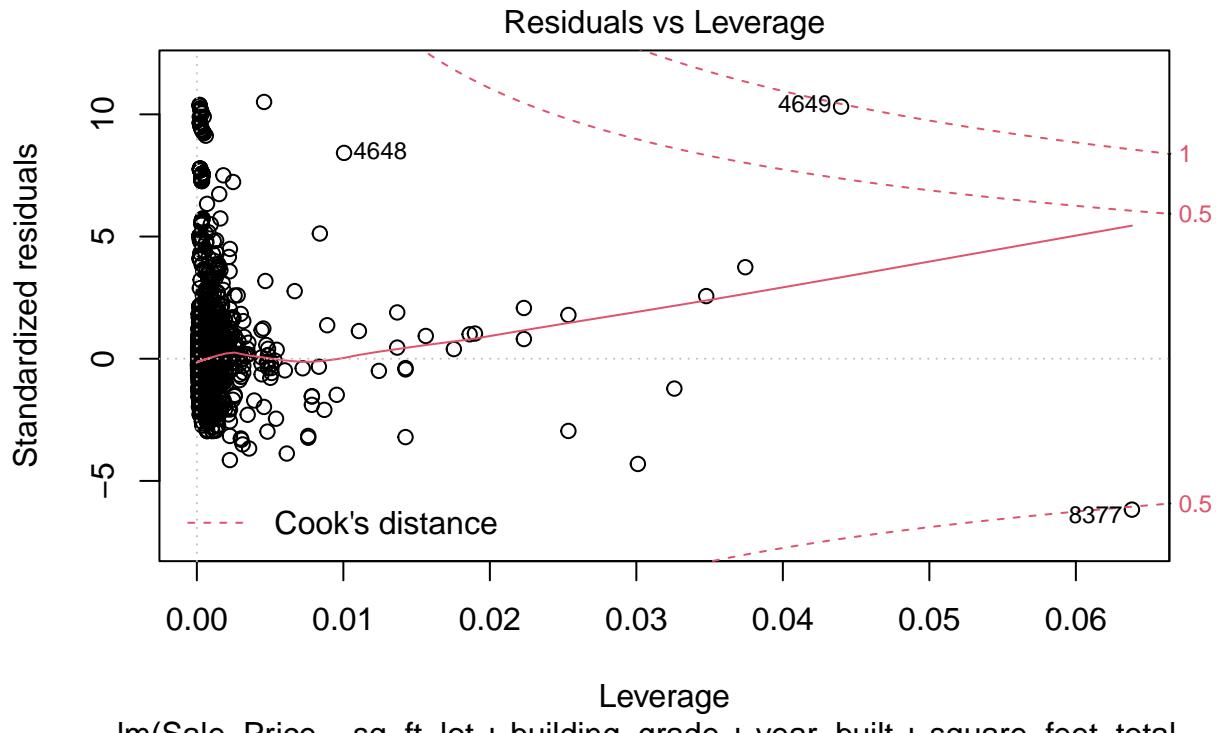
### Visually check the assumptions related to the residuals using the plot() and hist() functions. Summarize the results
plot(new_variable_lm)

```









This output provides us four useful plots:

Residuals vs Fitted Values, to check constant variance in residuals and linearity of association between predictors.

Normal Q-Q Plot, to check the assumption of normally distributed residuals.

Root of Standardized residuals vs Fitted values, this is very similar to number 1, where the Y axis is the square root of the absolute value of the residual.

Residuals vs Leverage, to check if the leverage of certain observations are driving abnormal residuals.