5205ProjectFinal.R

wuyin

2022-01-13

```
## import data
#install.packages("tidyverse")
#install.packages("ggplot2")
setwd('/Users/wuyin')
library(tidyverse)
```

```
## ── Attaching packages ─────────────────────────────────────
──────────────────────────── tidyverse 1.3.0 ──
```

```
## √ ggplot2 3.3.5.9000      √ purrr   0.3.4
## √ tibble  3.1.6           √ dplyr   1.0.5
## √ tidyr   1.1.3           √ stringr 1.4.0
## √ readr   1.4.0           √ forcats 0.5.1
```

```
## ── Conflicts ─────────────────────────────────────────────
──────────────────────── tidyverse_conflicts() ──
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
library(ggplot2)
library(corrplot)
```

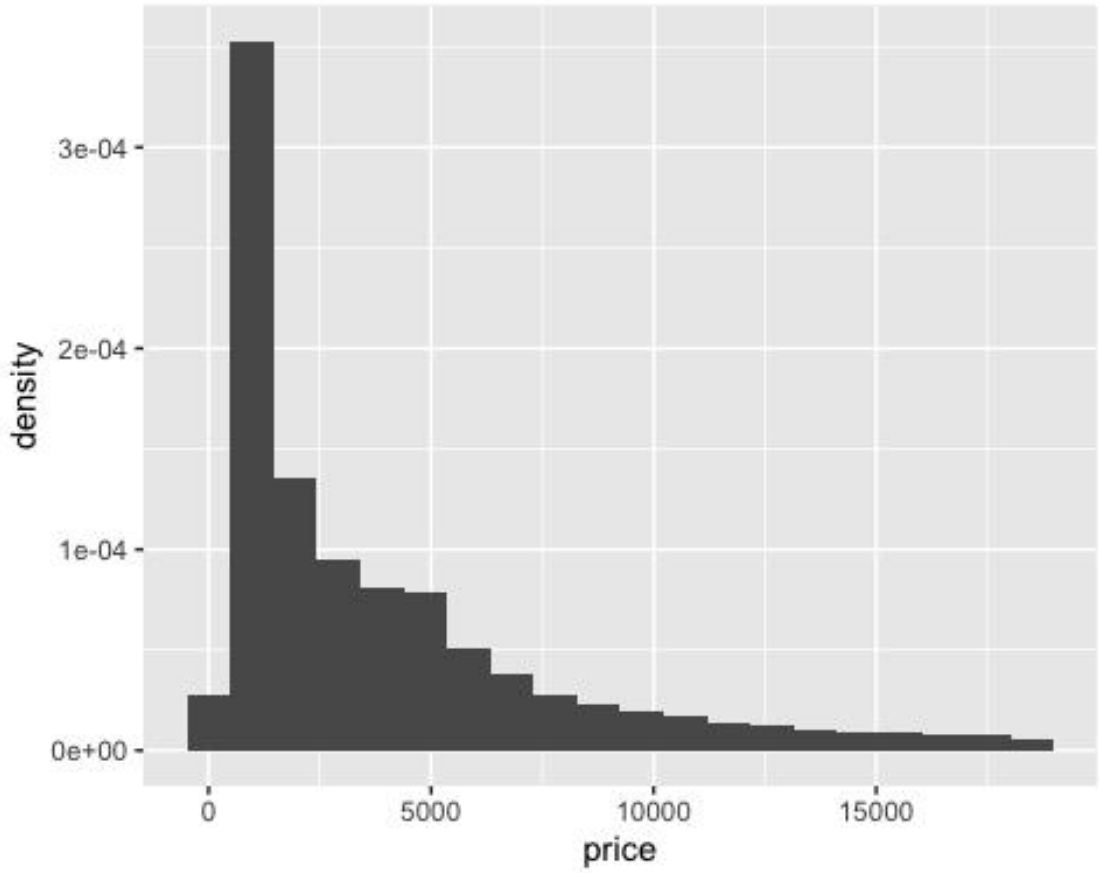
```
## corrplot 0.84 loaded
```

```
library(car)
```

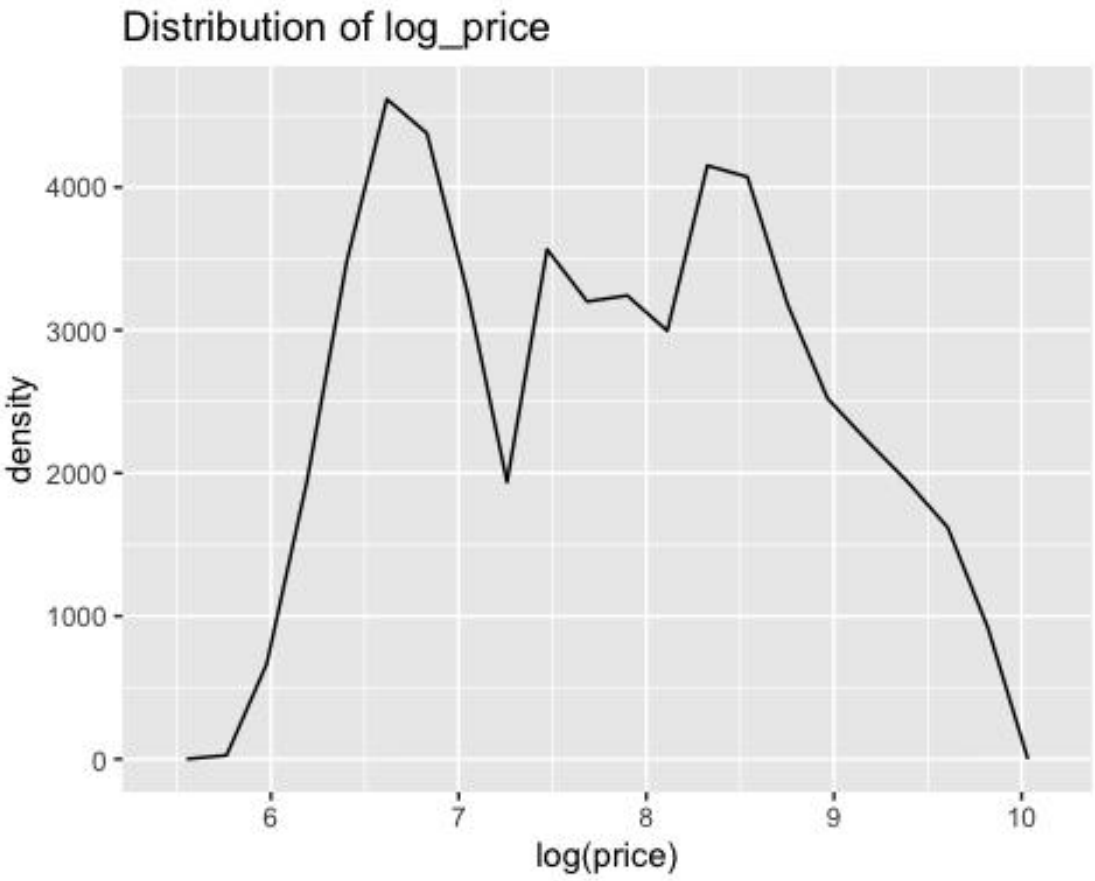
```
## Loading required package: carData
```

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

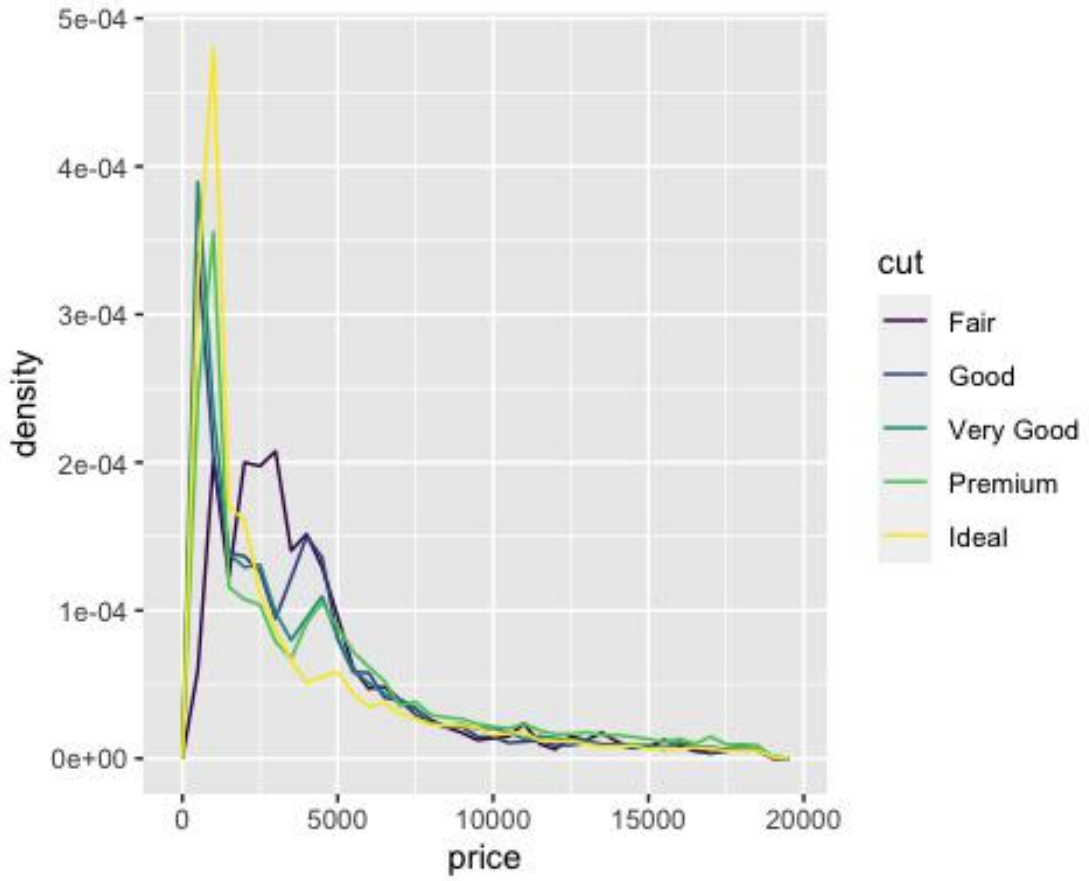
```
## The following object is masked from 'package:dplyr':
##
##       recode

## The following object is masked from 'package:purrr':
##
##       some

devtools::install_github("tidyverse/ggplot2")

## Skipping install of 'ggplot2' from a github remote, the SHA1 (c89c265a) has
 not changed since last install.
##    Use `force = TRUE` to force installation

df_diamond <- ggplot2::diamonds
##independent variable changes to log_price
g1 <- ggplot(df_diamond, aes(price)) +
  geom_histogram(bins = 20, aes(y = ..density..))
g1
```




```
g_lnprice <- ggplot(df_diamond, aes(log(price))) +
  geom_histogram(bins = 20, aes(y = ..density..)) +
  geom_freqpoly(bins = 20) +
  labs(title = "Distribution of log_price")
g_lnprice
```



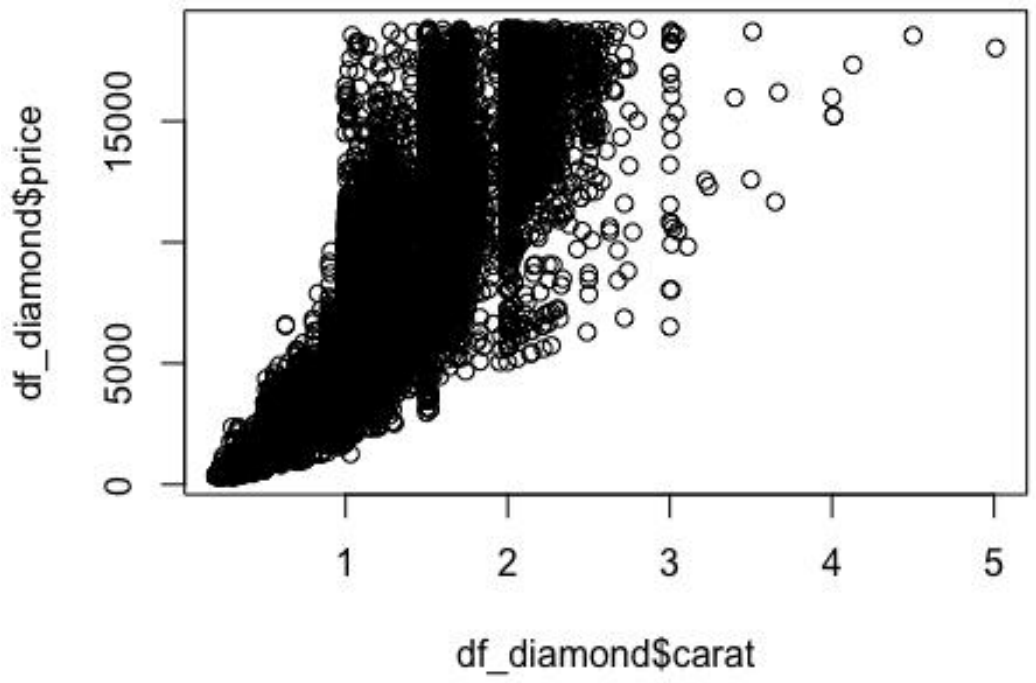

```
ggplot(df_diamond, aes(price, after_stat(density), colour = cut)) +
  geom_freqpoly(binwidth = 500)
```



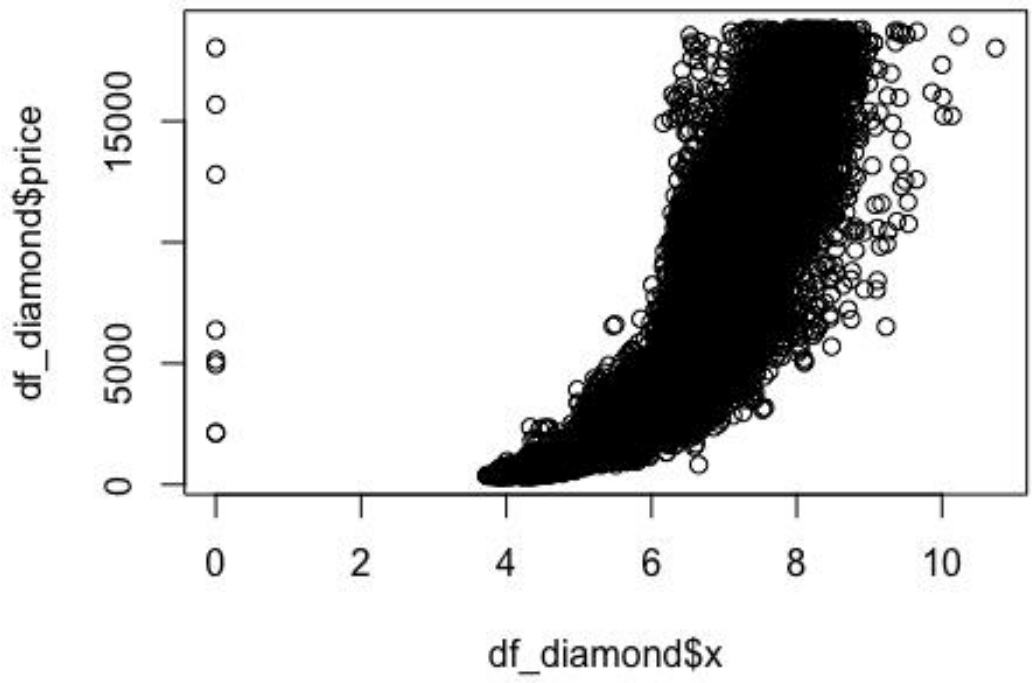

```
summary(diamonds$color)
```

```
##     D     E     F     G     H     I     J
##  6775  9797  9542 11292  8304  5422  2808
```

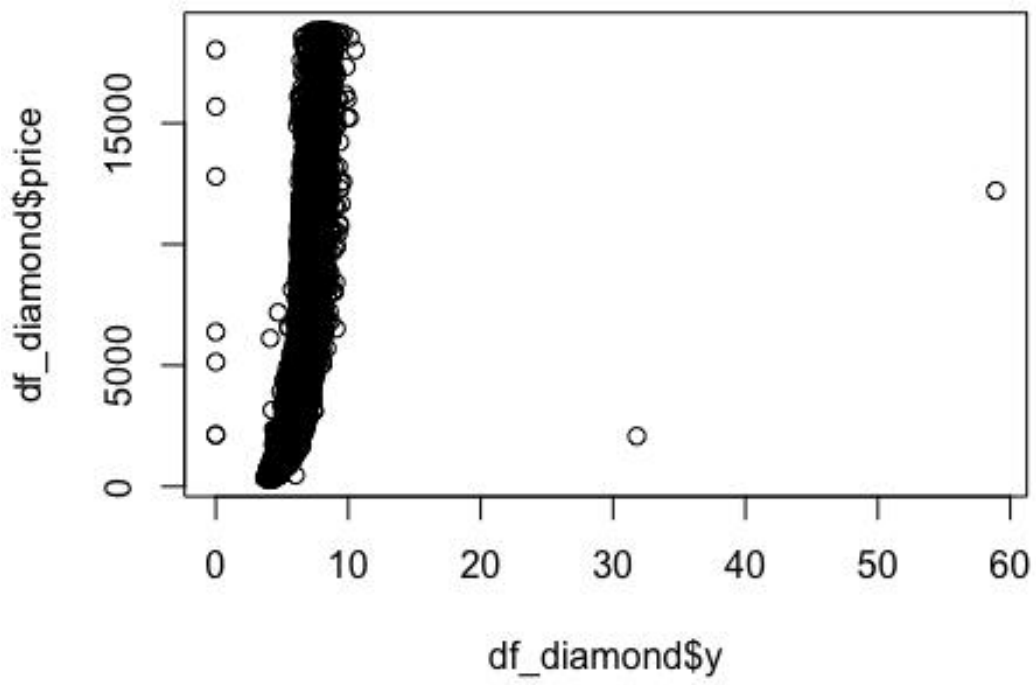
```
##divide diamonds into two categories, one is that carat is smaller than 1,
##the other one is that carat is bigger than 1.
plot(df_diamond$carat, df_diamond$price)
```



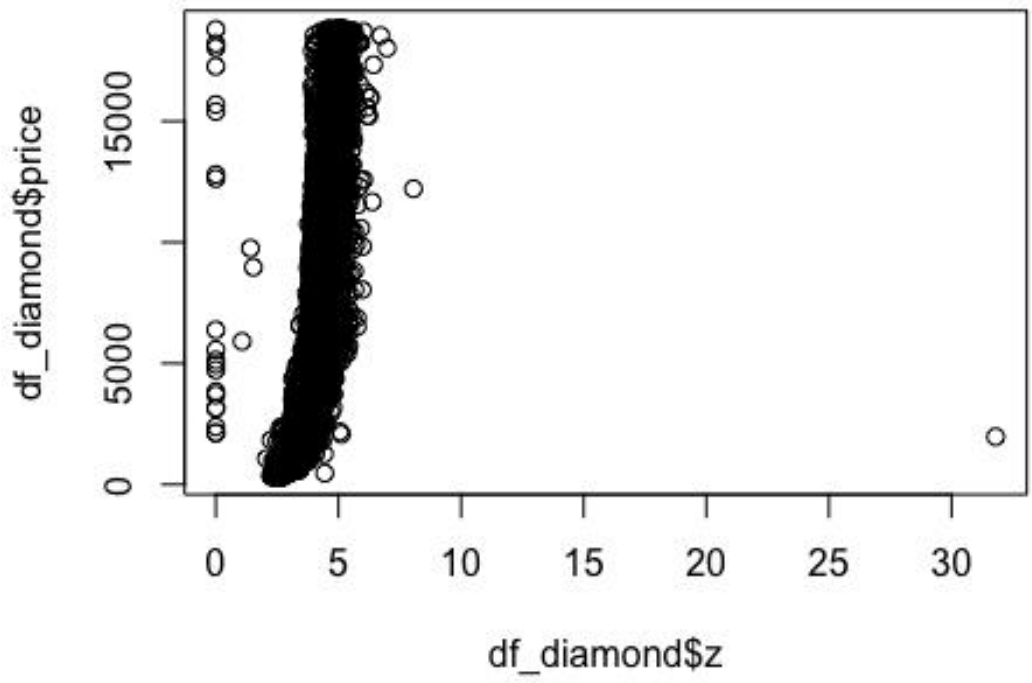

```
## delete outliers
plot(df_diamond$x, df_diamond$price)
```



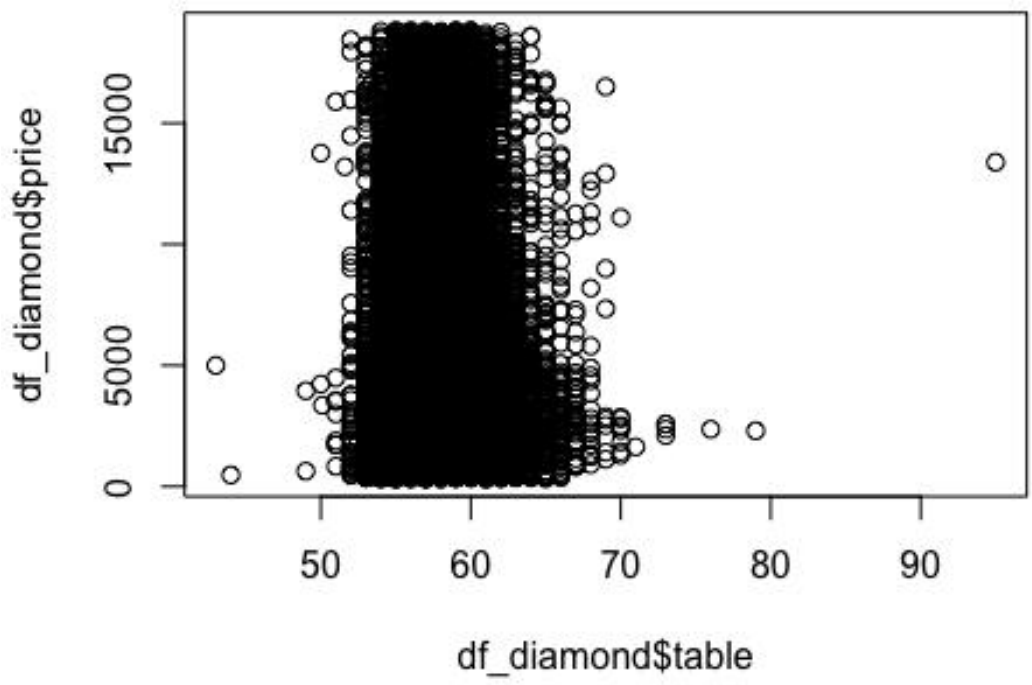

```
plot(df_diamond$y, df_diamond$price) ## filter y>30
```



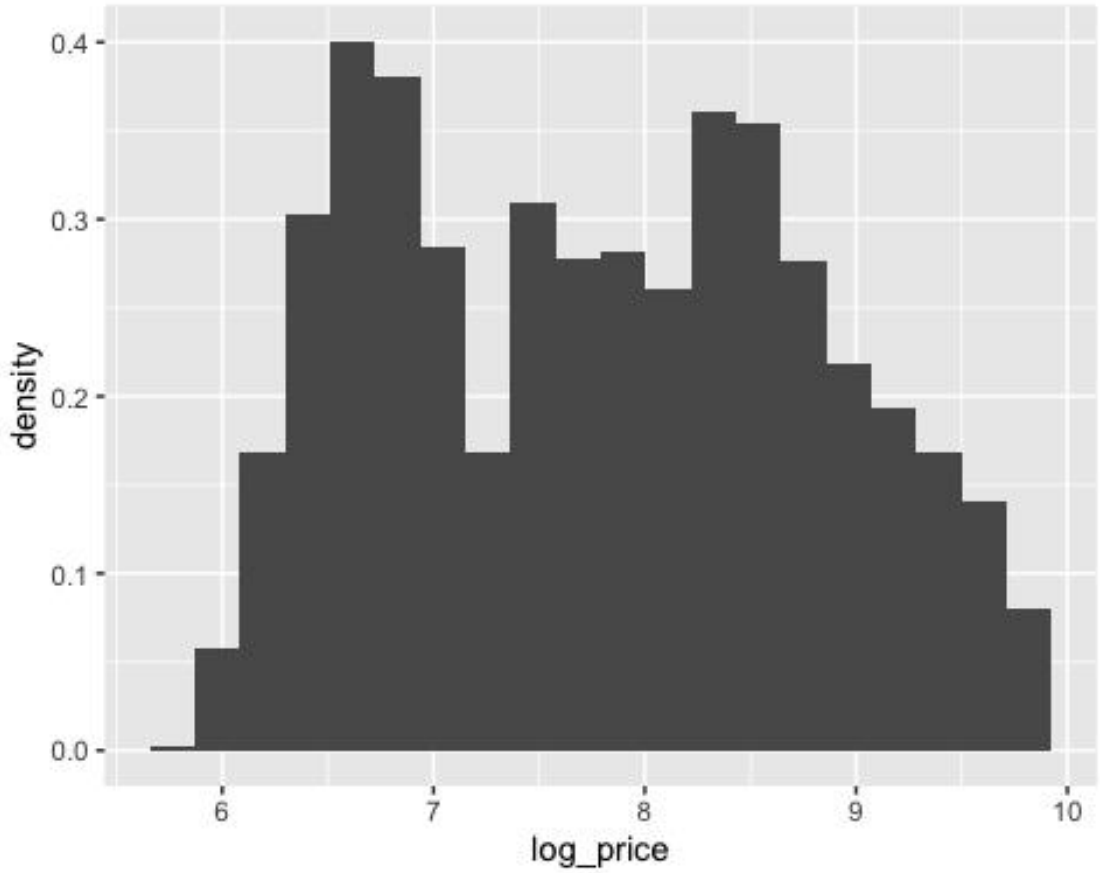

```
plot(df_diamond$z, df_diamond$price) ## filter z>30
```




```
plot(df_diamond$table, df_diamond$price) ## filter table>90
```

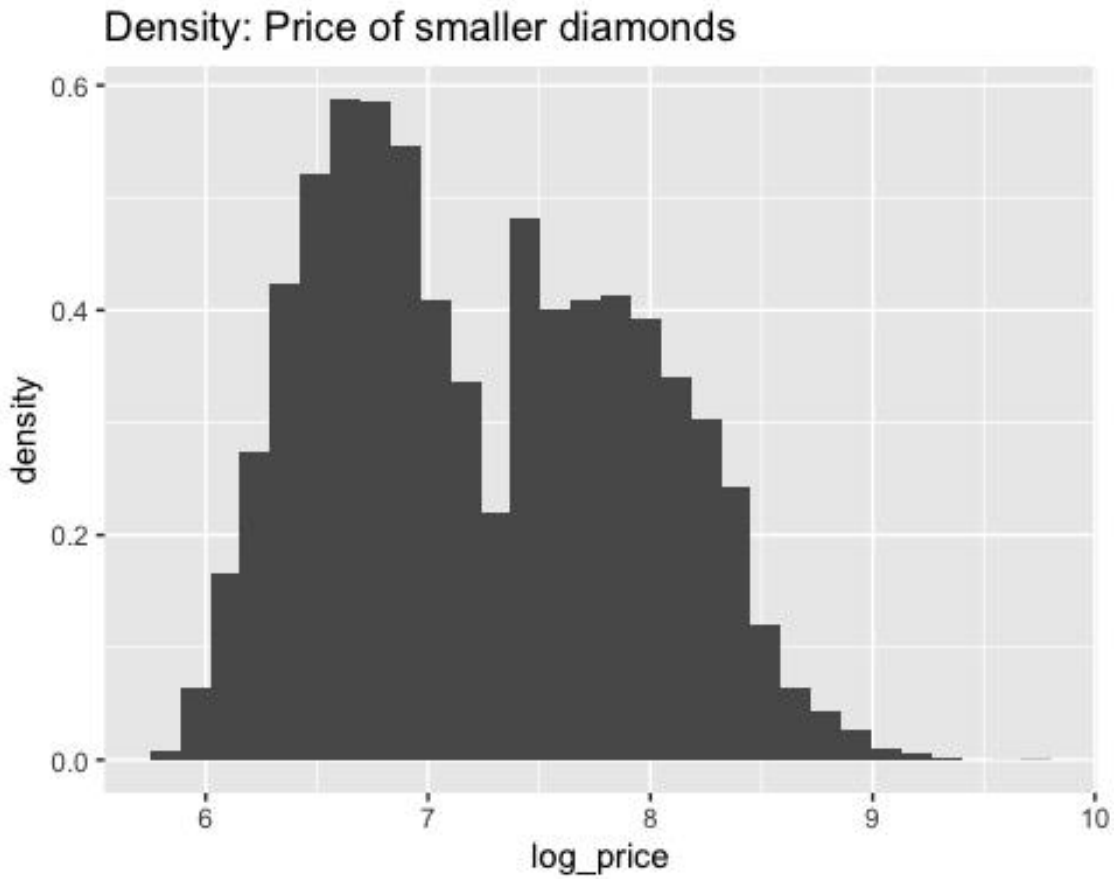



```
## data
df_diamond <- df_diamond %>%
  filter(y <= 30 & z <= 30 & table <= 90) %>%
  mutate(if_bigger = ifelse(carat>1, 1, 0),
         log_price = log(price))
g2 <- ggplot(df_diamond, aes(log_price)) +
  geom_histogram(bins = 20, aes(y = ..density..))
g2
```

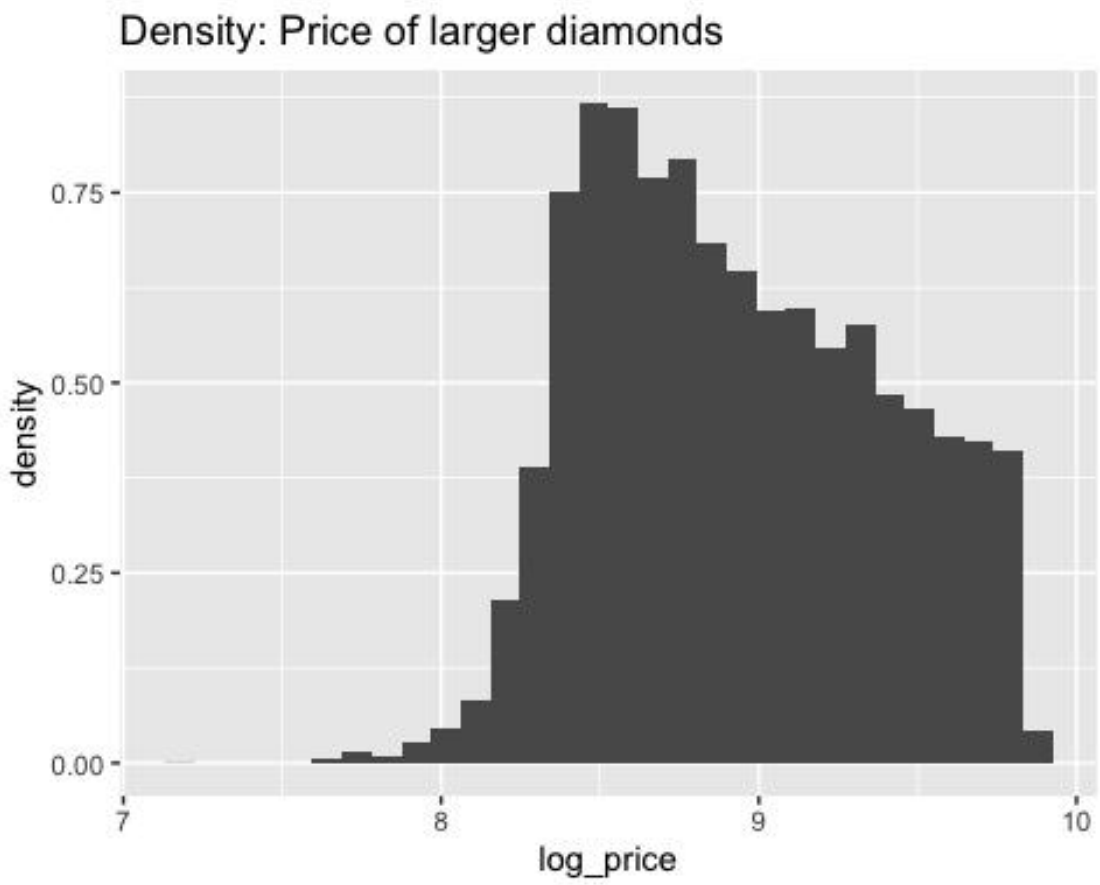



```
g_carat <- ggplot(df_diamond, aes(carat)) +
  geom_histogram(bins = 20, aes(y = ..density..))

## split the dataset
diamond_big <- df_diamond %>%
  filter(if_bigger==1) %>%
  select(-price,-x,-y,-z,-if_bigger)
diamond_small <- df_diamond %>%
  filter(if_bigger==0) %>%
  select(-price,-x,-y,-z,-if_bigger)

g_smallprice <- ggplot(diamond_small, aes(log_price)) +
  geom_histogram(bins = 30, aes(y = ..density..)) +
```

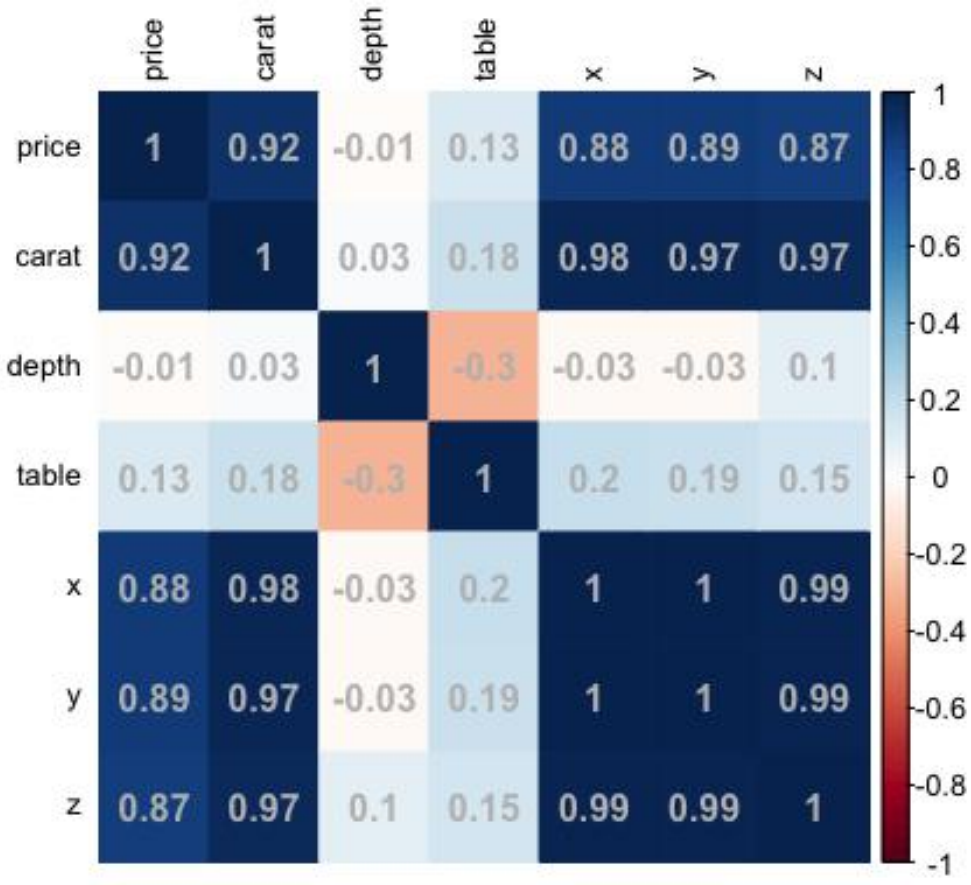
```
  labs(title = "Density: Price of smaller diamonds")
g_smallprice
```



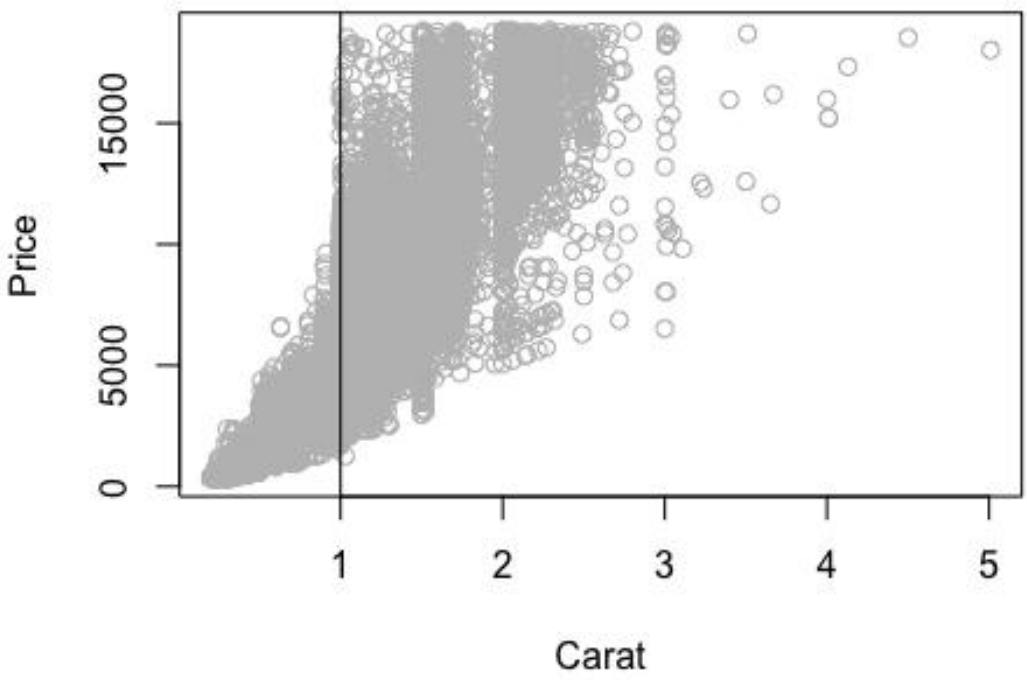

```
g_bigprice <- ggplot(diamond_big, aes(log_price)) +
  geom_histogram(bins = 30, aes(y = ..density..))  +
  labs(title = "Density: Price of larger diamonds")
g_bigprice
```



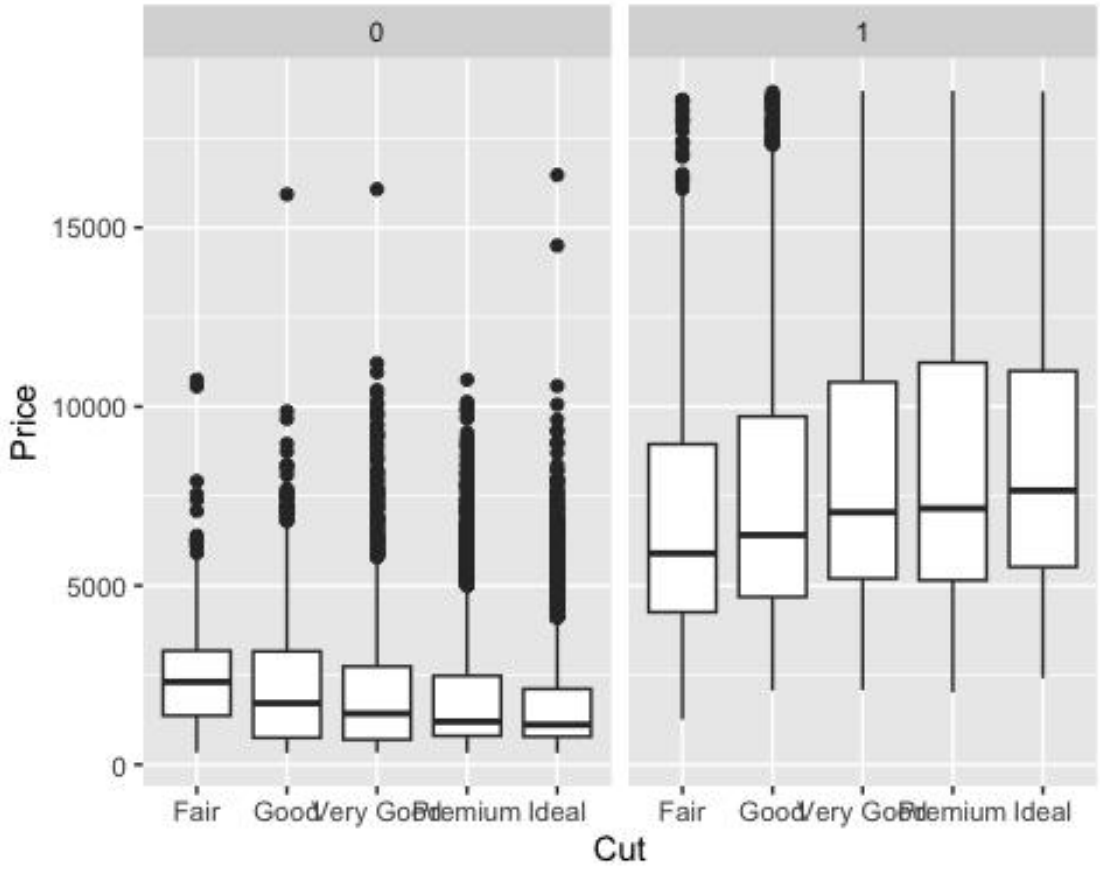

```r
# correlation
diamond_num <- df_diamond %>%
  select(price, carat,depth,table,x,y,z)
corr_diamond <- cor(diamond_num)
corrplot(corr_diamond, method = "color",
         addCoef.col = "gray",
         tl.cex = 0.8,
         tl.col = "black")
```



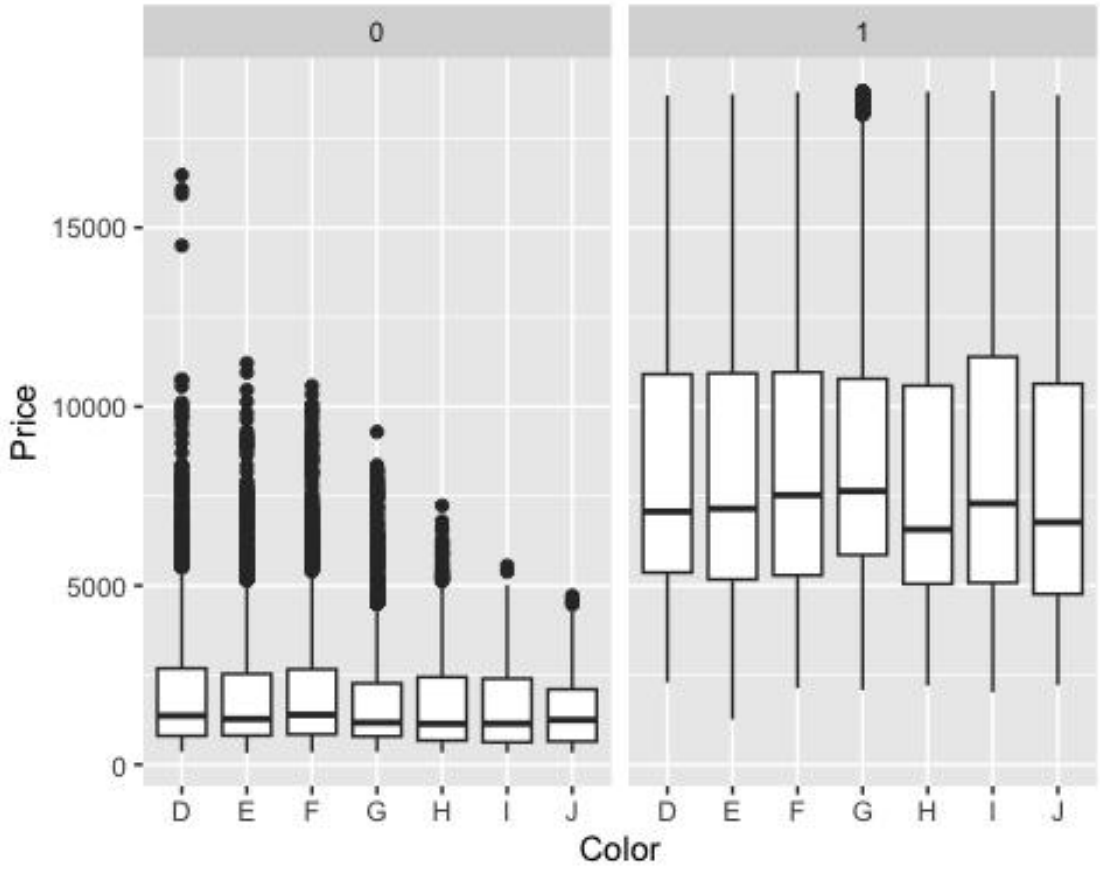

```
#car::scatterplotMatrix(diamond_num, spread=FALSE, smoother.args=list(lty=2), main="Scatter Plot Matrix")

plot(df_diamond$carat, df_diamond$price, type = "p",col = "grey",lwd = 1,
     xlab = "Carat",
     ylab = "Price")
abline(v=1)
```



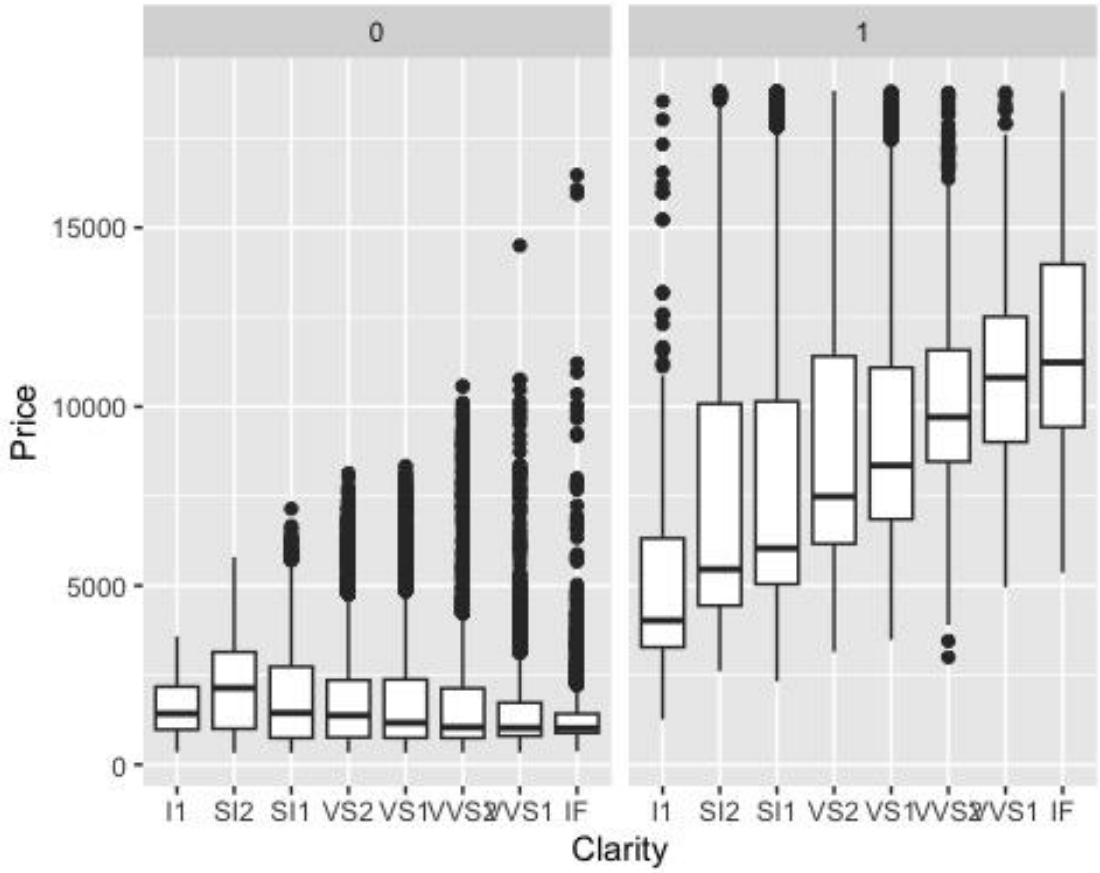

```
g_box_cut <- ggplot(data = df_diamond, aes(x = cut, y = price)) +
  geom_boxplot() +
  facet_grid(cols = vars(if_bigger)) +
  labs(x = "Cut", y="Price")
g_box_cut
```




```
g_box_color <- ggplot(data = df_diamond, aes(x = color, y = price)) +
  geom_boxplot() +
  facet_grid(cols = vars(if_bigger)) +
  labs(x = "Color", y="Price")
g_box_color
```




```
g_box_clarity <- ggplot(data = df_diamond, aes(x = clarity, y = price)) +
  geom_boxplot() +
  facet_grid(cols = vars(if_bigger)) +
  labs(x = "Clarity", y="Price")
g_box_clarity
```




```
### modeling
library(olsrr)

##
## Attaching package: 'olsrr'

## The following object is masked from 'package:datasets':
##
##       rivers

fit_all_big <- lm(log_price~., data = diamond_big)
summary(fit_all_big)

##
## Call:
## lm(formula = log_price ~ ., data = diamond_big)
##
```

```
## Residuals:
##       Min        1Q    Median        3Q       Max
## -2.19670 -0.07544  0.00643  0.08868  0.86235
##
## Coefficients:
##                Estimate Std. Error   t value Pr(>|t|)
## (Intercept)   7.9501365  0.0744237   106.823  < 2e-16 ***
## carat         1.1573848  0.0030783   375.981  < 2e-16 ***
## cut.L         0.1271199  0.0045858    27.720  < 2e-16 ***
## cut.Q        -0.0423229  0.0037130   -11.398  < 2e-16 ***
## cut.C         0.0405610  0.0031748    12.776  < 2e-16 ***
## cut^4         0.0188424  0.0026476     7.117 1.15e-12 ***
## color.L      -0.4330556  0.0035829  -120.868  < 2e-16 ***
## color.Q      -0.1054408  0.0032522   -32.421  < 2e-16 ***
## color.C      -0.0100612  0.0031137    -3.231  0.00123 **
## color^4       0.0007831  0.0029426     0.266  0.79014
## color^5      -0.0133570  0.0027611    -4.838 1.33e-06 ***
## color^6       0.0026300  0.0025056     1.050  0.29389
## clarity.L     1.0071650  0.0068936   146.101  < 2e-16 ***
## clarity.Q    -0.2819281  0.0063322   -44.523  < 2e-16 ***
## clarity.C     0.1374011  0.0057721    23.804  < 2e-16 ***
## clarity^4    -0.0786119  0.0051876   -15.154  < 2e-16 ***
## clarity^5     0.0279739  0.0045350     6.168 7.05e-10 ***
## clarity^6     0.0015269  0.0038071     0.401  0.68837
## clarity^7     0.0316179  0.0030098    10.505  < 2e-16 ***
## depth        -0.0053454  0.0008268    -6.465 1.04e-10 ***
## table        -0.0033654  0.0006410    -5.250 1.54e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1405 on 17479 degrees of freedom
```

```
## Multiple R-squared:  0.9048, Adjusted R-squared:  0.9047
## F-statistic:  8305 on 20 and 17479 DF,  p-value: < 2.2e-16

fit_all_small <- lm(log_price~., data = diamond_small)
summary(fit_all_small)

##
## Call:
## lm(formula = log_price ~ ., data = diamond_small)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.58381 -0.10454  0.00202  0.10697  1.86018
##
## Coefficients:
##                Estimate Std. Error  t value Pr(>|t|)
## (Intercept)  5.7377550  0.0575273   99.740  < 2e-16 ***
## carat        3.4004642  0.0039477  861.374  < 2e-16 ***
## cut.L        0.1352665  0.0037639   35.938  < 2e-16 ***
## cut.Q       -0.0145781  0.0029911   -4.874 1.10e-06 ***
## cut.C       -0.0017346  0.0025623   -0.677  0.49843
## cut^4       -0.0163077  0.0020011   -8.150 3.77e-16 ***
## color.L     -0.4303875  0.0030728 -140.065  < 2e-16 ***
## color.Q     -0.0745163  0.0028930  -25.757  < 2e-16 ***
## color.C     -0.0071991  0.0026396   -2.727  0.00639 **
## color^4      0.0186220  0.0023484    7.930 2.26e-15 ***
## color^5     -0.0023219  0.0021620   -1.074  0.28285
## color^6     -0.0038978  0.0019051   -2.046  0.04076 *
## clarity.L    0.8420229  0.0059398  141.760  < 2e-16 ***
## clarity.Q   -0.2384260  0.0056919  -41.889  < 2e-16 ***
## clarity.C    0.1267022  0.0047328   26.771  < 2e-16 ***
## clarity^4   -0.0463938  0.0035518  -13.062  < 2e-16 ***
## clarity^5    0.0175224  0.0026342    6.652 2.93e-11 ***
```

```
## clarity^6    -0.0064111   0.0021361    -3.001   0.00269 **
## clarity^7     0.0223963   0.0018657    12.005   < 2e-16 ***
## depth        -0.0045804   0.0006546    -6.997 2.65e-12 ***
## table        -0.0028218   0.0004681    -6.028 1.68e-09 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1481 on 36415 degrees of freedom
## Multiple R-squared:  0.9555, Adjusted R-squared:  0.9555
## F-statistic: 3.913e+04 on 20 and 36415 DF,  p-value: < 2.2e-16
```

```
## choose a better model

train_sub_big <-  sample(nrow(diamond_big),8/10*nrow(diamond_big))
train_big <-  diamond_big[train_sub_big,]
test_big <-  diamond_big[-train_sub_big,]

train_sub_small <-  sample(nrow(diamond_small),8/10*nrow(diamond_small))
train_small <-  diamond_small[train_sub_small,]
test_small <-  diamond_small[-train_sub_small,]

# stepwise selection
step_fit_big <- lm(log_price ~ ., data = train_big)
summary(step_fit_big)
```

```
##
## Call:
## lm(formula = log_price ~ ., data = train_big)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -2.22643 -0.07498  0.00673  0.08847  0.86405
##
```

```
## Coefficients:
##                Estimate  Std. Error    t value  Pr(>|t|)
## (Intercept)   7.9240317   0.0837391     94.628   < 2e-16 ***
## carat         1.1629870   0.0034465    337.443   < 2e-16 ***
## cut.L         0.1288300   0.0050770     25.375   < 2e-16 ***
## cut.Q        -0.0419703   0.0040998    -10.237   < 2e-16 ***
## cut.C         0.0402171   0.0035252     11.409   < 2e-16 ***
## cut^4         0.0188892   0.0029610      6.379  1.83e-10 ***
## color.L      -0.4345370   0.0039987   -108.671   < 2e-16 ***
## color.Q      -0.1067345   0.0036267    -29.430   < 2e-16 ***
## color.C      -0.0139027   0.0034712     -4.005  6.23e-05 ***
## color^4      -0.0002241   0.0032932     -0.068     0.946
## color^5      -0.0135659   0.0030735     -4.414  1.02e-05 ***
## color^6       0.0026994   0.0027899      0.968     0.333
## clarity.L     1.0004745   0.0076802    130.267   < 2e-16 ***
## clarity.Q    -0.2740171   0.0070344    -38.954   < 2e-16 ***
## clarity.C     0.1347587   0.0064285     20.963   < 2e-16 ***
## clarity^4    -0.0702105   0.0058194    -12.065   < 2e-16 ***
## clarity^5     0.0290418   0.0050960      5.699  1.23e-08 ***
## clarity^6     0.0037954   0.0042622      0.890     0.373
## clarity^7     0.0312933   0.0033630      9.305   < 2e-16 ***
## depth        -0.0049582   0.0009309     -5.327  1.02e-07 ***
## table        -0.0034471   0.0007155     -4.817  1.47e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1402 on 13979 degrees of freedom
## Multiple R-squared:  0.9055, Adjusted R-squared:  0.9053
## F-statistic:  6695 on 20 and 13979 DF,  p-value: < 2.2e-16

step_aic_forward_big <- ols_step_forward_aic(step_fit_big, details = TRUE)
```

```
## Forward Selection Method
## ------------------------
##
## Candidate Terms:
##
## 1 . carat
## 2 . cut
## 3 . color
## 4 . clarity
## 5 . depth
## 6 . table
##
##  Step 0: AIC = 17725.41
##  log_price ~ 1
##
## ------------------------------------------------------------------
-------------
## Variable       DF          AIC          Sum Sq          RSS          R-Sq       Adj. R
-Sq
## ------------------------------------------------------------------
-------------
## carat           1       6183.549      1632.286      1274.347      0.562           0.56
2
## clarity         1      15835.046       369.666      2536.967      0.127           0.127

## cut             1      17545.417        38.770      2867.863      0.013           0.013

## color           1      17648.530        18.395      2888.238      0.006           0.00
6
## depth           1      17669.695        11.958      2894.675      0.004           0.00
4
## table           1      17715.198         2.535      2904.098      0.001           0.001
```

```
## ------------------------------------------------------------------
------------
##
##
## - carat
##
##
##   Step 1 : AIC = 6183.549
##   log_price ~ carat
##
## ------------------------------------------------------------------
-----------
## Variable       DF          AIC          Sum Sq          RSS          R-Sq       Adj. R-
Sq
## ------------------------------------------------------------------
-----------
## clarity          1      -5154.670      707.938       566.409      0.805           0.805
## color            1       3250.099      241.783      1032.563      0.645           0.645

## cut              1       5044.739      100.227      1174.120      0.596           0.596
## table            1       5914.133       24.468      1249.879      0.570           0.570
## depth            1       5982.837       18.319      1256.028      0.568           0.568

## ------------------------------------------------------------------
-----------
##
## - clarity
##
##
##   Step 2 : AIC = -5154.67
##   log_price ~ carat + clarity
```

```
##
## ----------------------------------------------------------------
-----------
## Variable       DF         AIC          Sum Sq         RSS        R-Sq       Adj. R-
Sq
## ----------------------------------------------------------------
-----------
## color           1     -13902.377      263.442      302.967      0.896           0.89
6
## cut             1      -5760.462       24.296      542.113      0.813           0.813
## table           1      -5295.872        5.764      560.645      0.807           0.807

## depth           1      -5277.699        5.036      561.373      0.807           0.807

## ----------------------------------------------------------------
-----------
##
## - color
##
##
##   Step 3 : AIC = -13902.38
##   log_price ~ carat + clarity + color
##
## ----------------------------------------------------------------
----------
## Variable       DF         AIC          Sum Sq         RSS        R-Sq       Adj. R-S
q
## ----------------------------------------------------------------
----------
## cut             1     -15225.943       27.488      275.479      0.905           0.905

## table           1     -14174.949        5.884      297.083      0.898           0.898
```

```
## depth            1     -14044.914       3.112      299.855      0.897           0.897
## ------------------------------------------------------------------------------
----------
##
## - cut
##
##
##   Step 4 : AIC = -15225.94
##   log_price ~ carat + clarity + color + cut
##
## ------------------------------------------------------------------------------
----------
## Variable       DF          AIC          Sum Sq        RSS        R-Sq       Adj. R-S
q
## ------------------------------------------------------------------------------
----------
## depth            1     -15237.839       0.273      275.206      0.905           0.905

## table            1     -15232.676       0.172      275.307      0.905           0.905
## ------------------------------------------------------------------------------
----------
##
## - depth
##
##
##   Step 5 : AIC = -15237.84
##   log_price ~ carat + clarity + color + cut + depth
##
## ------------------------------------------------------------------------------
----------
## Variable       DF          AIC          Sum Sq        RSS        R-Sq       Adj. R-S
q
```

```
## ------------------------------------------------------------------
----------
## table            1     -15259.062       0.456      274.749      0.905           0.905
## ------------------------------------------------------------------
----------
##
## - table
##
##
## Variables Entered:
##
## - carat
## - clarity
## - color
## - cut
## - depth
## - table
##
##
## Final Model Output
## ------------------
##
##                             Model Summary
## ----------------------------------------------------------------
## R                       0.952          RMSE                0.140
## R-Squared               0.905          Coef. Var           1.570
## Adj. R-Squared          0.905          MSE                 0.020
## Pred R-Squared          0.905          MAE                 0.104
## ----------------------------------------------------------------
##  RMSE: Root Mean Square Error
##  MSE: Mean Square Error
##  MAE: Mean Absolute Error
```

```
##
##                                    ANOVA

## ------------------------------------------------------------------
----------
##                    Sum of
##                   Squares             DF      Mean Square         F             Sig.

## ------------------------------------------------------------------
----------
## Regression       2631.884             20          131.594      6695.391      0.0000

## Residual          274.749          13979            0.020
## Total            2906.633          13999
## ------------------------------------------------------------------
----------
##
##                                 Parameter Estimates

## ------------------------------------------------------------------
--------------------------
##          model        Beta      Std. Error      Std. Beta         t            Sig        l
ower       upper
## ------------------------------------------------------------------
--------------------------
## (Intercept)        7.924            0.084                     94.628      0.000        7.
760        8.088
##          carat        1.163            0.003           0.941      337.443      0.000
1.156        1.170
##     clarity.L        1.000            0.008           0.492      130.267      0.000        0.
985        1.016
##     clarity.Q       −0.274            0.007          −0.143      −38.954      0.000       −
```

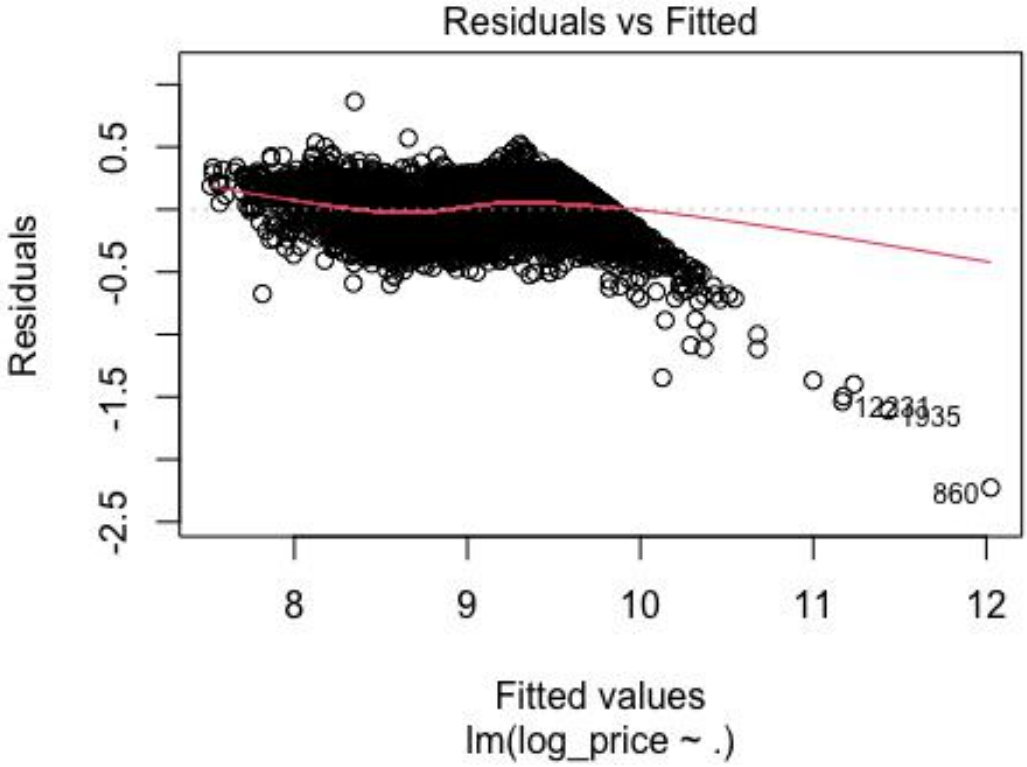
0.288 −0.260
clarity.C 0.135 0.006 0.081 20.963 0.000 0.
122 0.147
clarity^4 −0.070 0.006 −0.056 −12.065 0.000 −
0.082 −0.059
clarity^5 0.029 0.005 0.025 5.699 0.000
0.019 0.039
clarity^6 0.004 0.004 0.003 0.890 0.373 −
0.005 0.012
clarity^7 0.031 0.003 0.028 9.305 0.000
0.025 0.038
color.L −0.435 0.004 −0.306 −108.671 0.000
−0.442 −0.427
color.Q −0.107 0.004 −0.080 −29.430 0.000
−0.114 −0.100
color.C −0.014 0.003 −0.011 −4.005 0.000 −
0.021 −0.007
color^4 0.000 0.003 0.000 −0.068 0.946
−0.007 0.006
color^5 −0.014 0.003 −0.012 −4.414 0.000
−0.020 −0.008
color^6 0.003 0.003 0.003 0.968 0.333
−0.003 0.008
cut.L 0.129 0.005 0.099 25.375 0.000
0.119 0.139
cut.Q −0.042 0.004 −0.041 −10.237 0.000
−0.050 −0.034
cut.C 0.040 0.004 0.039 11.409 0.000
0.033 0.047
cut^4 0.019 0.003 0.019 6.379 0.000
0.013 0.025
depth −0.005 0.001 −0.017 −5.327 0.000

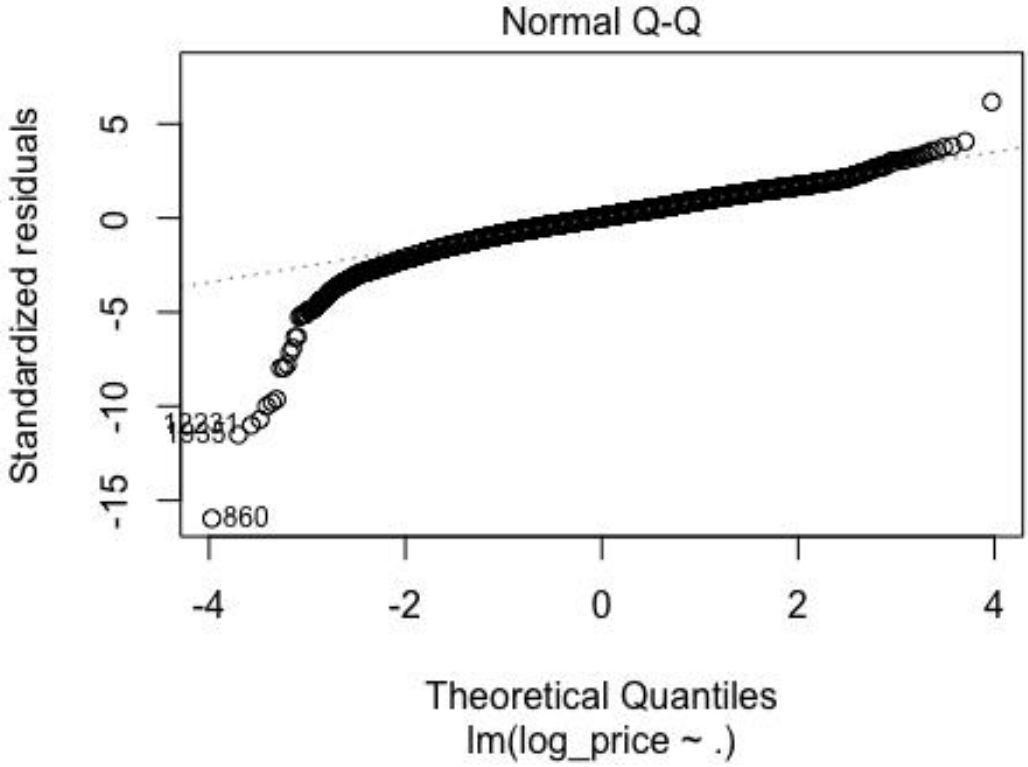
```
−0.007      −0.003
##          table      −0.003            0.001          −0.016         −4.817       0.000      −
0.005       −0.002
## ------------------------------------------------------------------
---------------------------
```

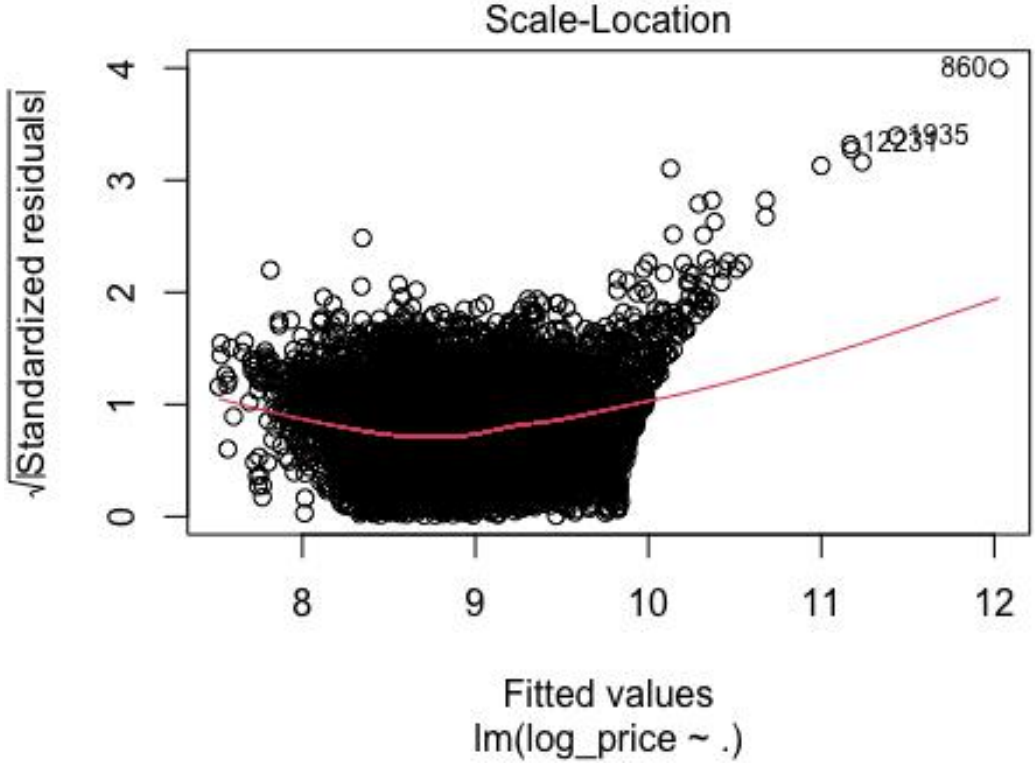
```
step_aic_forward_big
```

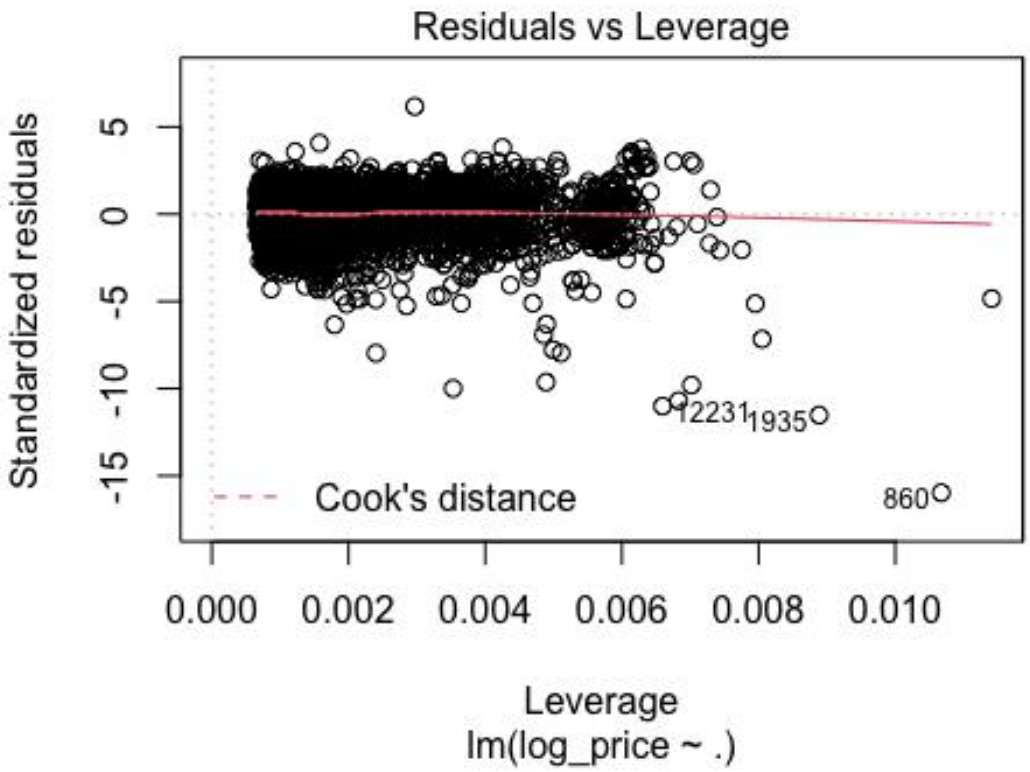
```
##
##                                  Selection  Summary
## ------------------------------------------------------------------
---------
## Variable           AIC            Sum  Sq          RSS           R−Sq         Adj.  R−Sq

## ------------------------------------------------------------------
---------
## carat               6183.549      1632.286      1274.347      0.56157         0.56154
## clarity           −5154.670       2340.224       566.409      0.80513         0.80502
## color             −13902.377      2603.666       302.967      0.89577         0.89566

## cut               −15225.943      2631.154       275.479      0.90522         0.90510
## depth             −15237.839      2631.428       275.206      0.90532         0.90519

## table             −15259.062      2631.884       274.749      0.90548         0.90534
## ------------------------------------------------------------------
---------
```

```
plot(step_fit_big)
```


Residuals vs Fitted
Residuals
0.5
-0.5
-1.5
-2.5
8
9
10
11
12
1935
860
Fitted values
lm(log_price ~ .)


Normal Q-Q
Standardized residuals
5
0
-5
-10
-15
12231
19350
860
-4
-2
0
2
4
Theoretical Quantiles
lm(log_price ~ .)


Scale-Location
√|Standardized residuals|
0
1
2
3
4
860
8
9
10
11
12
Fitted values
lm(log_price ~ .)




```
step_fit_small <- lm(log_price ~ ., data = train_small)
summary(step_fit_small)

##
## Call:
## lm(formula = log_price ~ ., data = train_small)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.5822 -0.1043  0.0027  0.1071  1.8747
##
## Coefficients:
##                    Estimate Std. Error  t value Pr(>|t|)
## (Intercept)   5.7117470  0.0640041   89.240  < 2e-16 ***
## carat         3.3967694  0.0044290  766.934  < 2e-16 ***
```

```
## cut.L          0.1368837   0.0041860    32.700   < 2e-16 ***
## cut.Q         -0.0147449   0.0033349    -4.421 9.84e-06 ***
## cut.C         -0.0014096   0.0028553    -0.494   0.62154
## cut^4         -0.0164039   0.0022328    -7.347 2.08e-13 ***
## color.L       -0.4298907   0.0034407  -124.944   < 2e-16 ***
## color.Q       -0.0737243   0.0032426   -22.736   < 2e-16 ***
## color.C       -0.0063807   0.0029537    -2.160   0.03076 *
## color^4        0.0189469   0.0026247     7.219 5.37e-13 ***
## color^5       -0.0011898   0.0024177    -0.492   0.62263
## color^6       -0.0029132   0.0021380    -1.363   0.17302
## clarity.L      0.8502866   0.0065522   129.770   < 2e-16 ***
## clarity.Q     -0.2455954   0.0062722   -39.156   < 2e-16 ***
## clarity.C      0.1342345   0.0052210    25.710   < 2e-16 ***
## clarity^4     -0.0531342   0.0039322   -13.512   < 2e-16 ***
## clarity^5      0.0194035   0.0029346     6.612 3.86e-11 ***
## clarity^6     -0.0074192   0.0023960    -3.097   0.00196 **
## clarity^7      0.0249569   0.0020940    11.918   < 2e-16 ***
## depth         -0.0045591   0.0007260    -6.280 3.44e-10 ***
## table         -0.0023908   0.0005248    -4.555 5.25e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1485 on 29127 degrees of freedom
## Multiple R-squared:  0.9553, Adjusted R-squared:  0.9552
## F-statistic: 3.109e+04 on 20 and 29127 DF,  p-value: < 2.2e-16

step_aic_forward_small <- ols_step_forward_aic(step_fit_small, details = TRUE)

## Forward Selection Method
## ------------------------
##
## Candidate Terms:
##
```

```
## 1 . carat
## 2 . cut
## 3 . color
## 4 . clarity
## 5 . depth
## 6 . table
##
##   Step 0: AIC = 62098.76
##   log_price ~ 1
##
## ----------------------------------------------------------------
--------------
## Variable       DF          AIC           Sum Sq            RSS          R-Sq       Adj.
 R-Sq
## ----------------------------------------------------------------
--------------
## carat           1       2806.402      12486.881       1878.708       0.869          0.
869
## table           1      61486.410        299.612      14065.977       0.021          0.0
21
## clarity         1      61519.851        289.261      14076.328       0.020          0.02
0
## cut             1      61592.049        251.447      14114.142       0.018          0.01
7
## color           1      61848.040        128.898      14236.691       0.009          0.0
09
## depth           1      62095.848          2.419      14363.170       0.000          0.
000
## ----------------------------------------------------------------
--------------
##
##
```

```
## - carat
##
##
##   Step 1 : AIC = 2806.402
##   log_price ~ carat
##
## ----------------------------------------------------------------
------------
## Variable       DF          AIC          Sum Sq          RSS          R-Sq       Adj. R
-Sq
## ----------------------------------------------------------------
------------
## clarity         1      -11740.969      738.720      1139.988      0.921          0.921
## color           1       -2380.702      306.918      1571.790      0.891          0.891

## cut             1         395.368      149.622      1729.086      0.880          0.88
0
## depth           1        2357.839       28.817      1849.891      0.871          0.871

## table           1        2407.119       25.687      1853.021      0.871          0.871
## ----------------------------------------------------------------
------------
##
## - clarity
##
##
##   Step 2 : AIC = -11740.97
##   log_price ~ carat + clarity
##
## ----------------------------------------------------------------
------------
## Variable       DF          AIC          Sum Sq          RSS          R-Sq       Adj. R
```

```
-Sq
## ----------------------------------------------------------------
------------
## color            1     -25645.929      432.787       707.201      0.951           0.95
1
## cut              1     -13635.129       72.019      1067.969      0.926           0.92
6
## depth            1     -12080.588       13.283      1126.705      0.922           0.92
2
## table            1     -11947.919        8.143      1131.845      0.921           0.921
## ----------------------------------------------------------------
------------
##
## - color
##
##
##   Step  3 : AIC = -25645.93
##   log_price ~ carat + clarity + color
##
## ----------------------------------------------------------------
----------
## Variable       DF          AIC          Sum Sq        RSS        R-Sq       Adj. R-S
q
## ----------------------------------------------------------------
----------
## cut              1     -28380.683       63.511      643.690      0.955           0.955

## table            1     -26028.048        9.259      697.942      0.951           0.951
## depth            1     -25876.598        5.623      701.578      0.951           0.951
## ----------------------------------------------------------------
----------
##
```

```
## - cut
##
##
##  Step 4 : AIC = -28380.68
##  log_price ~ carat + clarity + color + cut
##
## ----------------------------------------------------------------
----------
## Variable       DF          AIC          Sum Sq        RSS        R-Sq       Adj. R-S
q
## ----------------------------------------------------------------
----------
## depth           1      -28401.901       0.513      643.177      0.955          0.955
## table           1      -28383.219       0.100      643.590      0.955          0.955
## ----------------------------------------------------------------
----------
##
## - depth
##
##
##  Step 5 : AIC = -28401.9
##  log_price ~ carat + clarity + color + cut + depth
##
## ----------------------------------------------------------------
----------
## Variable       DF          AIC          Sum Sq        RSS        R-Sq       Adj. R-S
q
## ----------------------------------------------------------------
----------
## table           1      -28420.658       0.458      642.719      0.955          0.955
## ----------------------------------------------------------------
----------
```

```
##
## - table
##
##
## Variables Entered:
##
## - carat
## - clarity
## - color
## - cut
## - depth
## - table
##
##
## Final Model Output
## ------------------
##
##                             Model Summary
## ----------------------------------------------------------------
## R                       0.977       RMSE                 0.149
## R-Squared               0.955       Coef. Var            2.052
## Adj. R-Squared          0.955       MSE                  0.022
## Pred R-Squared          0.955       MAE                  0.120
## ----------------------------------------------------------------
##  RMSE: Root Mean Square Error
##  MSE: Mean Square Error
##  MAE: Mean Absolute Error
##
##                                    ANOVA

## ----------------------------------------------------------------
-------------
```

```
##                     Sum of
##                    Squares                DF       Mean Square           F              Si
g.
## ------------------------------------------------------------------------
-------------
## Regression      13722.870                20           686.144      31094.906       0.00
00
## Residual          642.719             29127             0.022
## Total           14365.590             29147
## ------------------------------------------------------------------------
-------------
##
##                                        Parameter Estimates
## ------------------------------------------------------------------------
--------------------------
##          model         Beta      Std. Error      Std. Beta          t             Sig        l
ower       upper
## ------------------------------------------------------------------------
--------------------------
## (Intercept)        5.712              0.064                     89.240       0.000        5.
586        5.837
##          carat        3.397              0.004            1.056        766.934       0.000
 3.388        3.405
##     clarity.L         0.850              0.007            0.310        129.770       0.000        0.
837        0.863
##     clarity.Q        −0.246              0.006           −0.084        −39.156       0.000       −
0.258       −0.233
##     clarity.C         0.134              0.005            0.060         25.710       0.000        0.
```

```
124        0.144
##     clarity^4      −0.053        0.004      −0.026      −13.512      0.000      −
0.061      −0.045
##     clarity^5       0.019        0.003       0.010        6.612      0.000       0.
014        0.025
##     clarity^6      −0.007        0.002      −0.004       −3.097      0.002      −
0.012      −0.003
##     clarity^7       0.025        0.002       0.015       11.918      0.000       0.
021        0.029
##       color.L      −0.430        0.003      −0.188      −124.944      0.000
−0.437      −0.423
##       color.Q      −0.074        0.003      −0.036      −22.736      0.000
−0.080      −0.067
##       color.C      −0.006        0.003      −0.003       −2.160      0.031
−0.012      −0.001
##       color^4       0.019        0.003       0.011        7.219      0.000       0.
014        0.024
##       color^5      −0.001        0.002      −0.001       −0.492      0.623
−0.006        0.004
##       color^6      −0.003        0.002      −0.002       −1.363      0.173
−0.007        0.001
##         cut.L       0.137        0.004       0.069       32.700      0.000
0.129        0.145
##         cut.Q      −0.015        0.003      −0.010       −4.421      0.000
−0.021      −0.008
##         cut.C      −0.001        0.003      −0.001       −0.494      0.622
−0.007        0.004
##         cut^4      −0.016        0.002      −0.010       −7.347      0.000
−0.021      −0.012
##         depth      −0.005        0.001      −0.009       −6.280      0.000
 −0.006      −0.003
##         table      −0.002        0.001      −0.008       −4.555      0.000
```

```
-0.003      -0.001
## ----------------------------------------------------------------
----------------------------

step_aic_forward_small

##
##                                Selection  Summary
## ----------------------------------------------------------------
----------
## Variable          AIC           Sum  Sq          RSS          R-Sq        Adj.  R-S
q
## ----------------------------------------------------------------
----------
## carat             2806.402      12486.881     1878.708     0.86922        0.86922

## clarity         -11740.969      13225.601     1139.988     0.92064        0.92062
## color           -25645.929      13658.389      707.201     0.95077        0.95075

## cut             -28380.683      13721.900      643.690     0.95519        0.95516

## depth           -28401.901      13722.412      643.177     0.95523        0.95520

## table           -28420.658      13722.870      642.719     0.95526        0.95523

## ----------------------------------------------------------------
----------

#plot(step_fit_small)



## poly
train_big2 <- train_big %>%
```

```
  mutate(carat2 = carat^2)
step_fit_big2 <- lm(log_price ~., data = train_big2)
summary(step_fit_big2)

##
## Call:
## lm(formula = log_price ~ ., data = train_big2)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.87009 -0.06691  0.01009  0.07993  1.11537
##
## Coefficients:
##                Estimate Std. Error  t value Pr(>|t|)
## (Intercept)   7.2274477  0.0749728   96.401  < 2e-16 ***
## carat         2.1234537  0.0157573  134.760  < 2e-16 ***
## cut.L         0.1207724  0.0044962   26.861  < 2e-16 ***
## cut.Q        -0.0371858  0.0036301  -10.244  < 2e-16 ***
## cut.C         0.0372040  0.0031210   11.920  < 2e-16 ***
## cut^4         0.0208147  0.0026214    7.940 2.17e-15 ***
## color.L      -0.4410264  0.0035413 -124.537  < 2e-16 ***
## color.Q      -0.1022921  0.0032113  -31.853  < 2e-16 ***
## color.C      -0.0085437  0.0030741   -2.779  0.00546 **
## color^4       0.0034021  0.0029158    1.167  0.24332
## color^5      -0.0147890  0.0027209   -5.435 5.56e-08 ***
## color^6       0.0023220  0.0024697    0.940  0.34714
## clarity.L     0.9739634  0.0068122  142.973  < 2e-16 ***
## clarity.Q    -0.2402646  0.0062508  -38.437  < 2e-16 ***
## clarity.C     0.1200892  0.0056957   21.084  < 2e-16 ***
## clarity^4    -0.0631633  0.0051529  -12.258  < 2e-16 ***
## clarity^5     0.0254949  0.0045115    5.651 1.63e-08 ***
## clarity^6     0.0082616  0.0037738    2.189  0.02860 *
```

```
## clarity^7      0.0326594   0.0029772    10.970   < 2e-16 ***
## depth         -0.0047981   0.0008240    -5.823 5.92e-09 ***
## table         -0.0037498   0.0006334    -5.920 3.30e-09 ***
## carat2        -0.2988801   0.0048106   -62.129   < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1241 on 13978 degrees of freedom
## Multiple R-squared:  0.9259, Adjusted R-squared:  0.9258
## F-statistic:  8321 on 21 and 13978 DF,  p-value: < 2.2e-16

step_aic_forward_big2 <- ols_step_forward_aic(step_fit_big2, details = TRUE)

## Forward Selection Method
## ------------------------
##
## Candidate Terms:
##
## 1 . carat
## 2 . cut
## 3 . color
## 4 . clarity
## 5 . depth
## 6 . table
## 7 . carat2
##
##  Step 0: AIC = 17725.41
##  log_price ~ 1
##
## ----------------------------------------------------------------
------------
## Variable       DF          AIC          Sum Sq          RSS          R-Sq       Adj. R
-Sq
```

```
## ------------------------------------------------------------------
------------
## carat             1       6183.549      1632.286      1274.347      0.562           0.56
2
## carat2            1       8220.869      1432.667      1473.966      0.493           0.49
3
## clarity           1      15835.046       369.666      2536.967      0.127           0.127

## cut               1      17545.417        38.770      2867.863      0.013           0.013

## color             1      17648.530        18.395      2888.238      0.006           0.00
6
## depth             1      17669.695        11.958      2894.675      0.004           0.00
4
## table             1      17715.198         2.535      2904.098      0.001           0.001

## ------------------------------------------------------------------
------------
##
##
## - carat
##
##
##   Step 1 : AIC = 6183.549
##   log_price ~ carat
##
## ------------------------------------------------------------------
-----------
## Variable       DF          AIC          Sum Sq          RSS          R-Sq       Adj. R-
Sq
## ------------------------------------------------------------------
-----------
```

```
## clarity          1     -5154.670      707.938       566.409      0.805          0.805
## color            1      3250.099      241.783      1032.563      0.645          0.645

## carat2           1      4989.790      104.325      1170.022      0.597          0.597

## cut              1      5044.739      100.227      1174.120      0.596          0.596
## table            1      5914.133       24.468      1249.879      0.570          0.570
## depth            1      5982.837       18.319      1256.028      0.568          0.568

## ----------------------------------------------------------------
----------
##
## - clarity
##
##
##   Step  2 : AIC = -5154.67
##   log_price ~ carat + clarity
##
## ----------------------------------------------------------------
----------
## Variable       DF          AIC          Sum Sq          RSS        R-Sq       Adj. R-
Sq
## ----------------------------------------------------------------
----------
## color            1     -13902.377      263.442       302.967      0.896          0.89
6
## carat2           1      -6557.088       54.063       512.346      0.824          0.82
4
## cut              1      -5760.462       24.296       542.113      0.813          0.813
## table            1      -5295.872        5.764       560.645      0.807          0.807

## depth            1      -5277.699        5.036       561.373      0.807          0.807
```

```
## ----------------------------------------------------------------
----------
##
## - color
##
##
##  Step 3 : AIC = -13902.38
##  log_price ~ carat + clarity + color
##
## ----------------------------------------------------------------
---------
## Variable       DF          AIC          Sum Sq        RSS        R-Sq       Adj. R-S
q
## ----------------------------------------------------------------
---------
## carat2          1      -17069.271      61.369      241.598      0.917          0.917
## cut             1      -15225.943      27.488      275.479      0.905          0.905

## table           1      -14174.949       5.884      297.083      0.898          0.898
## depth           1      -14044.914       3.112      299.855      0.897          0.897
## ----------------------------------------------------------------
---------
##
## - carat2
##
##
##  Step 4 : AIC = -17069.27
##  log_price ~ carat + clarity + color + carat2
##
## ----------------------------------------------------------------
---------
```

```
## Variable       DF         AIC          Sum Sq        RSS        R-Sq       Adj. R-S
q
## ----------------------------------------------------------------
----------
## cut             1     -18625.526      25.541      216.057      0.926          0.926
## table           1     -17424.506       6.087      235.511      0.919          0.919
## depth           1     -17218.764       2.600      238.997      0.918          0.918
## ----------------------------------------------------------------
----------
##
## - cut
##
##
##   Step 5 : AIC = -18625.53
##   log_price ~ carat + clarity + color + carat2 + cut
##
## ----------------------------------------------------------------
----------
## Variable       DF         AIC          Sum Sq        RSS        R-Sq       Adj. R-S
q
## ----------------------------------------------------------------
----------
## table           1     -18639.054       0.240      215.817      0.926          0.926
## depth           1     -18637.914       0.222      215.835      0.926          0.926
## ----------------------------------------------------------------
----------
##
## - table
##
##
##   Step 6 : AIC = -18639.05
##   log_price ~ carat + clarity + color + carat2 + cut + table
```

```
##
## ----------------------------------------------------------------
----------
## Variable       DF          AIC          Sum Sq        RSS        R-Sq       Adj. R-S
q
## ----------------------------------------------------------------
----------
## depth           1      -18670.969       0.522      215.295      0.926           0.926

## ----------------------------------------------------------------
----------
##
## - depth
##
##
## Variables Entered:
##
## - carat
## - clarity
## - color
## - carat2
## - cut
## - table
## - depth
##
##
## Final Model Output
## ------------------
##
##                             Model Summary
## ----------------------------------------------------------------
## R                          0.962          RMSE                 0.124
```

```
## R-Squared                0.926          Coef. Var              1.390
## Adj. R-Squared           0.926          MSE                    0.015
## Pred R-Squared           0.925          MAE                    0.094
## ----------------------------------------------------------------
##  RMSE: Root Mean Square Error
##  MSE: Mean Square Error
##  MAE: Mean Absolute Error
##
##                                    ANOVA

## ----------------------------------------------------------------
----------
##                  Sum of
##                 Squares            DF      Mean Square         F             Sig.

## ----------------------------------------------------------------
----------
## Regression      2691.338            21          128.159      8320.704      0.0000
## Residual         215.295         13978            0.015
## Total           2906.633         13999
## ----------------------------------------------------------------
----------
##
##                                  Parameter Estimates

## ----------------------------------------------------------------
----------
##         model        Beta      Std. Error      Std. Beta         t            Sig        l
ower       upper
## ----------------------------------------------------------------
----------
## (Intercept)       7.227            0.075                      96.401      0.000        7.
```

```
080        7.374
##           carat        2.123              0.016            1.719        134.760       0.000        2.
093        2.154
##      clarity.L        0.974              0.007            0.479        142.973       0.000        0.
961        0.987
##      clarity.Q       −0.240              0.006           −0.125        −38.437       0.000       −
0.253       −0.228
##      clarity.C        0.120              0.006            0.072         21.084       0.000        0.
109        0.131
##      clarity^4       −0.063              0.005           −0.050        −12.258       0.000       −
0.073       −0.053
##      clarity^5        0.025              0.005            0.022          5.651       0.000
0.017        0.034
##      clarity^6        0.008              0.004            0.007          2.189       0.029
0.001        0.016
##      clarity^7        0.033              0.003            0.029         10.970       0.000
0.027        0.038
##         color.L       −0.441              0.004           −0.311       −124.537       0.000       −
0.448       −0.434
##         color.Q       −0.102              0.003           −0.076        −31.853       0.000
−0.109       −0.096
##         color.C       −0.009              0.003           −0.007         −2.779       0.005
−0.015       −0.003
##         color^4        0.003              0.003            0.003          1.167       0.243       −
0.002        0.009
##         color^5       −0.015              0.003           −0.013         −5.435       0.000
−0.020       −0.009
##         color^6        0.002              0.002            0.002          0.940       0.347
−0.003        0.007
##          carat2       −0.299              0.005           −0.792        −62.129       0.000
−0.308       −0.289
##           cut.L        0.121              0.004            0.092         26.861       0.000
```

```
0.112        0.130
##          cut.Q      −0.037            0.004          −0.036       −10.244      0.000
−0.044      −0.030
##          cut.C       0.037            0.003           0.036        11.920      0.000
0.031       0.043
##          cut^4       0.021            0.003           0.021         7.940      0.000
0.016       0.026
##          table      −0.004            0.001          −0.018        −5.920      0.000
−0.005      −0.003
##          depth      −0.005            0.001          −0.016        −5.823      0.000
−0.006      −0.003
## ----------------------------------------------------------------
----------------------------

step_aic_forward_big2

##
##                                Selection Summary
## ----------------------------------------------------------------
---------
## Variable          AIC          Sum Sq         RSS          R−Sq        Adj. R−Sq

## ----------------------------------------------------------------
---------
## carat             6183.549     1632.286     1274.347     0.56157        0.56154
## clarity          −5154.670     2340.224      566.409     0.80513        0.80502
## color           −13902.377     2603.666      302.967     0.89577        0.89566

## carat2          −17069.271     2665.036      241.598     0.91688        0.91679
## cut             −18625.526     2690.576      216.057     0.92567        0.92557

## table           −18639.054     2690.816      215.817     0.92575        0.92564
## depth           −18670.969     2691.338      215.295     0.92593        0.92582
```

```
## ------------------------------------------------------------------
---------

#plot(step_fit_big2)



train_small2 <- train_small %>%
  mutate(carat2 = carat^2)
step_fit_small2 <- lm(log_price ~., data = train_small2)
summary(step_fit_small2)

##
## Call:
## lm(formula = log_price ~ ., data = train_small2)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.45391 -0.08532 -0.00768  0.08079  1.88748
##
## Coefficients:
##                   Estimate Std. Error   t value Pr(>|t|)
## (Intercept)  4.8241382  0.0539876    89.356  < 2e-16 ***
## carat        5.7169458  0.0209159   273.330  < 2e-16 ***
## cut.L        0.1199624  0.0034964    34.310  < 2e-16 ***
## cut.Q       -0.0207264  0.0027834    -7.447 9.85e-14 ***
## cut.C       -0.0045085  0.0023828    -1.892 0.058487 .
## cut^4       -0.0194080  0.0018634   -10.415  < 2e-16 ***
## color.L     -0.4289012  0.0028712  -149.382  < 2e-16 ***
## color.Q     -0.0788961  0.0027063   -29.153  < 2e-16 ***
## color.C     -0.0119554  0.0024653    -4.849 1.24e-06 ***
## color^4      0.0169333  0.0021903     7.731 1.10e-14 ***
## color^5      0.0041748  0.0020180     2.069 0.038579 *
```

```
## color^6         0.0016346   0.0017845      0.916  0.359681
## clarity.L       0.8636184   0.0054690    157.912   < 2e-16 ***
## clarity.Q      -0.2188624   0.0052394    -41.773   < 2e-16 ***
## clarity.C       0.1240468   0.0043578     28.466   < 2e-16 ***
## clarity^4      -0.0559136   0.0032815    -17.039   < 2e-16 ***
## clarity^5       0.0206619   0.0024489      8.437   < 2e-16 ***
## clarity^6      -0.0069235   0.0019994     -3.463  0.000535 ***
## clarity^7       0.0306306   0.0017481     17.522   < 2e-16 ***
## depth          -0.0011795   0.0006066     -1.945  0.051826 .
## table          -0.0007158   0.0004382     -1.633  0.102388
## carat2         -1.9334738   0.0171556   -112.702   < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.124 on 29126 degrees of freedom
## Multiple R-squared:  0.9688, Adjusted R-squared:  0.9688
## F-statistic: 4.313e+04 on 21 and 29126 DF,  p-value: < 2.2e-16
```

```
step_aic_forward_small2 <- ols_step_forward_aic(step_fit_small2, details = TRUE)
```

```
## Forward Selection Method
## ------------------------
##
## Candidate Terms:
##
## 1 . carat
## 2 . cut
## 3 . color
## 4 . clarity
## 5 . depth
## 6 . table
## 7 . carat2
##
```

```
##   Step 0: AIC = 62098.76
##   log_price ~ 1
##
## ----------------------------------------------------------------
--------------
## Variable       DF          AIC          Sum Sq            RSS          R-Sq       Adj.
 R-Sq
## ----------------------------------------------------------------
--------------
## carat           1       2806.402      12486.881       1878.708      0.869           0.
869
## carat2          1      13425.587      11661.125       2704.465      0.812           0.8
12
## table           1      61486.410        299.612      14065.977      0.021           0.0
21
## clarity         1      61519.851        289.261      14076.328      0.020           0.02
0
## cut             1      61592.049        251.447      14114.142      0.018           0.01
7
## color           1      61848.040        128.898      14236.691      0.009           0.0
09
## depth           1      62095.848          2.419      14363.170      0.000           0.
000
## ----------------------------------------------------------------
--------------
##
##
## - carat
##
##
##   Step 1 : AIC = 2806.402
##   log_price ~ carat
```

```
##
## ----------------------------------------------------------------
------------
## Variable       DF         AIC          Sum Sq         RSS         R-Sq       Adj. R
-Sq
## ----------------------------------------------------------------
------------
## clarity         1     -11740.969      738.720      1139.988      0.921           0.921
## color           1      -2380.702      306.918      1571.790      0.891           0.891

## carat2          1       -469.296      199.816      1678.892      0.883           0.88
3
## cut             1        395.368      149.622      1729.086      0.880           0.88
0
## depth           1       2357.839       28.817      1849.891      0.871           0.871

## table           1       2407.119       25.687      1853.021      0.871           0.871
## ----------------------------------------------------------------
------------
##
## - clarity
##
##
##   Step 2 : AIC = -11740.97
##   log_price ~ carat + clarity
##
## ----------------------------------------------------------------
------------
## Variable       DF         AIC          Sum Sq         RSS         R-Sq       Adj. R
-Sq
## ----------------------------------------------------------------
------------
```

```
## color            1     -25645.929     432.787      707.201     0.951          0.95
1
## carat2           1     -18339.626     231.011      908.977     0.937          0.93
7
## cut              1     -13635.129      72.019     1067.969     0.926          0.92
6
## depth            1     -12080.588      13.283     1126.705     0.922          0.92
2
## table            1     -11947.919       8.143     1131.845     0.921          0.921
## ------------------------------------------------------------------------
------------
##
## - color
##
##
##   Step  3 : AIC = -25645.93
##   log_price ~ carat + clarity + color
##
## ------------------------------------------------------------------------
-----------
## Variable       DF          AIC          Sum Sq          RSS         R-Sq       Adj. R-
Sq
## ------------------------------------------------------------------------
-----------
## carat2           1     -36422.115     218.603      488.598     0.966          0.966

## cut              1     -28380.683      63.511      643.690     0.955          0.95
5
## table            1     -26028.048       9.259      697.942     0.951          0.951

## depth            1     -25876.598       5.623      701.578     0.951          0.951
```

```
## ----------------------------------------------------------------
----------
##
## - carat2
##
##
##   Step 4 : AIC = -36422.11
##   log_price ~ carat + clarity + color + carat2
##
## ----------------------------------------------------------------
----------
## Variable       DF          AIC          Sum Sq        RSS        R-Sq       Adj. R-S
q
## ----------------------------------------------------------------
----------
## cut              1      -38967.563      40.981      447.617      0.969          0.969
## table            1      -36635.163       3.592      485.007      0.966          0.966
## depth            1      -36582.520       2.715      485.883      0.966          0.966

## ----------------------------------------------------------------
----------
##
## - cut
##
##
##   Step 5 : AIC = -38967.56
##   log_price ~ carat + clarity + color + carat2 + cut
##
## ----------------------------------------------------------------
----------
## Variable       DF          AIC          Sum Sq        RSS        R-Sq       Adj. R-S
q
```

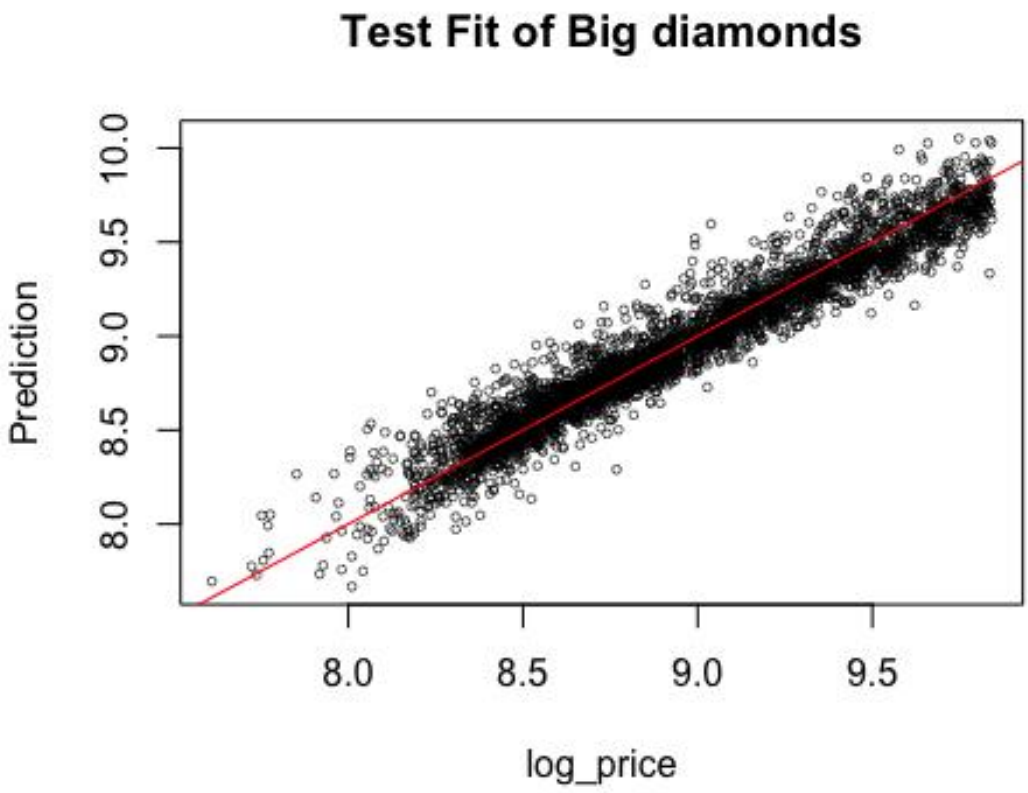
```
## ----------------------------------------------------------------
----------
## depth            1      -38967.494       0.030      447.587      0.969           0.969

## table            1      -38966.380       0.013      447.604      0.969           0.969
## ----------------------------------------------------------------
----------
##
##
## No more variables to be added.
##
## Variables Entered:
##
## - carat
## - clarity
## - color
## - carat2
## - cut
##
##
## Final Model Output
## ------------------
##
##                             Model Summary
## ----------------------------------------------------------------
## R                       0.984          RMSE                 0.124
## R-Squared               0.969          Coef. Var            1.713
## Adj. R-Squared          0.969          MSE                  0.015
## Pred R-Squared          0.969          MAE                  0.098
## ----------------------------------------------------------------
##  RMSE: Root Mean Square Error
##  MSE: Mean Square Error
```

```
##   MAE: Mean Absolute Error
##
##                                        ANOVA

## ------------------------------------------------------------------
-------------
##                      Sum of

##                      Squares              DF      Mean Square           F              Si
g.
## ------------------------------------------------------------------
-------------
## Regression      13917.973              19           732.525      47667.984      0.00
00
## Residual          447.617           29128             0.015

## Total           14365.590           29147

## ------------------------------------------------------------------
-------------
##
##                                        Parameter Estimates

## ------------------------------------------------------------------
---------------------------
##          model        Beta      Std. Error      Std. Beta          t             Sig        l
ower       upper
## ------------------------------------------------------------------
---------------------------
## (Intercept)       4.709             0.006                    812.191      0.000       4.
698       4.720
```

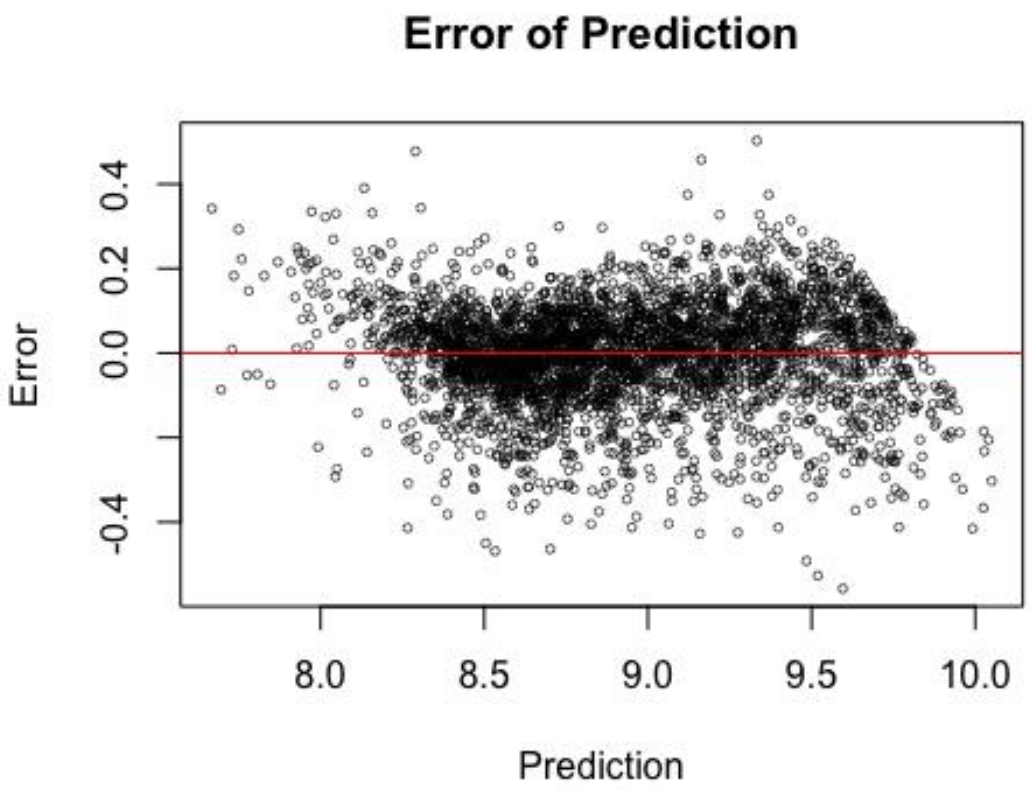
```
##            carat       5.719          0.021          1.778       273.638       0.000
5.678       5.760
##      clarity.L       0.864          0.005          0.315       158.239       0.000       0.
853       0.875
##      clarity.Q      −0.219          0.005         −0.075       −41.791       0.000      −
0.229      −0.209
##      clarity.C       0.124          0.004          0.055        28.531       0.000       0.
116       0.133
##      clarity^4      −0.056          0.003         −0.027       −17.068       0.000      −
0.062      −0.050
##      clarity^5       0.021          0.002          0.011         8.522       0.000       0.
016       0.026
##      clarity^6      −0.007          0.002         −0.004        −3.505       0.000
−0.011      −0.003
##      clarity^7       0.031          0.002          0.019        17.535       0.000       0.
027       0.034
##        color.L      −0.429          0.003         −0.188      −149.594       0.000
−0.435      −0.423
##        color.Q      −0.079          0.003         −0.039       −29.181       0.000
−0.084      −0.074
##        color.C      −0.012          0.002         −0.006        −4.840       0.000
−0.017      −0.007
##        color^4       0.017          0.002          0.009         7.745       0.000
0.013       0.021
##        color^5       0.004          0.002          0.002         2.042       0.041
0.000       0.008
##        color^6       0.002          0.002          0.001         0.929       0.353
−0.002       0.005
##         carat2      −1.935          0.017         −0.733      −112.957       0.000      −
1.969      −1.902
##           cut.L       0.123          0.003          0.062        38.999       0.000
0.117       0.129
```

```
##          cut.Q      -0.021           0.003         -0.014        -7.795       0.000
-0.027      -0.016
##          cut.C      -0.004           0.002         -0.002        -1.613       0.107      -
0.008       0.001
##          cut^4      -0.019           0.002         -0.012       -10.396       0.000
-0.023      -0.015
## ---------------------------------------------------------------------------
-----------------------------

step_aic_forward_small2

##
##                                  Selection  Summary
## ---------------------------------------------------------------------------
----------
## Variable           AIC            Sum  Sq          RSS          R-Sq        Adj.  R-S
q
## ---------------------------------------------------------------------------
----------
## carat              2806.402      12486.881     1878.708      0.86922         0.86922

## clarity         -11740.969      13225.601     1139.988      0.92064         0.92062
## color           -25645.929      13658.389      707.201      0.95077         0.95075

## carat2          -36422.115      13876.991      488.598      0.96599         0.96597

## cut             -38967.563      13917.973      447.617      0.96884         0.96882

## ---------------------------------------------------------------------------
----------

#plot(step_fit_small2)
```

```r
## use test dataset to predict
test_small2 <- test_small %>%
  mutate(carat2 = carat^2)
test_big2 <- test_big %>%
  mutate(carat2 = carat^2)

prediction_test_big <- predict(step_fit_big2, newdata = test_big2)
error_test_big <- test_big2$log_price - prediction_test_big
plot(x = test_big2$log_price, y = prediction_test_big,
     main = "Test Fit of Big diamonds",
     lwd = 0.5,
     type = "p",
     cex = 0.5,
     xlab = "log_price",
     ylab = "Prediction")
abline(a=0, b = 1,col = "red")
```




```
plot(x = prediction_test_big, y = error_test_big,
     main = "Error of Prediction",
     lwd = 0.5,
     type = "p",
     cex = 0.5,
     xlab = "Prediction",
     ylab = "Error")
abline(h = 0,col = "red")
```




```
ssto_big = sum((test_big2$log_price - mean(test_big2$log_price))^2)
ssto_big
```

```
## [1] 717.7368
```

```
sse_big = sum(error_test_big^2)
sse_big
```

```
## [1] 51.04277
```

```
ssp_big = sum((prediction_test_big - mean(test_big2$log_price))^2)
ssp_big
```

```
## [1] 672.8299
```

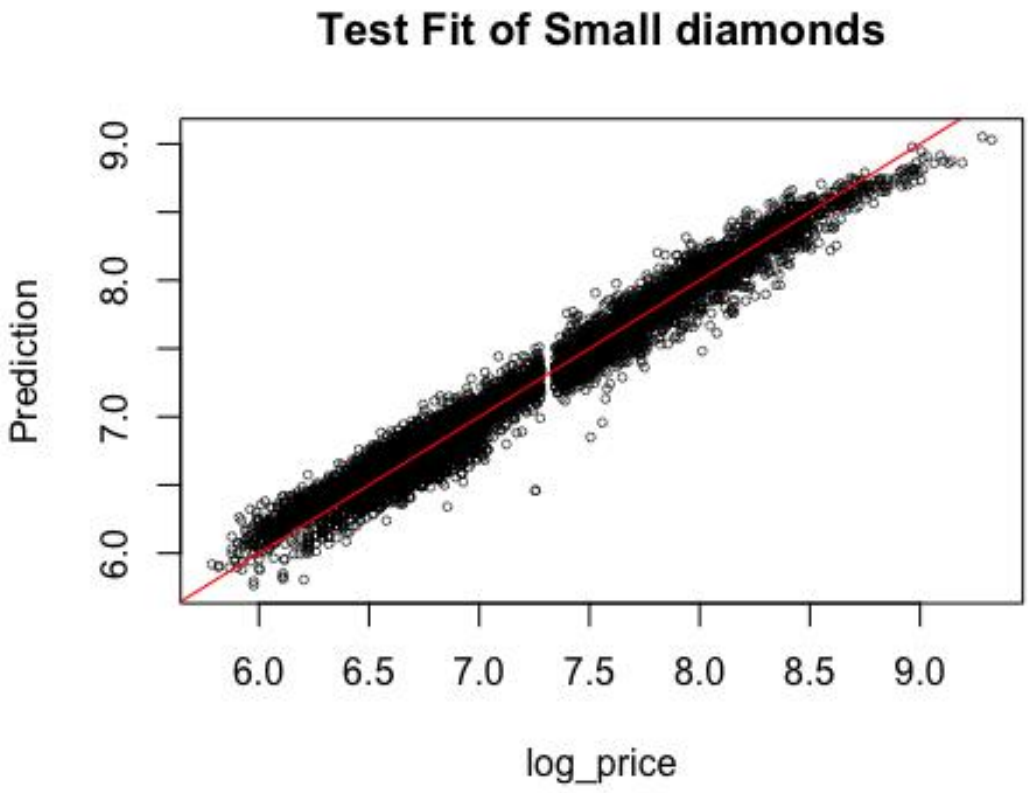
```
ssp_big+sse_big
```

```
## [1] 723.8726
```

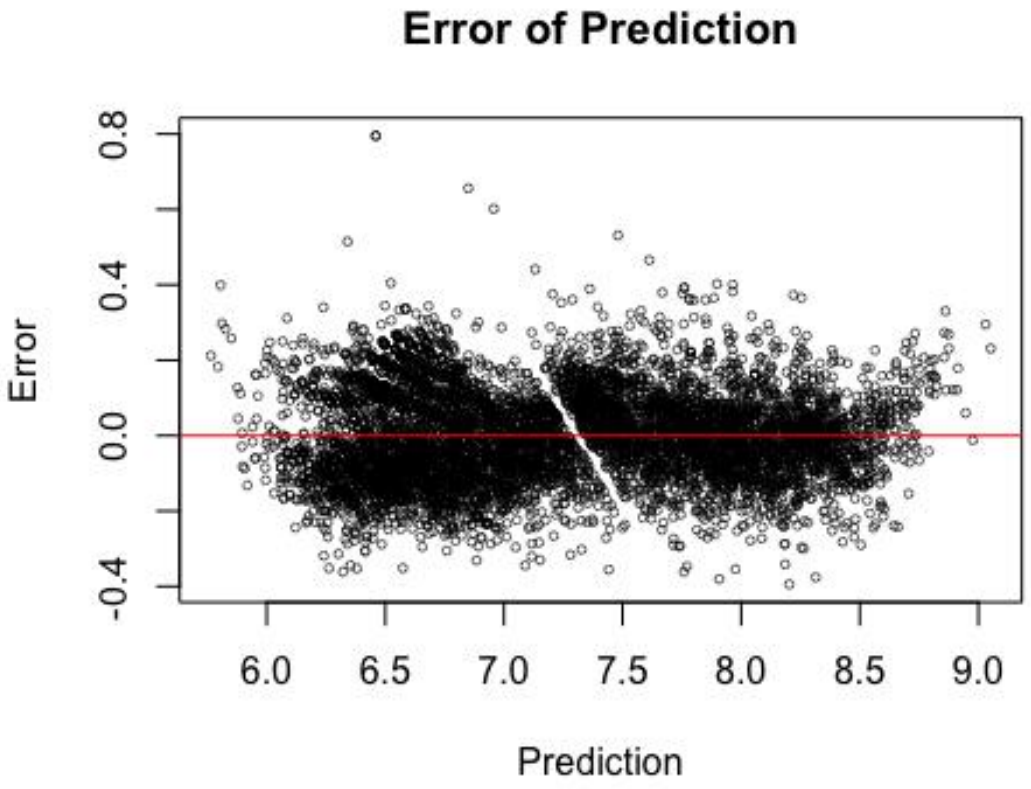
```
ssp_big/ssto_big
```

```
## [1] 0.9374325
```

```
prediction_test_small <- predict(step_fit_small2, newdata = test_small2)
error_test_small <- test_small2$log_price - prediction_test_small
plot(x = test_small2$log_price, y = prediction_test_small,
     main = "Test Fit of Small diamonds",
     lwd = 0.5,
     type = "p",
     cex = 0.5,
     xlab = "log_price",
     ylab = "Prediction")
abline(a=0, b = 1,col = "red")
```



```
plot(x = prediction_test_small, y = error_test_small,
     main = "Error of Prediction",
     lwd = 0.5,
     type = "p",
     cex = 0.5,
     xlab = "Prediction",
     ylab = "Error")
abline(h = 0,col = "red")
```




```
ssto_small = sum((test_small2$log_price - mean(test_small2$log_price))^2)
ssto_small
```

```
## [1] 3611.437
```

```
sse_small = sum(error_test_small^2)
sse_small
```

```
## [1] 107.4503
```

```
ssp_small = sum((prediction_test_small - mean(test_small2$log_price))^2)
ssp_small
```

```
## [1] 3480.672
```

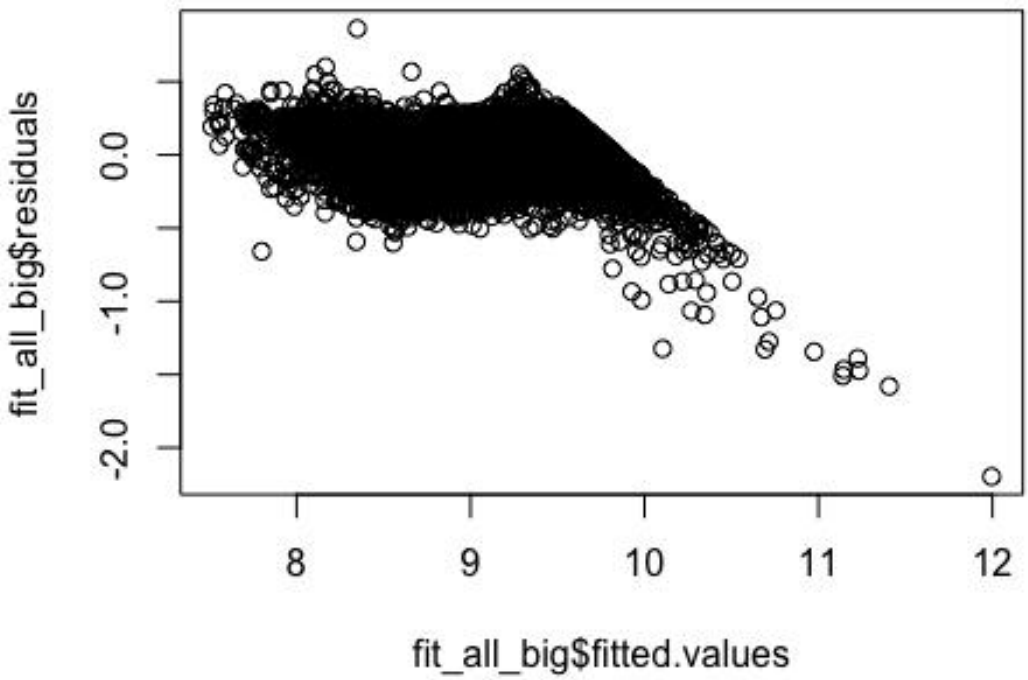
```
ssp_small+sse_small
```

```
## [1] 3588.123
```

```
ssp_small/ssto_small
```

```
## [1] 0.9637915
```

```
## need to assign a best model from above analysis
best_fit_big <- fit_all_big  ### 【need to choose】
best_fit_small <- fit_all_small


## residuals
plot(fit_all_big$fitted.values, fit_all_big$residuals)
```


fit_all_big$residuals
0.0
-1.0
-2.0
8
9
10
11
12
fit_all_big$fitted.values