sp23_Assignment_3

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```
library(tidyverse)
```

```
## Warning: package 'tidyverse' was built under R version 4.1.3

## -- Attaching packages --------------------------------------- tidyverse 1.3.2 --
## v ggplot2 3.4.0     v purrr   1.0.1
## v tibble  3.1.8     v dplyr   1.1.0
## v tidyr   1.3.0     v stringr 1.5.0
## v readr   2.1.4     v forcats 1.0.0

## Warning: package 'ggplot2' was built under R version 4.1.3

## Warning: package 'tibble' was built under R version 4.1.3

## Warning: package 'tidyr' was built under R version 4.1.3

## Warning: package 'readr' was built under R version 4.1.3

## Warning: package 'purrr' was built under R version 4.1.3

## Warning: package 'dplyr' was built under R version 4.1.3

## Warning: package 'stringr' was built under R version 4.1.3

## Warning: package 'forcats' was built under R version 4.1.3

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

Question 1

```
oneway.test(price ~ cut,
            data = diamonds)
```

```
##
##  One-way analysis of means (not assuming equal variances)
##
## data:  price and cut
## F = 166.04, num df = 4.0, denom df = 9398.6, p-value < 2.2e-16
```

```
#' The p-value of < 2.2e-16 is significant (< 0.05 or lower), thus there is no evidence to confirm the
```

Question 2

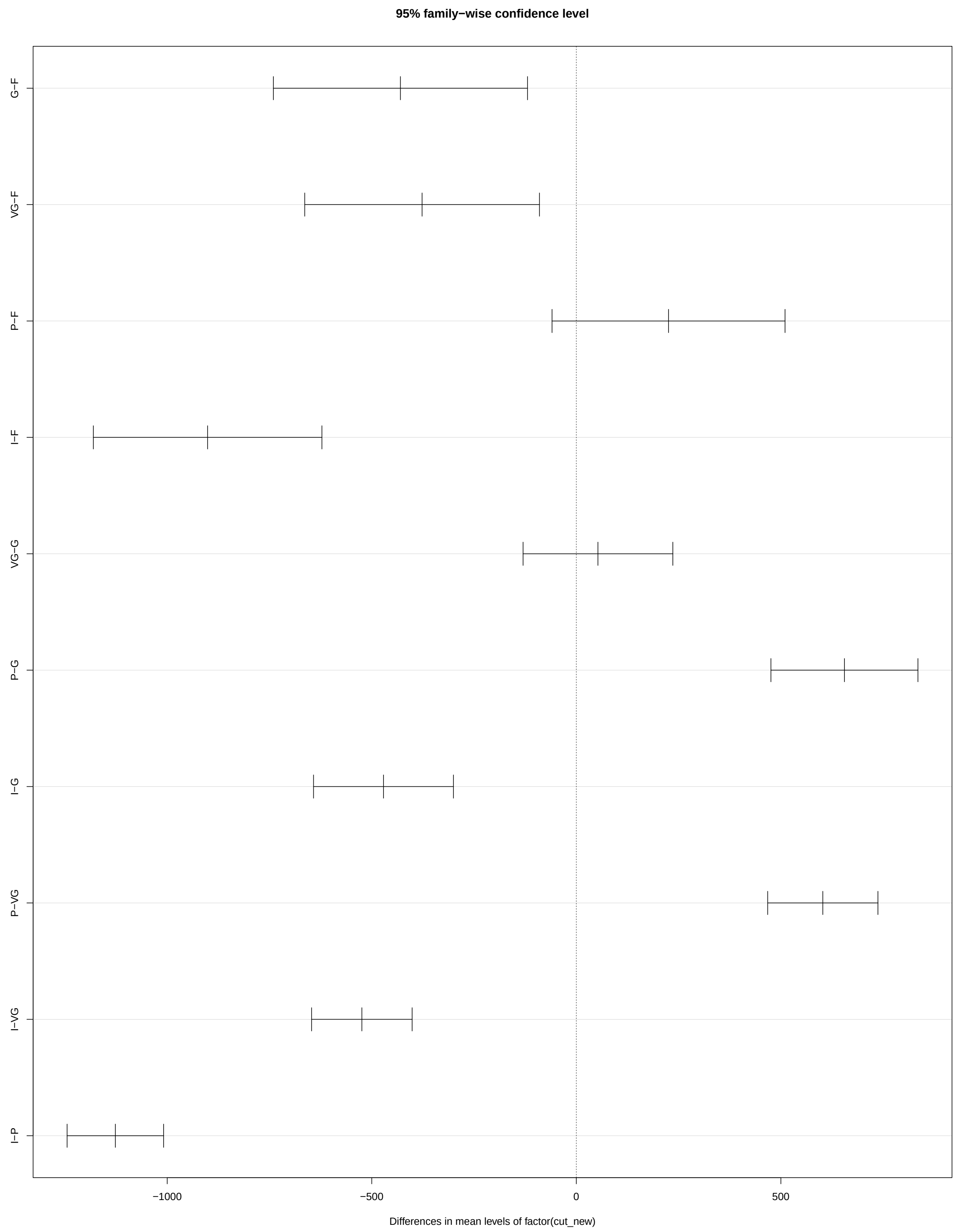
```
oneway.test(price ~ cut,
            var.equal = TRUE,
            data = diamonds)
```

```
##
##  One-way analysis of means
##
## data:  price and cut
## F = 175.69, num df = 4, denom df = 53935, p-value < 2.2e-16
```

```
#' The p-value of < 2.2e-16 is the same and significant (< 0.05 or lower),
#' thus there is no evidence to confirm the null hypothesis, so we reject
#' the null hypothesis (Ha). There is a statistically significant difference between the means of the g
```

Question 3

```
diamonds$cut_new <- factor(diamonds$cut, labels = c("F", "G", "VG", "P", "I"))
anova_model <- aov(price ~ factor(cut_new),
                   data = diamonds)
plot(TukeyHSD(anova_model))
```



```
#' there is a significant difference between the group means of all cuts
#' except for "Premium" & "Fair" and "Very Good" & "Good"
```

Question 4

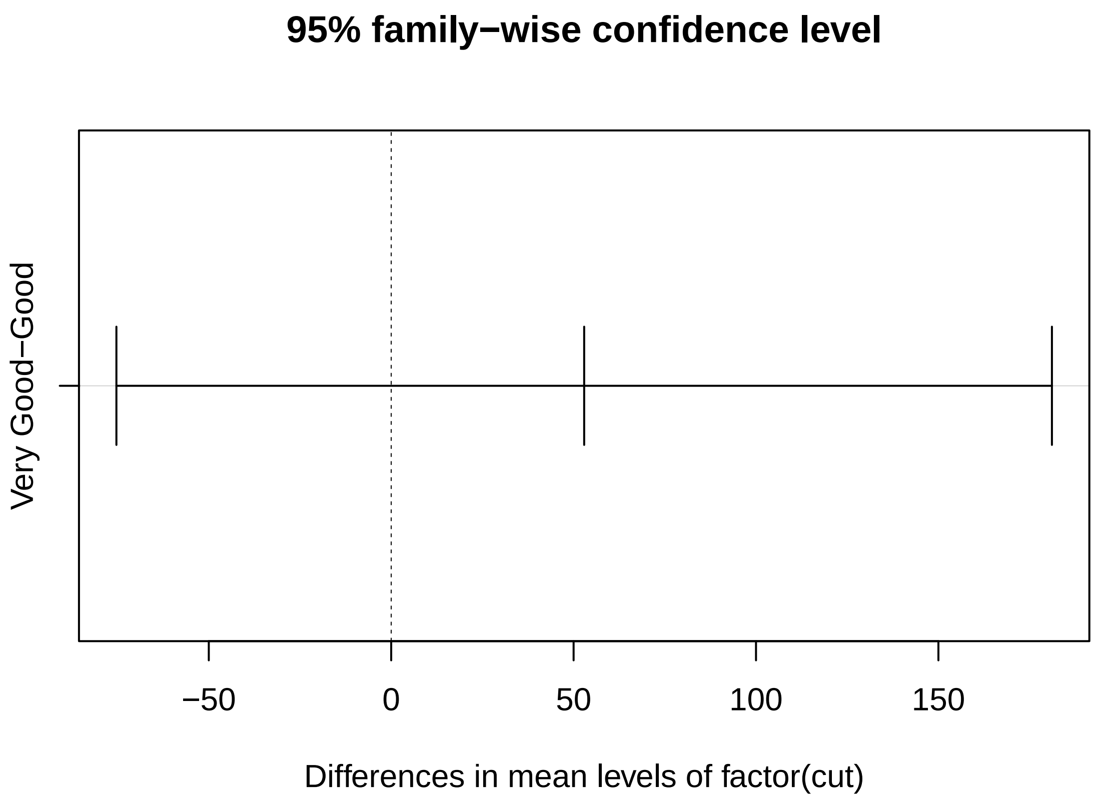
```r
#' extract the "Good" and "Very Good" diamonds
diamonds2 <- diamonds[diamonds$cut == "Good" | diamonds$cut == "Very Good",]
# or
diamonds2 <- subset(diamonds, cut == "Good" | diamonds$cut == "Very Good")

# perform the one-way ANOVA
oneway.test(price ~ cut,
            var.equal = TRUE,
            data = diamonds2)
```

```
##
##  One-way analysis of means
##
## data:  price and cut
## F = 0.65381, num df = 1, denom df = 16986, p-value = 0.4188
```

```r
#' The p-value of 0.4188 not significant (> 0.05), thus we accept
#' the null hypothesis (H0)
```

Question 5

```r
anova_model2 <- aov(price ~ factor(cut),
                    data = diamonds2)
plot(TukeyHSD(anova_model2))
```



```
#' There is no significant difference between the group means of "Good" &
#' "Very Good"
```

Question 6

```
#convert categorical variables into factors
model <- lm(price ~ factor(cut) + carat + factor(color) + depth,
            data = diamonds)
summary(model)
```

```
##
## Call:
## lm(formula = price ~ factor(cut) + carat + factor(color) + depth,
##     data = diamonds)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -17265.2   -751.5    -83.6    544.2  12256.1
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)      -910.028    286.893  -3.172  0.00151 **
## factor(cut).L    1177.948     26.101  45.130  < 2e-16 ***
## factor(cut).Q    -491.180     22.520 -21.811  < 2e-16 ***
## factor(cut).C     370.862     19.151  19.365  < 2e-16 ***
## factor(cut)^4      85.419     15.425   5.538 3.08e-08 ***
## carat            8183.774     13.889 589.216  < 2e-16 ***
## factor(color).L -1572.449     21.727 -72.373  < 2e-16 ***
## factor(color).Q  -732.336     19.849 -36.896  < 2e-16 ***
## factor(color).C  -109.973     18.631  -5.903 3.60e-09 ***
## factor(color)^4    82.481     17.106   4.822 1.43e-06 ***
## factor(color)^5  -137.643     16.174  -8.510  < 2e-16 ***
## factor(color)^6  -161.317     14.672 -10.995  < 2e-16 ***
## depth             -35.979      4.602  -7.819 5.43e-15 ***
## ---
## Signif. codes:  0 ’***’ 0.001 ’**’ 0.01 ’*’ 0.05 ’.’ 0.1 ’ ’ 1
##
## Residual standard error: 1431 on 53927 degrees of freedom
## Multiple R-squared:  0.8713, Adjusted R-squared:  0.8713
## F-statistic: 3.042e+04 on 12 and 53927 DF,  p-value: < 2.2e-16
```

```
#' the model presents a good fit with a p-value of < 2.2e-16 and
#' F-statistic of 3.042e+04. All coefficients demonstrate
#' significant values.
```

Question 7

```
min.model <- lm(price ~ 1, data = diamonds)
fwd.model <- step(min.model,
                  direction = "forward",
                  scope = (price ~
                  carat +
                  factor(cut) +
                  factor(color) +
                  factor(clarity) +
                  depth +
                  table +
                  x +
                  y +
                  z)
                  )
```

```
## Start:  AIC=894477.9
## price ~ 1
##
##                    Df  Sum of Sq        RSS    AIC
## + carat            1 7.2913e+11 1.2935e+11 792389
## + x                1 6.7152e+11 1.8695e+11 812259
## + y                1 6.4296e+11 2.1552e+11 819929
## + z                1 6.3677e+11 2.2170e+11 821454
## + factor(color)    6 2.6849e+10 8.3162e+11 892776
## + factor(clarity)  7 2.3308e+10 8.3517e+11 893007
## + table            1 1.3876e+10 8.4460e+11 893601
## + factor(cut)      4 1.1042e+10 8.4743e+11 893788
## + depth            1 9.7323e+07 8.5838e+11 894474
## <none>                          8.5847e+11 894478
##
## Step:  AIC=792389.4
## price ~ carat
##
##                    Df  Sum of Sq        RSS    AIC
## + factor(clarity)  7 3.9082e+10 9.0264e+10 772998
## + factor(color)    6 1.2561e+10 1.1678e+11 786891
## + factor(cut)      4 6.1332e+09 1.2321e+11 789777
## + x                1 3.5206e+09 1.2583e+11 790903
## + z                1 2.8493e+09 1.2650e+11 791190
## + table            1 1.4377e+09 1.2791e+11 791789
## + y                1 1.2425e+09 1.2810e+11 791871
## + depth            1 1.1546e+09 1.2819e+11 791908
## <none>                          1.2935e+11 792389
##
## Step:  AIC=772998.5
## price ~ carat + factor(clarity)
##
##                  Df  Sum of Sq        RSS    AIC
## + factor(color)  6 1.6402e+10 7.3862e+10 762193
## + x              1 1.8542e+09 8.8410e+10 771881
## + factor(cut)    4 1.7808e+09 8.8483e+10 771932
## + z              1 1.4814e+09 8.8783e+10 772108
## + y              1 7.4127e+08 8.9523e+10 772556
## + table          1 3.7751e+08 8.9886e+10 772774
## + depth          1 3.5822e+08 8.9906e+10 772786
## <none>                        9.0264e+10 772998
##
## Step:  AIC=762193.4
## price ~ carat + factor(clarity) + factor(color)
##
##                Df  Sum of Sq        RSS    AIC
## + x             1 2733710969 7.1128e+10 760161
## + z             1 1842294631 7.2020e+10 760833
## + factor(cut)  4 1699187372 7.2163e+10 760946
## + y             1 1145039064 7.2717e+10 761353
## + table         1  409645878 7.3452e+10 761895
## + depth         1  174658715 7.3687e+10 762068
## <none>                       7.3862e+10 762193
##
## Step:  AIC=760161.1
## price ~ carat + factor(clarity) + factor(color) + x
##
##                Df  Sum of Sq        RSS    AIC
## + factor(cut)  4 1918248123 6.9210e+10 758694
## + depth         1  722282102 7.0406e+10 759613
## + table         1  273738191 7.0855e+10 759955
## + z             1  199547343 7.0929e+10 760012
## + y             1    5354253 7.1123e+10 760159
## <none>                       7.1128e+10 760161
##
## Step:  AIC=758694.4
## price ~ carat + factor(clarity) + factor(color) + x + factor(cut)
##
##         Df Sum of Sq        RSS    AIC
## + depth  1 244682865 6.8965e+10 758505
## + z      1  72666922 6.9137e+10 758640
## + table  1   9935285 6.9200e+10 758689
## <none>               6.9210e+10 758694
## + y      1    982101 6.9209e+10 758696
##
## Step:  AIC=758505.4
## price ~ carat + factor(clarity) + factor(color) + x + factor(cut) +
##     depth
##
##         Df Sum of Sq        RSS    AIC
## + table  1 105497218 6.8860e+10 758425
## <none>               6.8965e+10 758505
## + z      1   2323719 6.8963e+10 758506
## + y      1    298553 6.8965e+10 758507
##
## Step:  AIC=758424.8
## price ~ carat + factor(clarity) + factor(color) + x + factor(cut) +
##     depth + table
##
##        Df Sum of Sq        RSS    AIC
## + z     1   2662170 6.8857e+10 758425
## <none>              6.8860e+10 758425
## + y     1    116788 6.8860e+10 758427
##
## Step:  AIC=758424.7
## price ~ carat + factor(clarity) + factor(color) + x + factor(cut) +
##     depth + table + z
```

```
##
##        Df Sum of Sq        RSS    AIC
## <none>              6.8857e+10 758425
## + y     1    315487 6.8857e+10 758426
```

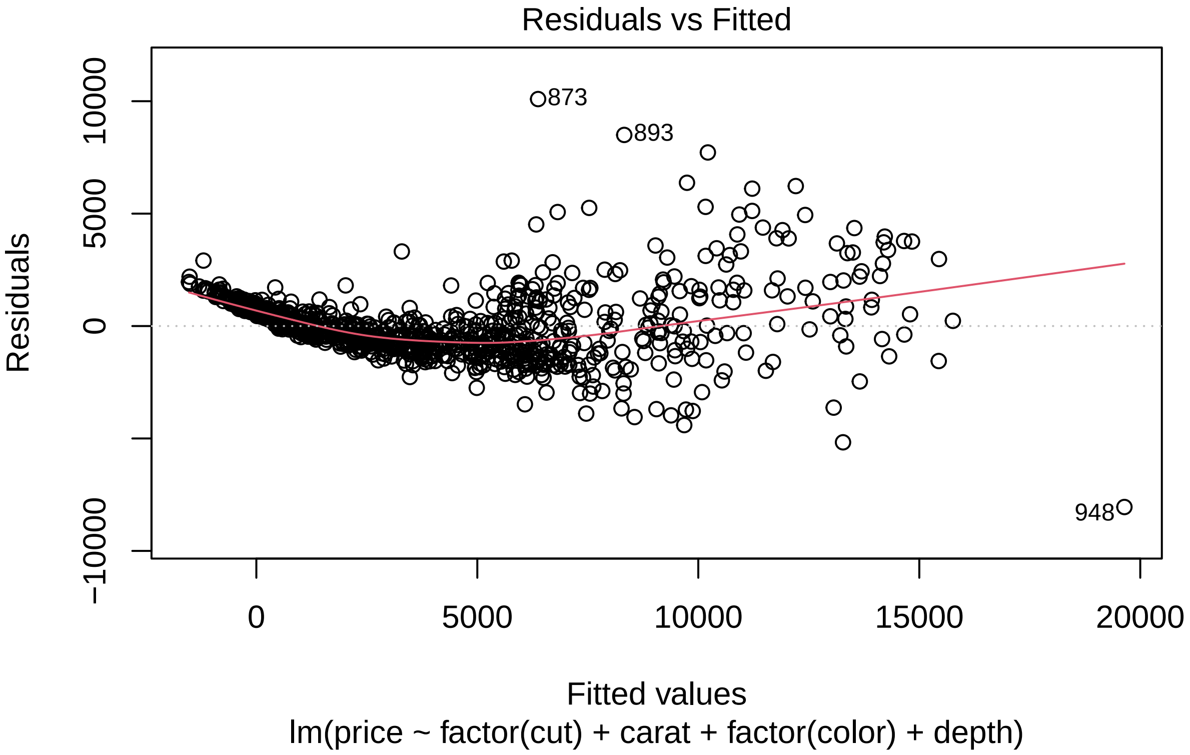
```
#' the best model is price ~ carat + clarity + color + x + cut + depth +
#' table + z, with the lowest AIC of 758424.7

# print the summary of the best fit model
summary(fwd.model)
```

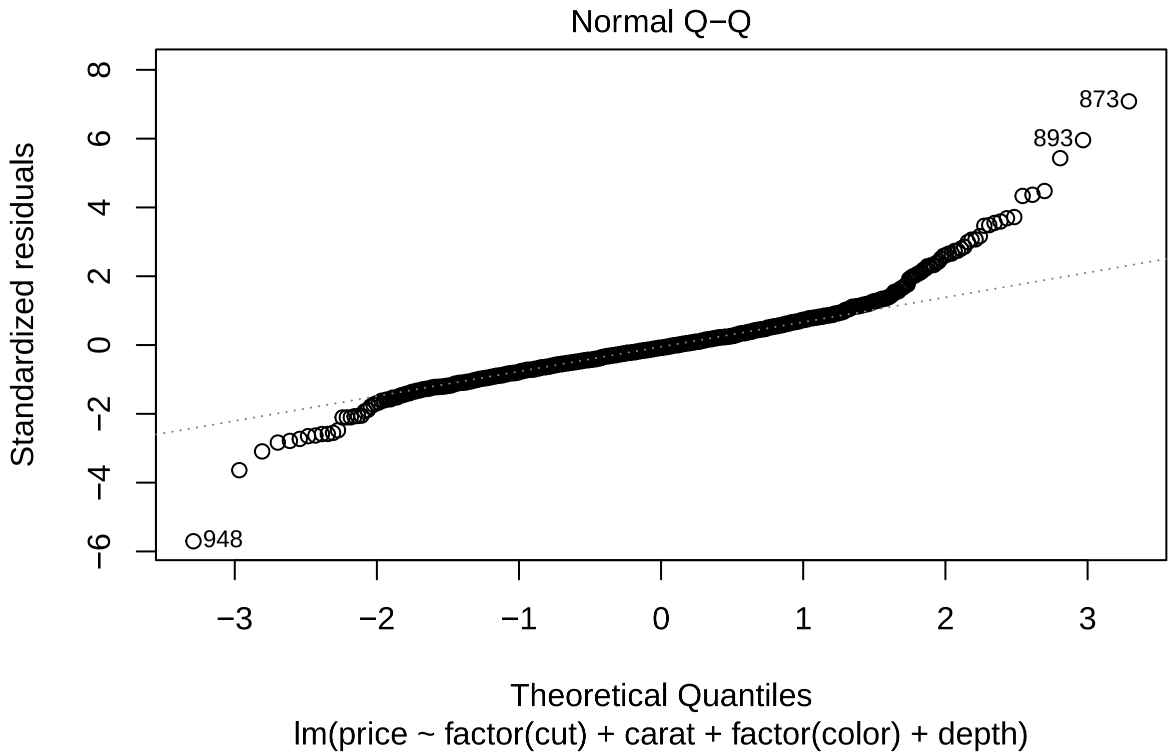
```
##
## Call:
## lm(formula = price ~ carat + factor(clarity) + factor(color) +
##     x + factor(cut) + depth + table + z, data = diamonds)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -21378.8   -592.5   -183.5    376.3  10694.1
##
## Coefficients:
##                     Estimate Std. Error  t value Pr(>|t|)
## (Intercept)         5768.782    395.474   14.587  < 2e-16 ***
## carat              11257.752     48.602  231.630  < 2e-16 ***
## factor(clarity).L   4097.613     30.256  135.431  < 2e-16 ***
## factor(clarity).Q  -1925.133     28.226  -68.205  < 2e-16 ***
## factor(clarity).C    982.322     24.150   40.676  < 2e-16 ***
## factor(clarity)^4   -364.976     19.285  -18.926  < 2e-16 ***
## factor(clarity)^5    233.635     15.751   14.833  < 2e-16 ***
## factor(clarity)^6      6.871     13.715    0.501  0.61640
## factor(clarity)^7     90.622     12.103    7.487 7.13e-14 ***
## factor(color).L    -1952.179     17.342 -112.572  < 2e-16 ***
## factor(color).Q     -672.075     15.777  -42.599  < 2e-16 ***
## factor(color).C     -165.277     14.725  -11.224  < 2e-16 ***
## factor(color)^4       38.193     13.526    2.824  0.00475 **
## factor(color)^5      -95.780     12.776   -7.497 6.64e-14 ***
## factor(color)^6      -48.452     11.614   -4.172 3.02e-05 ***
## x                  -1000.354     28.795  -34.740  < 2e-16 ***
## factor(cut).L        584.600     22.476   26.010  < 2e-16 ***
## factor(cut).Q       -302.211     17.983  -16.805  < 2e-16 ***
## factor(cut).C        148.446     15.461    9.601  < 2e-16 ***
## factor(cut)^4        -20.619     12.371   -1.667  0.09559 .
## depth                -64.003      4.517  -14.168  < 2e-16 ***
## table                -26.501      2.911   -9.103  < 2e-16 ***
## z                    -47.925     33.194   -1.444  0.14880
## ---
## Signif. codes:  0 ’***’ 0.001 ’**’ 0.01 ’*’ 0.05 ’.’ 0.1 ’ ’ 1
##
## Residual standard error: 1130 on 53917 degrees of freedom
## Multiple R-squared:  0.9198, Adjusted R-squared:  0.9198
## F-statistic: 2.81e+04 on 22 and 53917 DF,  p-value: < 2.2e-16
```

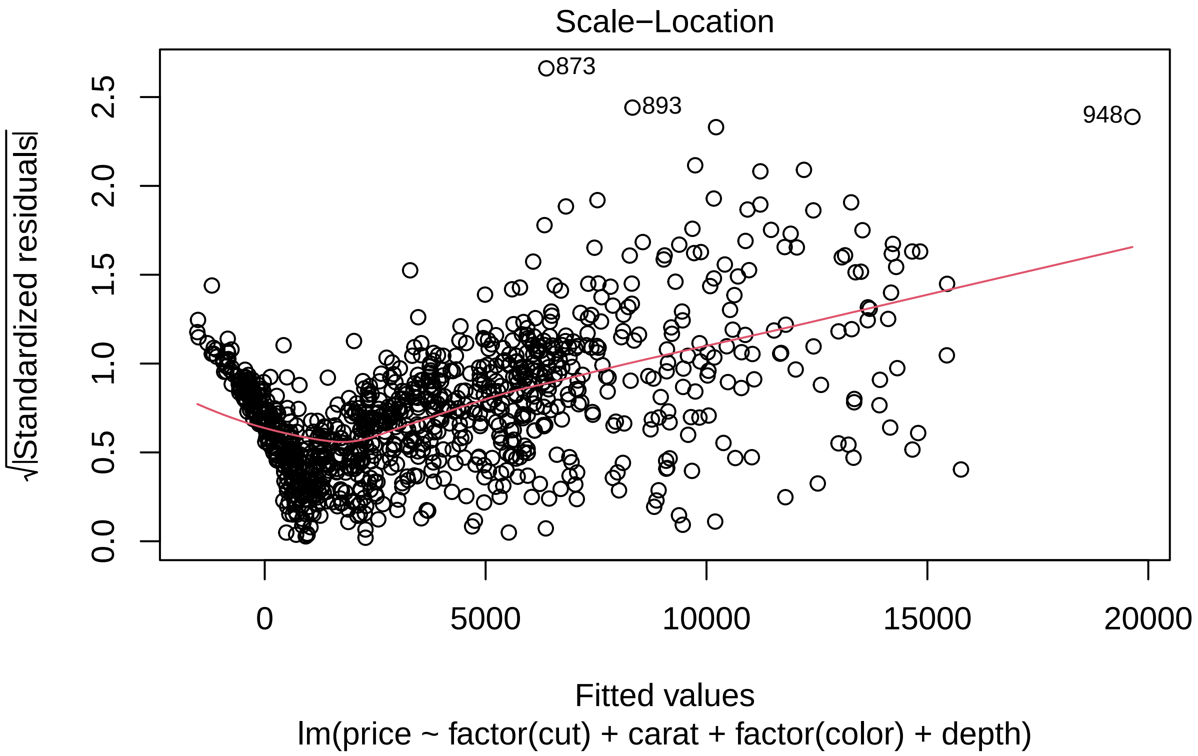
Regress “price” on 4 variables, cut, carat, color, and depth. Draw the diagnostic plots for a sample of 1000 observations of the diamonds dataset.

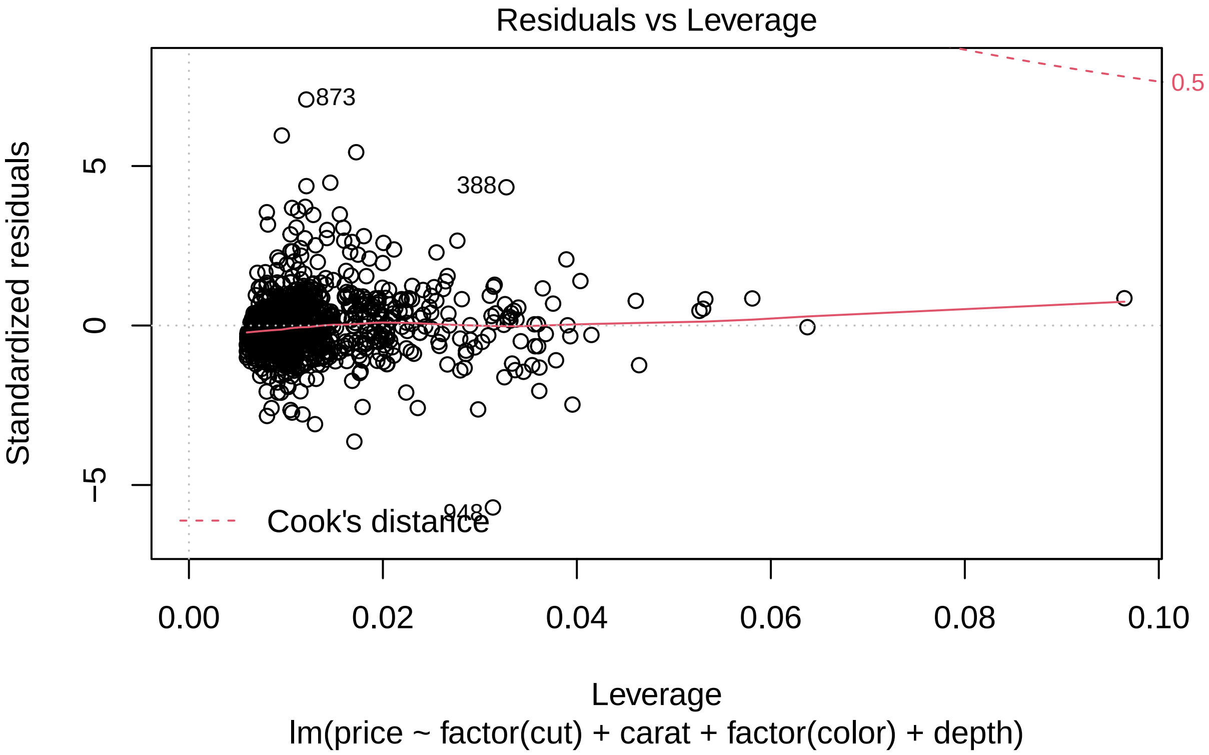
Question 8

```
sample <- diamonds[sample(1:53940, 1000), ]
model <- lm(price ~ factor(cut) + carat + factor(color) + depth,
            data = sample)
plot(model)
```




Normal Q−Q
Standardized residuals
8
6
4
2
0
−2
−4
−6
−3
−2
−1
0
1
2
3
873
893
948
Theoretical Quantiles
lm(price ~ factor(cut) + carat + factor(color) + depth)


Scale−Location
√|Standardized residuals|
0.0
0.5
1.0
1.5
2.0
2.5
0
5000
10000
15000
20000
Fitted values
lm(price ~ factor(cut) + carat + factor(color) + depth)
873
893
948



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Student Signature: Areej Mulla