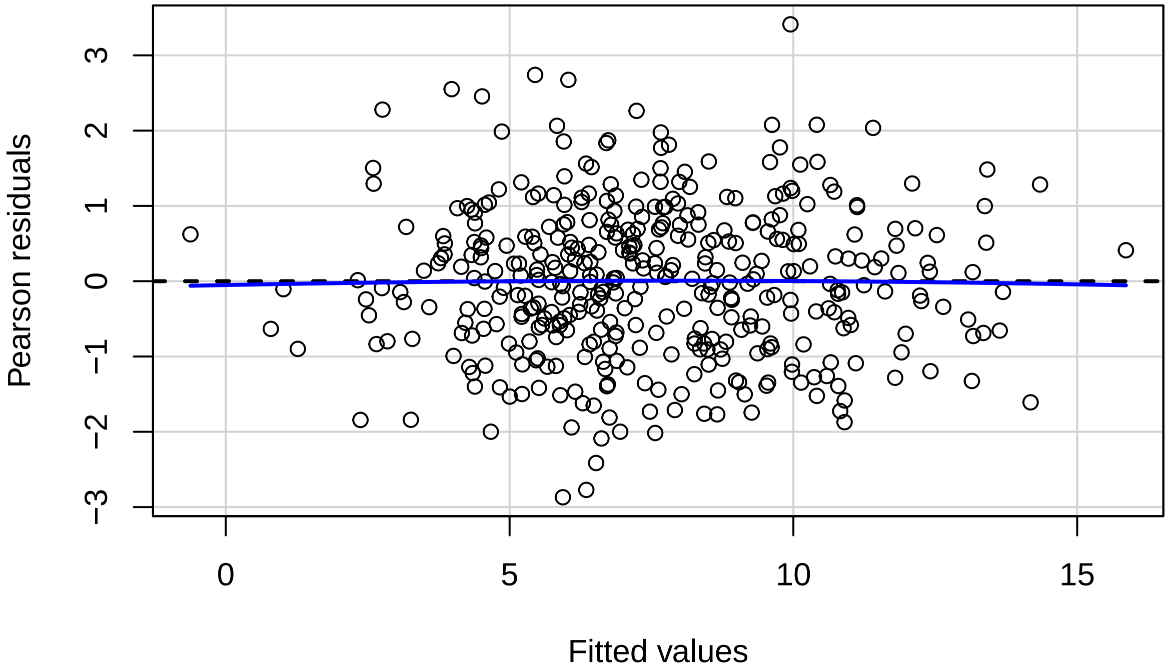
# 2 Q2.

### (a)

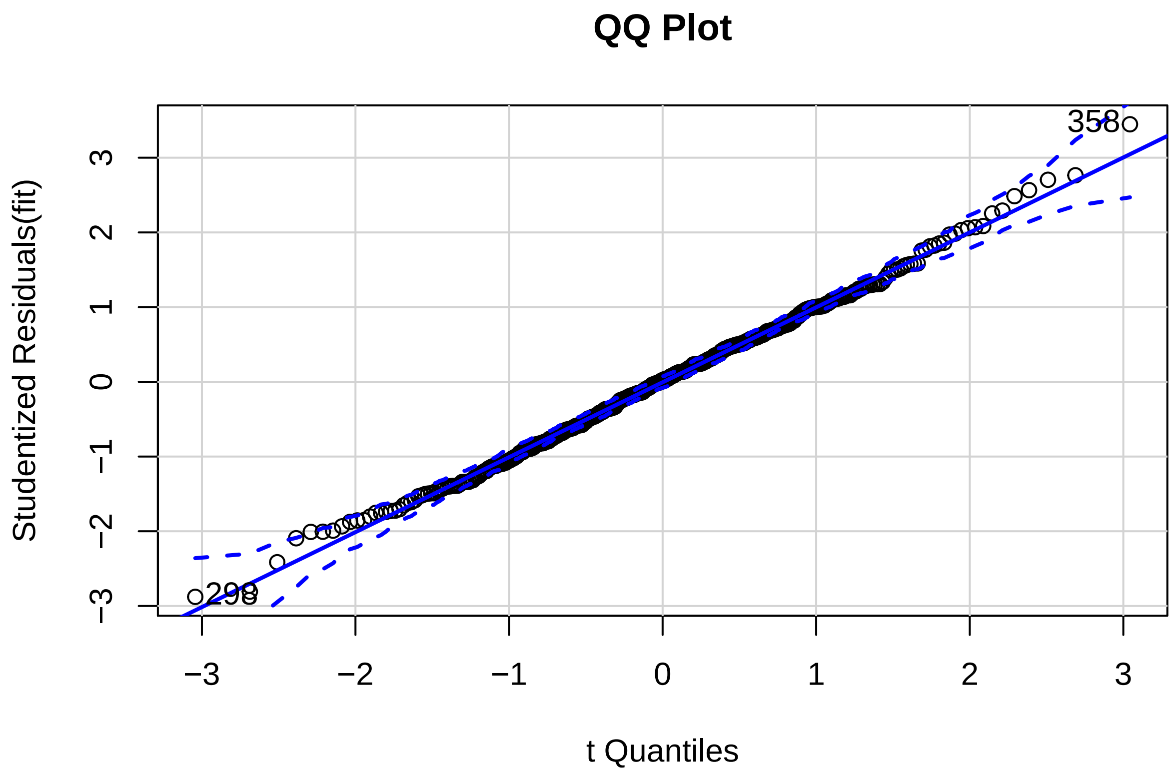
```r
library(ISLR)
data("Carseats")
fit <- lm(Sales ~ CompPrice+Income+Advertising+Population+Price+ShelveLoc+Age+Education+Urban+US, data =
summary(fit)
```

```
##
## Call:
## lm(formula = Sales ~ CompPrice + Income + Advertising + Population +
##     Price + ShelveLoc + Age + Education + Urban + US, data = Carseats)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -2.8692 -0.6908  0.0211  0.6636  3.4115
##
## Coefficients:
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)      5.6606231  0.6034487   9.380  < 2e-16 ***
## CompPrice        0.0928153  0.0041477  22.378  < 2e-16 ***
## Income           0.0158028  0.0018451   8.565 2.58e-16 ***
## Advertising      0.1230951  0.0111237  11.066  < 2e-16 ***
## Population       0.0002079  0.0003705   0.561    0.575
## Price           -0.0953579  0.0026711 -35.700  < 2e-16 ***
## ShelveLocGood    4.8501827  0.1531100  31.678  < 2e-16 ***
## ShelveLocMedium  1.9567148  0.1261056  15.516  < 2e-16 ***
## Age             -0.0460452  0.0031817 -14.472  < 2e-16 ***
## Education       -0.0211018  0.0197205  -1.070    0.285
## UrbanYes         0.1228864  0.1129761   1.088    0.277
## USYes           -0.1840928  0.1498423  -1.229    0.220
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.019 on 388 degrees of freedom
## Multiple R-squared:  0.8734, Adjusted R-squared:  0.8698
## F-statistic: 243.4 on 11 and 388 DF,  p-value: < 2.2e-16
```

```r
##The multiple R-squared value is 0.8698, which shows that this regression
##can interpret 87% of the changes of the dependent variable.
residualPlot(fit)           #Diagnostic residual plots
```




```r
qqPlot(fit, main="QQ Plot") #qq plot for studentized residuals
```




```
## [1] 298 358
```

```
##There is no clear interaction between the predicted value and residuals
```

**(b)**

```
##We can see that CompPrice, Income, Advertising, Price,
##and ShelveLoc have significant p-values.

##For the variable "Urban", we have the P-value = 0.277 > 0.05, hence, we
##rejected the hypothesis that the variable Urban is significant.
```

**(c)**

```
fit1 <- lm(Sales ~ CompPrice+Income+Advertising+Price+ShelveLoc, data = Carseats)
summary(fit1)
```

```
##
## Call:
## lm(formula = Sales ~ CompPrice + Income + Advertising + Price +
##     ShelveLoc, data = Carseats)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3.7962 -0.9251  0.0043  0.8457  4.4179
##
## Coefficients:
##                    Estimate Std. Error t value Pr(>|t|)
```

```
## (Intercept)      2.431262   0.569032   4.273 2.43e-05 ***
## CompPrice        0.095676   0.005100  18.760  < 2e-16 ***
## Income           0.016042   0.002276   7.049 8.16e-12 ***
## Advertising      0.116205   0.009566  12.148  < 2e-16 ***
## Price           -0.093241   0.003302 -28.236  < 2e-16 ***
## ShelveLocGood    4.797696   0.188847  25.405  < 2e-16 ***
## ShelveLocMedium  1.849895   0.155037  11.932  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.263 on 393 degrees of freedom
## Multiple R-squared:  0.8031, Adjusted R-squared:  0.8001
## F-statistic: 267.2 on 6 and 393 DF,  p-value: < 2.2e-16
```

```r
##The multiple R-squared value is 0.8001, which shows that this regression can
##interpret 80% of the changes of the dependent variable

##The R-squared value  of the reduced model slightly decreased from the previous
##value with the full model.
```

**(d)**

```r
anova(fit,fit1)
```

```
## Analysis of Variance Table
##
## Model 1: Sales ~ CompPrice + Income + Advertising + Population + Price +
##     ShelveLoc + Age + Education + Urban + US
## Model 2: Sales ~ CompPrice + Income + Advertising + Price + ShelveLoc
##   Res.Df    RSS Df Sum of Sq      F    Pr(>F)
## 1    388 402.83
## 2    393 626.51 -5   -223.68 43.088 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
#The P-value is significant, i.e. we can not reject the hypothesis that the two
# models have different variance.

#Hence, the different between the R-squared value is not significant, and the
#second model is better.
```

**(e)**

y = 2.431 + 0.096 x CompPrice + 0.016 x Income + 0.116 x Advertising - 0.093 x Price + 4.798 (If shelveLoc = Good) + 1.850 (If ShelveLoc = Medium)

**(f)**

```r
fit2 <- lm(Sales ~ CompPrice+Income+Advertising+Price+ShelveLoc + Price:ShelveLoc, data = Carseats)
summary(fit2)
```

```
##
## Call:
## lm(formula = Sales ~ CompPrice + Income + Advertising + Price +
##     ShelveLoc + Price:ShelveLoc, data = Carseats)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
```

```
## -3.7547 -0.9336  0.0078  0.8386  4.3561
##
## Coefficients:
##                         Estimate Std. Error t value Pr(>|t|)
## (Intercept)             1.964179   0.795606   2.469  0.01398 *
## CompPrice               0.095881   0.005144  18.638  < 2e-16 ***
## Income                  0.015969   0.002290   6.974 1.32e-11 ***
## Advertising             0.116309   0.009596  12.121  < 2e-16 ***
## Price                  -0.089335   0.005739 -15.567  < 2e-16 ***
## ShelveLocGood           5.353757   0.920389   5.817 1.25e-08 ***
## ShelveLocMedium         2.473173   0.774915   3.192  0.00153 **
## Price:ShelveLocGood    -0.004843   0.007752  -0.625  0.53249
## Price:ShelveLocMedium -0.005441   0.006626  -0.821  0.41205
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.265 on 391 degrees of freedom
## Multiple R-squared:  0.8035, Adjusted R-squared:  0.7995
## F-statistic: 199.8 on 8 and 391 DF,  p-value: < 2.2e-16
```

```r
##We can see that the interaction between Price and ShelveLoc have
##non-significant p-values, hence the interaction term is not necessary.
```

**(d)**

```r
anova(fit1,fit2)
```

```
## Analysis of Variance Table
##
## Model 1: Sales ~ CompPrice + Income + Advertising + Price + ShelveLoc
## Model 2: Sales ~ CompPrice + Income + Advertising + Price + ShelveLoc +
##     Price:ShelveLoc
##   Res.Df    RSS Df Sum of Sq      F Pr(>F)
## 1    393 626.51
## 2    391 625.38  2    1.1343 0.3546 0.7017
```

```r
#The P-value is not significant, i.e. we canreject the hypothesis that the two
# models have different variance.

#Hence, the different between the R-squared value is significant, and the
#interaction term is not necessary.
```