STAT0030_ICA2

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R Question 1

Question 1(a)

```
rawdata <- read.table("cars.dat", #input data
                      header=TRUE) #the first line as the names of the variables
```

Read the data into R.

Question 1(b)

```
summary(rawdata)
```

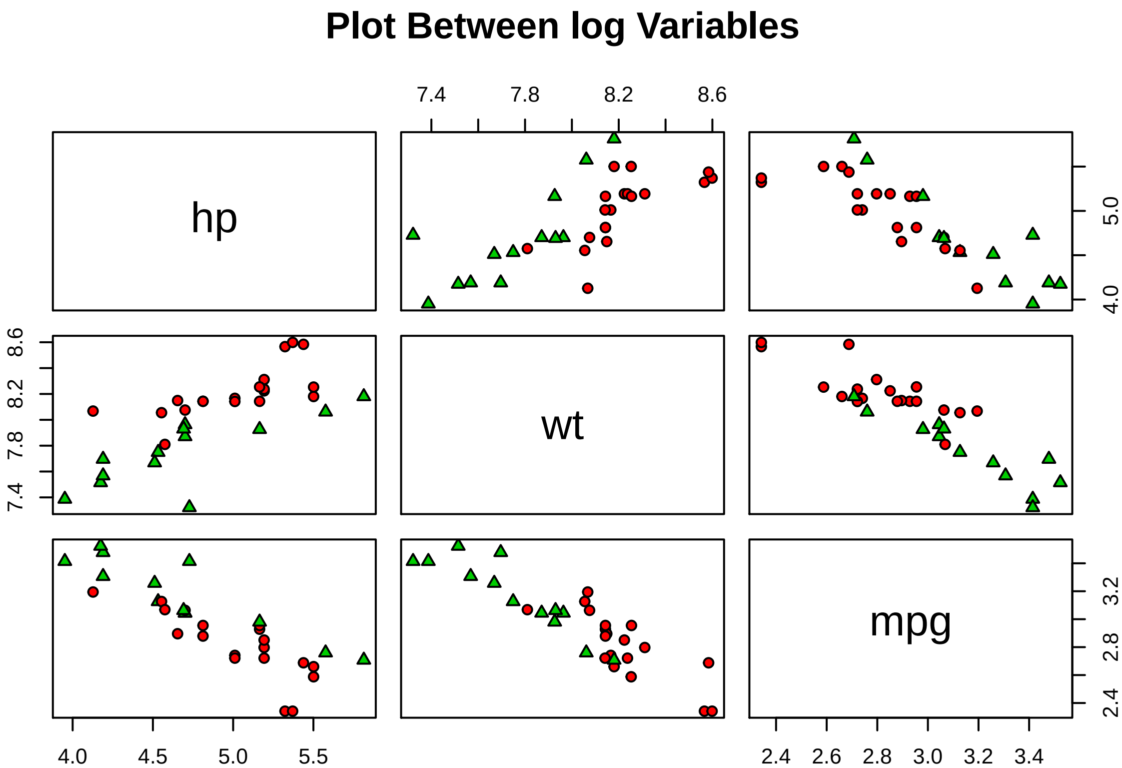
```
##        tr               hp              wt            mpg
##  Min.   :0.0000   Min.   : 52.0   Min.   :1513   Min.   :10.40
##  1st Qu.:0.0000   1st Qu.: 96.5   1st Qu.:2581   1st Qu.:15.43
##  Median :0.0000   Median :123.0   Median :3325   Median :19.20
##  Mean   :0.4062   Mean   :146.7   Mean   :3217   Mean   :20.09
##  3rd Qu.:1.0000   3rd Qu.:180.0   3rd Qu.:3610   3rd Qu.:22.80
##  Max.   :1.0000   Max.   :335.0   Max.   :5425   Max.   :33.90
```

```
table(rawdata$tr)
```

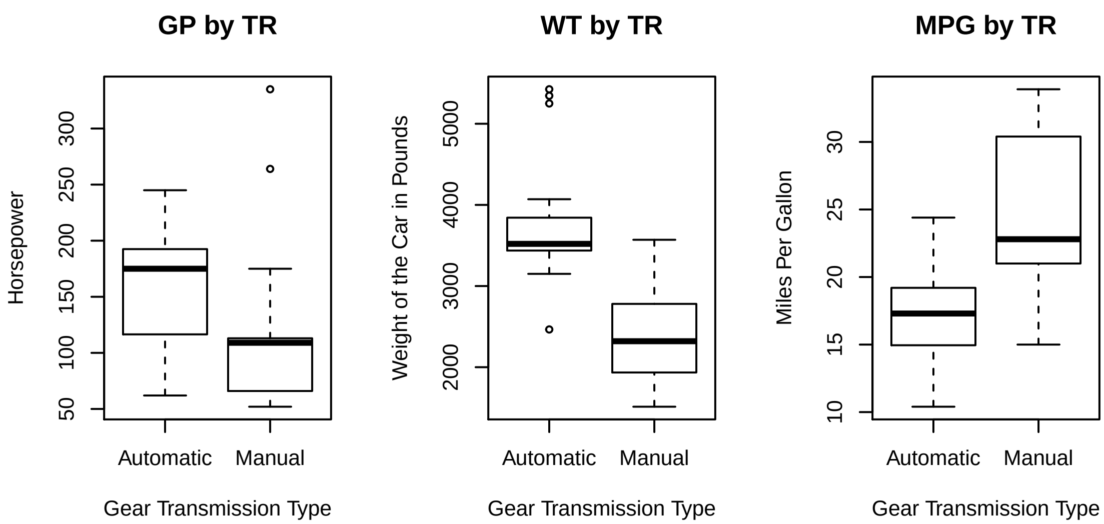
```
##
##  0  1
## 19 13
```

From this result, it shows that there are four variables. The range of the values between the last three variables is relatively large, so it is necessary to log the original data. From the table results, the sample is divided into manual and automatic transmissions, of which 19 are automatic and 13 are manual.

```
logdata <- cbind(rawdata[,1],log(rawdata[,c(2,3,4)])) #log the data
names(logdata) <- c("tr","hp","wt","mpg")#rename the names of the variables
pairs(logdata[,2:4], # plot log(hp), log(wt), log(mpg)
      main = "Plot Between log Variables", #add the main title
      pch = c(21,24)[unclass(logdata$tr)+1], #different tr shows different shape
      bg = c("red", "green3")[unclass(logdata$tr)+1]) #different tr shows different colour
```



We can see from the plot that the point group by TR is significantly different in the other three variables, but the plot is not easy to see what kind of specific difference it is. So next step we will do boxplots.



The box plot shows a significant change between the automatic and manual gears between three variables. The automatic cars have higher HP and WT. And the manual cars have the higher MPG.

```
t.test(mpg~tr, data=logdata)# the t-test above MPG is related to TR.
```

```
##
```

```
##  Welch Two Sample t-test
##
## data:  mpg by tr
## t = -3.8257, df = 23.958, p-value = 0.0008194
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.5336626 -0.1596180
## sample estimates:
## mean in group 0 mean in group 1
##        2.816692        3.163332
```

In fact, we can infer from the t-test that the MPG is related to the TR. According to Two Sample t-test, the p-value is less than 0.01, so we should reject the null hypothesis and conclude: The manual transmission car has the better fuel efficiency in miles per gallon than the automatic transmission car. However, this t-test cannot prove that the TR is the only significant variables for the MPG. We need to add more variables for regression to get more accurate results. In other words, the type of transmission may be linearly related to other variables, such as the weight of the car, so we need to make more regressions to ensure a better explanation of the change in the MPG.

question 1(c)

Through computing, it is easy to find: each of the variables has a statistically significant relationship with the MPG. Because the results are too much, so there is no result displayed here. Firstly, MPG is regressed with all variables to observe the effect of the overall regression.

```r
rawdata_model<-lm(mpg~tr+hp+wt, data=rawdata) #rawdata linear model
summary(rawdata_model)
```

```
##
## Call:
## lm(formula = mpg ~ tr + hp + wt, data = rawdata)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3.4222 -1.7921 -0.3788  1.2250  5.5318
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) 34.0016421  2.6423265  12.868 2.82e-13 ***
## tr           2.0841138  1.3763314   1.514 0.141169
## hp          -0.0374810  0.0096049  -3.902 0.000546 ***
## wt          -0.0028781  0.0009048  -3.181 0.003574 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.538 on 28 degrees of freedom
## Multiple R-squared:  0.8399, Adjusted R-squared:  0.8227
## F-statistic: 48.96 on 3 and 28 DF,  p-value: 2.908e-11
```

```r
logdata_model<-lm(mpg~tr+hp+wt, data=logdata) #logdata linear model
summary(logdata_model)
```

```
##
```

```
## Call:
## lm(formula = mpg ~ tr + hp + wt, data = logdata)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.204243 -0.081099 -0.003198  0.080083  0.197919
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  8.59990    0.86159   9.981    1e-10 ***
## tr           0.01069    0.06040   0.177 0.860813
## hp          -0.25971    0.06438  -4.034 0.000384 ***
## wt          -0.54535    0.13062  -4.175 0.000262 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1072 on 28 degrees of freedom
## Multiple R-squared:  0.883,  Adjusted R-squared:  0.8705
## F-statistic: 70.44 on 3 and 28 DF,  p-value: 3.686e-13
```

This two regression shows logdata has better R-squared and p-value than rawdata. This means logarithm of rawdata has better performance in regeression and logdata will be used as following.

From the regression, we can know a variable is not significant to the MPG. So using stepwise regression to distinguish significant variables.

```r
best_model<-step(logdata_model, direction="both")
```

```r
summary(best_model)
```

```
##
## Call:
## lm(formula = mpg ~ hp + wt, data = logdata)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.201439 -0.079566  0.002144  0.078778  0.196144
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  8.71876    0.53056  16.433 3.12e-16 ***
## hp          -0.25531    0.05840  -4.372 0.000145 ***
## wt          -0.56228    0.08741  -6.433 4.89e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1054 on 29 degrees of freedom
## Multiple R-squared:  0.8829, Adjusted R-squared:  0.8748
## F-statistic: 109.3 on 2 and 29 DF,  p-value: 3.133e-14
```

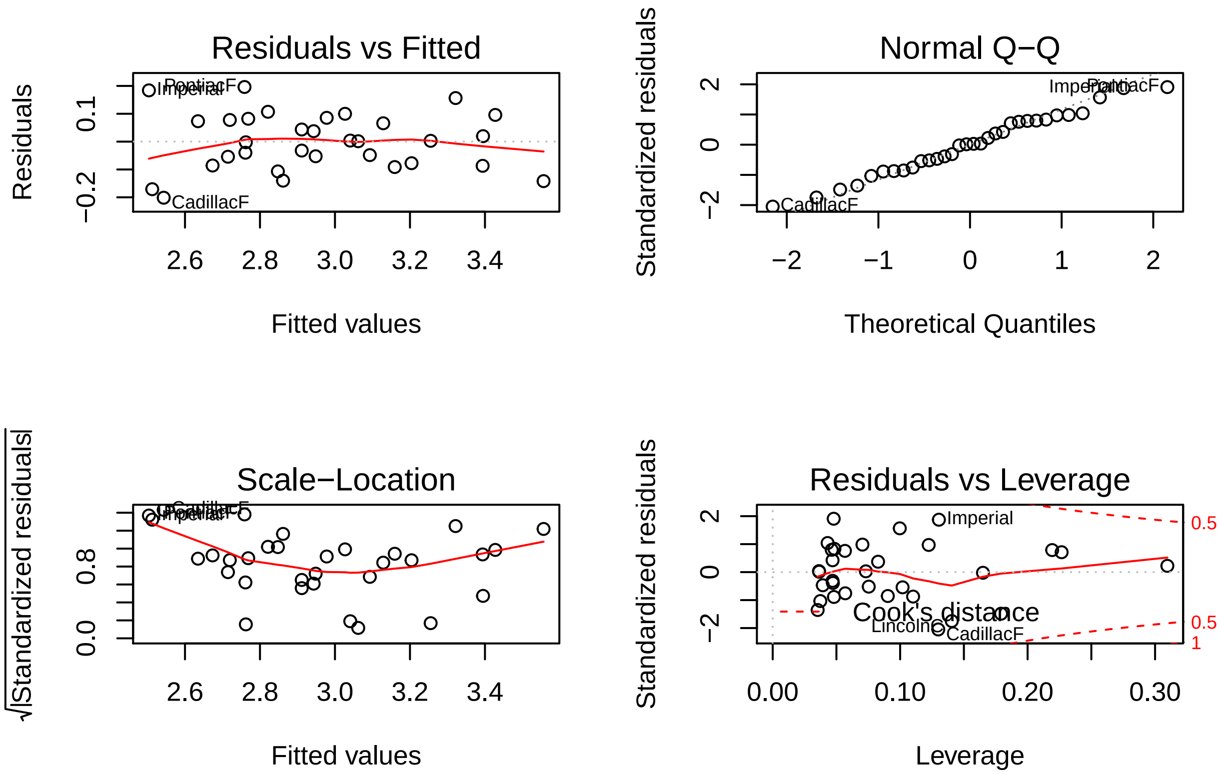
```
## The final model is
##                    MPG =  8.718758 -0.2553122 *HP -0.2553122 *WT
```

According to the stepwise regression, the transmission type was moved out in this regression,

and MPG was related to HP and WT. Therefore, we can not determine whether the type of transmission has a significant influence on MPG.

question 1(d)

```
par(mfrow=c(2,2)) #put 4 graphes together
plot(best_model)#plot 4 graphes as following.
```



Residuals looks like normally distributed, independent, random and has no outliers. This means the result of regression is accepted.

Conclution:After adding the HP and the WT, the gear transmission type disappears. So we are not sure if the gear transmission type has an significant effect on the MPG. According to the regression result, we can conclude that the MPG decreases as the HP rises and the WT rises.