Project Course

Motor Trend Car Road Tests

Summary

This report explores the relationship between miles-per-gallon (MPG) and other variables in the mtcars data set. In particular, the analysis attempts to identify whether an automatic or manual transmission is better for MPG, and quantifies the MPG difference.

The analysis set consludes that the prediction model depends on the the variables am, cyl, disp, hp and wt. The average MPG for cars with automatic transmissions is 17.147, and for cars with manual transmissions is 24.392. From the multiple regression model, we can see manual transmission is 1.55 bigger than automatic.

Analysis

Loading the data

```
library(ggplot2);library(dplyr);library(datasets);library(psych)
data("mtcars")
```

Exploratory Data Analysis

```
str(mtcars)
```

```
## 'data.frame':    32 obs. of  11 variables:
##  $ mpg : num  21 21 22.8 21.4 18.7 18.1 14.3 24.4 22.8 19.2 ...
##  $ cyl : num  6 6 4 6 8 6 8 4 4 6 ...
##  $ disp: num  160 160 108 258 360 ...
##  $ hp  : num  110 110 93 110 175 105 245 62 95 123 ...
##  $ drat: num  3.9 3.9 3.85 3.08 3.15 2.76 3.21 3.69 3.92 3.92 ...
##  $ wt  : num  2.62 2.88 2.32 3.21 3.44 ...
##  $ qsec: num  16.5 17 18.6 19.4 17 ...
##  $ vs  : num  0 0 1 1 0 1 0 1 1 1 ...
##  $ am  : num  1 1 1 0 0 0 0 0 0 0 ...
##  $ gear: num  4 4 4 3 3 3 3 4 4 4 ...
##  $ carb: num  4 4 1 1 2 1 4 2 2 4 ...
```

In order to explore the relationship between the variables, some plots were build. In apendix 1 we can see that the automatic transimision consumes more gasoline. In apendix 2 we can see that the variables that seem to have more relation with the the consumed gasoline are: number of cylinders (-0.85), displacement (-0.85), gross horsepower (-0.78) and weight (-0.87).

Inference

From the apendix 1 we can assume that manual transmission is better than automatic transmission, in order to confirm this result we are going to perfom a t test.

```
# Automatic vs Manual Transmission Hypothesis Test
# To perform the t-test we assume that data is normal and has homogeneous variances.
# H0: There is not significant difference between the mean of the miles per
#gallon associated to the automatic transmission and the mean of miles per
#gallon associated to manual transmision.
automatic <- mtcars[mtcars$am == "0",];manual <- mtcars[mtcars$am == "1",]
t.test(automatic$mpg, manual$mpg)
```

The p-value is smaller than 0.5, then the null hypothesis is rejected. From the t-test we conclude that the type of transmission has an effect on the miles per gallon, and manual transmission is better than automatic transmission. Now we can built a regression model depending on this variable.

Regression

As "mpg" is a continuous variable we are going to use a linear regression model.

```
# Building the regression model
model_1<-lm(mpg~am,data=mtcars)
summary(model_1)
```

The linear model shows that the average MPG for automatic is 17.1 MPG, while manual is 7.2 MPG higher. The R2-value is 0.36, which says this model only explains the 36% of the variance. As a result, we need to build a multivariate linear regression.

The new model will use the other variables to make it more accurate. From the apendix 2 we can see that the variables with the strongest correlation with mpg are cyl, disp, hp, and wt.

```
model_2 <- lm(mpg ~ am + cyl + disp + hp + wt, data = mtcars)
summary(model_2)
```

The model explains 86.64% of the variance and as a result, cyl, disp, hp, wt does affect the correlation between mpg and am. From this new model we can observe the difference between automatic and manual transmissions is 1.55 MPG.

The ecuation to predict the miles per gallon are:

$mpg = 30.20 + 1.55am - 1.1cyl + 0.01disp - 0.02hp - 3.30wt$

No we are going to perform a anova test to claim that the model 2 is the best one.

```
anova(model_1, model_2)
```

The p-value is 8.637e-08, and we can claim that the best model is the model 2. To confirm this we do a residuals plot for non-normality and we can see that they are all normally distributed and homoskedastic. See apendix 3.

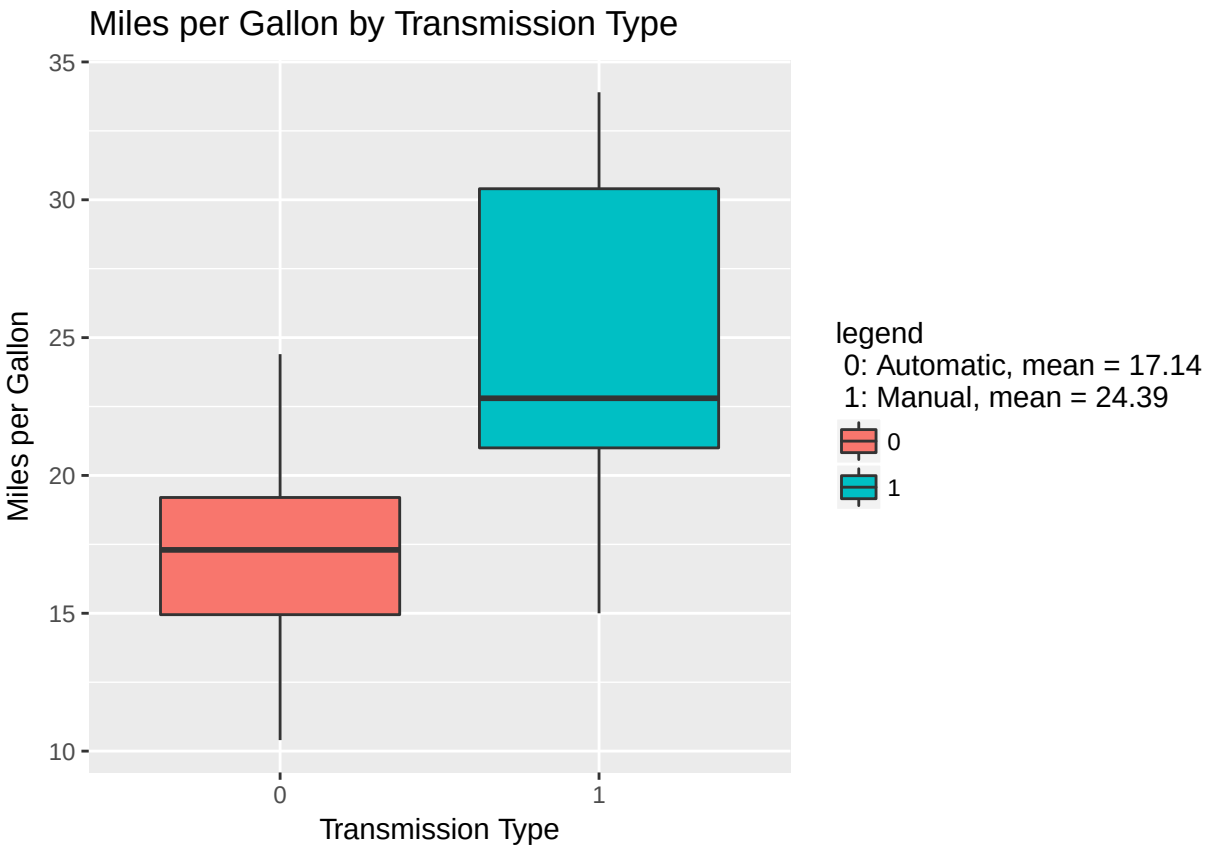
Conclusions

From the analysis we can conclude:

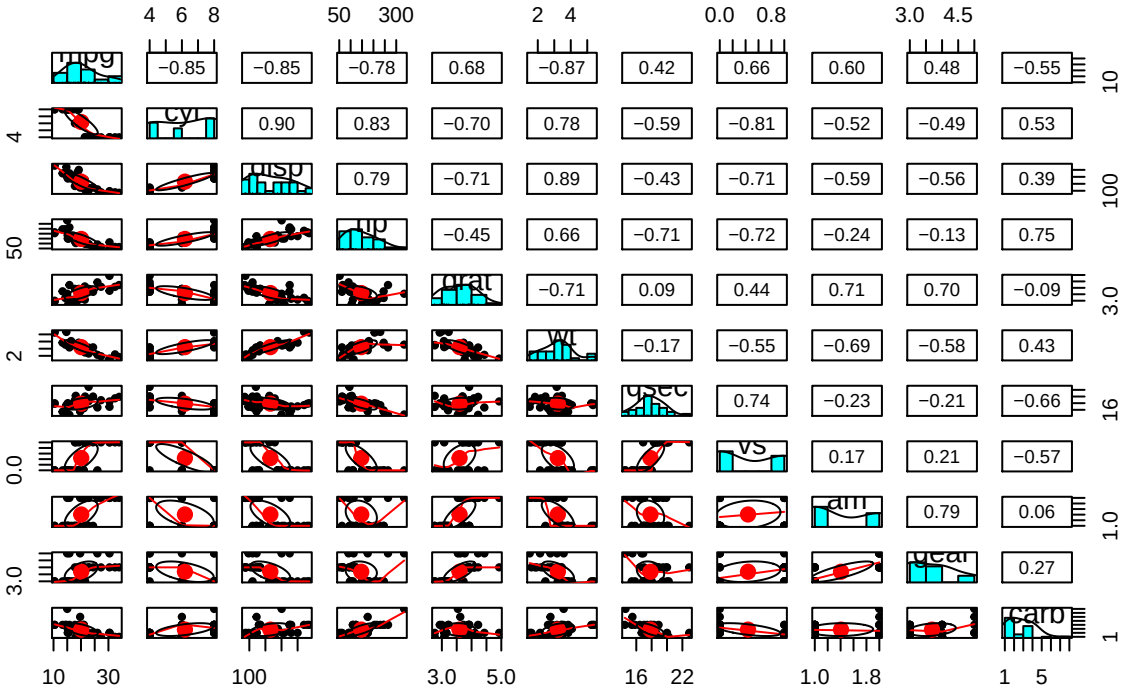
- The type of transmission afects the miles per gallon.
- The outcome mpg depends on the trasnmission type and other variables.
- Manual transmission consumes less fuel, it is better.
- Using the best model, it is observed that manual transmission gets 1.55 miles per gallon more than automatic transmission.

Apendix

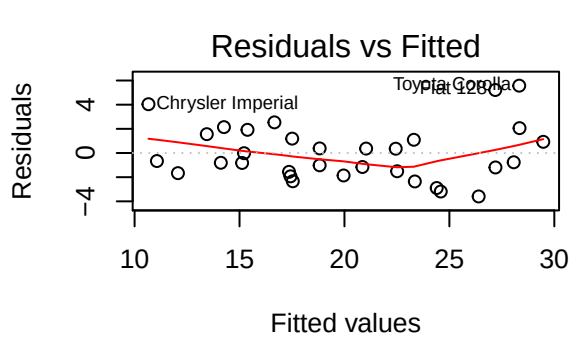
Apendix 1: Boxplot of MPG by Transmission Type

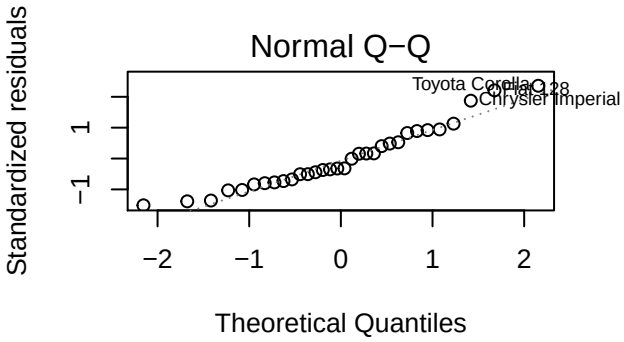


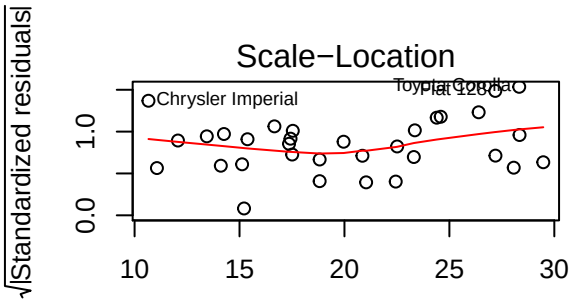
Apendix 2: Dispersion, Histogram and Correlation

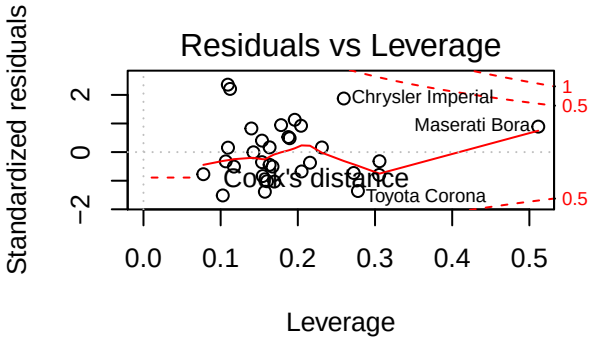


Apendix 3: Residuals Plot


Residuals vs Fitted
Residuals
Fitted values
Chrysler Imperial
Toyota Corolla
Fiat 128
10
15
20
25
30
−4
0
4


Normal Q−Q
Standardized residuals
Theoretical Quantiles
Toyota Corolla
Fiat 128
Chrysler Imperial
−2
−1
0
1
2


Scale−Location
√|Standardized residuals|
Fitted values
Chrysler Imperial
Toyota Corolla
Fiat 128
10
15
20
25
30
0.0
1.0


Residuals vs Leverage
Standardized residuals
Leverage
Chrysler Imperial
Maserati Bora
Toyota Corona
Cook's distance
1
0.5
0.5
0.0
0.1
0.2
0.3
0.4
0.5
−2
0
2