

The MPG Difference between Automatic and Manual Transmission

LiTx

2015.3.18

1. Summary

This report explores the relationship between a set of variables and miles per gallon (MPG) (outcome). Investigates whether automatic or manual transmission is better for MPG, and quantify the MPG difference between automatic and manual transmissions.

2. Load the data

```
data(mtcars)
mtcars$am <- factor(mtcars$am, labels=c('Automatic', 'Manual'))
```

3. Is an automatic or manual transmission better for MPG

Plot the MPG of automatic and manual transmission as shown in 6.1. From the figure, we can see that the MPG of manual is significantly larger than that of automatic.

Perform t-test as below.

```
test <- t.test(mpg ~ am, data = mtcars)
```

The result is shown in 6.2. The test above gives a p-value of 0.0013736 and a 95% confidence interval of -11.2801944, -3.2096842, suggesting a difference in MPG between automatic and manual transmission.

4. Quantify the MPG difference between automatic and manual transmissions

Select model to in a Stepwise Algorithm.

```
selectModel = step(lm(data = mtcars, mpg ~ .), trace=0, steps=10000)
print(selectModel$call)
```

```
## lm(formula = mpg ~ wt + qsec + am, data = mtcars)
```

The result is shown in 6.3. From the result, we can choose the model with 3 variable: `wt`, `qsec` and `am`.

```
model <- lm(mpg~am:wt + am:qsec, data=mtcars)
```

The result is shown in 6.4.

5. Conclusion

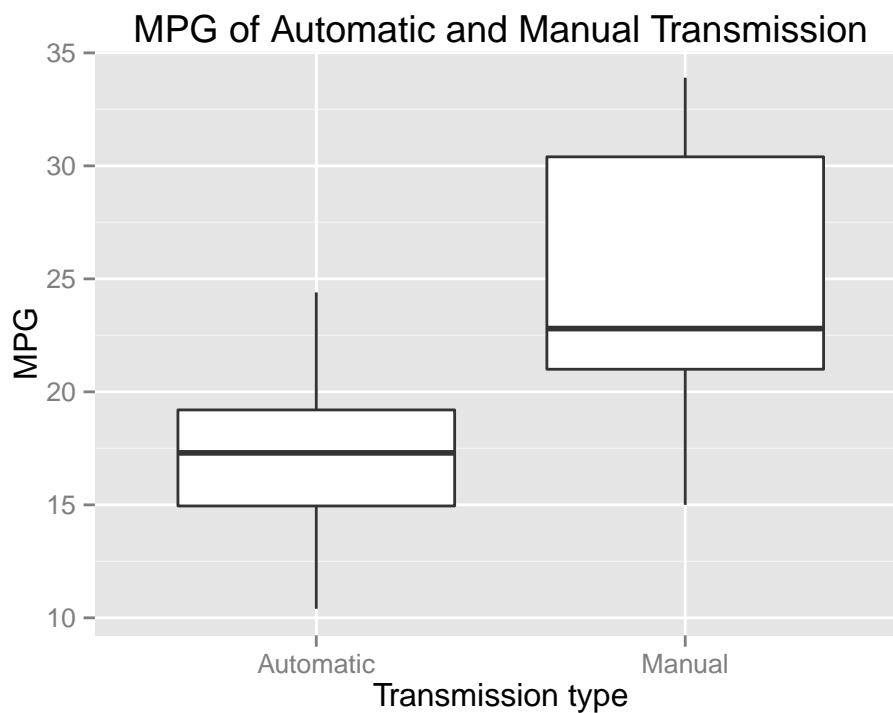
The model we choose in 4 takes `wt`, `qsec` and `am` into consideration. The `mpg` is largely determined by the interplay between weight, acceleration and transmission. Cars with manual transmission have better MPG performance when the weight gets heavier. But for cars with higher acceleration speed, automatic beats manual on MPG performance.

As a result, the question of automatic and manual transmission cannot be answered without taking weight and acceleration into consideration.

6. Appendix

6.1.

```
library(ggplot2)
p <- ggplot(mtcars, aes(am, mpg))
p + geom_boxplot() +
  ggtitle("MPG of Automatic and Manual Transmission") +
  labs(x="Transmission type", y="MPG")
```



6.2.

```
print(test)
```

```
##
```

```
## Welch Two Sample t-test
##
## data: mpg by am
## t = -3.7671, df = 18.332, p-value = 0.001374
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -11.280194 -3.209684
## sample estimates:
## mean in group Automatic mean in group Manual
## 17.14737 24.39231
```

6.3.

```
summary(selectModel)
```

```
##
## Call:
## lm(formula = mpg ~ wt + qsec + am, data = mtcars)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -3.4811 -1.5555 -0.7257  1.4110  4.6610
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   9.6178     6.9596   1.382 0.177915
## wt           -3.9165     0.7112  -5.507 6.95e-06 ***
## qsec          1.2259     0.2887   4.247 0.000216 ***
## amManual      2.9358     1.4109   2.081 0.046716 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.459 on 28 degrees of freedom
## Multiple R-squared:  0.8497, Adjusted R-squared:  0.8336
## F-statistic: 52.75 on 3 and 28 DF, p-value: 1.21e-11
```

6.4.

```
summary(model)
```

```
##
## Call:
## lm(formula = mpg ~ am:wt + am:qsec, data = mtcars)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -3.9361 -1.4017 -0.1551  1.2695  3.8862
##
## Coefficients:
```

```
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)    13.9692     5.7756   2.419  0.02259 *
## amAutomatic:wt  -3.1759     0.6362  -4.992  3.11e-05 ***
## amManual:wt     -6.0992     0.9685  -6.297  9.70e-07 ***
## amAutomatic:qsec  0.8338     0.2602   3.205  0.00346 **
## amManual:qsec    1.4464     0.2692   5.373  1.12e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.097 on 27 degrees of freedom
## Multiple R-squared:  0.8946, Adjusted R-squared:  0.879
## F-statistic: 57.28 on 4 and 27 DF,  p-value: 8.424e-13
```

```
par(mfrow=c(2, 2))
plot(model)
```

