Interaction Between Transmission Type and MPG

KTezel

12/19/2020

Executive Summary

Motor Trend is a magazine about the automobile industry. It is interested in exploring the relationship between a set of variables and miles per gallon (MPG) (outcome), particularly:

"Is an automatic or manual transmission better for MPG" "Quantify the MPG difference between automatic and manual transmissions"

From the dataset, it is clear that there is a significant difference between the average mpg per automatic and manual transmission. To show the differences between average mpg per transmission type, a boxplot method is used to show the differences between median mpgs. Then, hypothesis testing, specifically, T-test is used to see whether the difference between the differences in means are significant or not. According to the T-test, differences were significant and that the mpg for automatic cars were higher than that of the cars with manual transmission.

Libraries

```
library(ggplot2)
library(dplyr)
```

```
##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##     filter, lag

## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
library(tidyr)
```

Getting the Data

```
data(mtcars)
```

Data Preprocessing

```
mtcars$cyl <- as.factor(mtcars$cyl)
mtcars$vs <- as.factor(mtcars$vs)
mtcars$am <- factor(mtcars$am)
mtcars$gear <- factor(mtcars$gear)
mtcars$carb <- factor(mtcars$carb)
```

Exploratory Data Analysis

Looking at data briefly

```
head(mtcars)
```

```
##                   mpg cyl disp  hp drat    wt  qsec vs am gear carb
## Mazda RX4         21.0   6  160 110 3.90 2.620 16.46  0  1    4    4
## Mazda RX4 Wag     21.0   6  160 110 3.90 2.875 17.02  0  1    4    4
## Datsun 710        22.8   4  108  93 3.85 2.320 18.61  1  1    4    1
## Hornet 4 Drive    21.4   6  258 110 3.08 3.215 19.44  1  0    3    1
## Hornet Sportabout 18.7   8  360 175 3.15 3.440 17.02  0  0    3    2
## Valiant           18.1   6  225 105 2.76 3.460 20.22  1  0    3    1
```

```
dim(mtcars)
```

```
## [1] 32 11
```

Looking for missing data

There is no missing data.

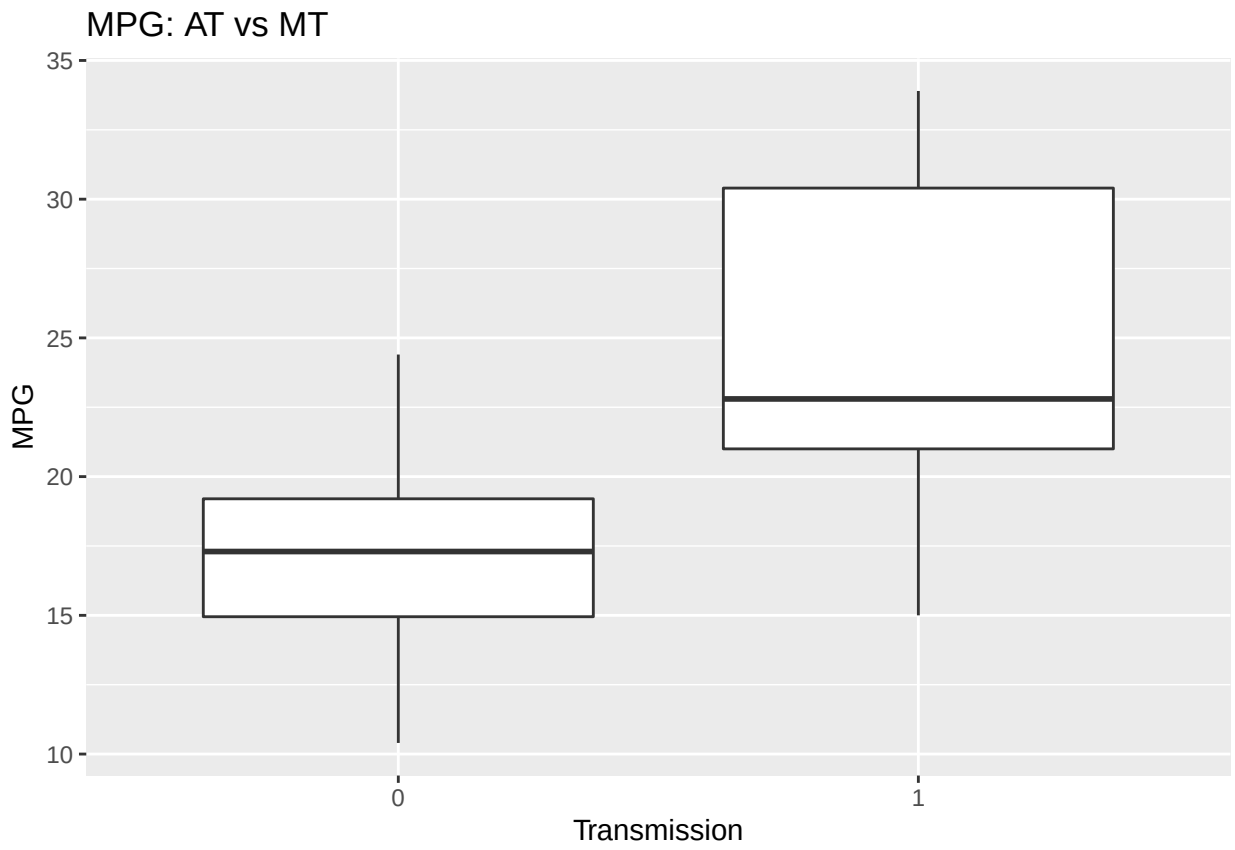
```
colSums(is.na(mtcars))
```

```
##  mpg  cyl disp   hp drat   wt qsec   vs   am gear carb
##    0    0    0    0    0    0    0    0    0    0    0
```

Plotting MPG and Automatic Transmission (1 = Yes, 2 = No)

From the plot graph, it looks like when the transmission is automatic, MPG increases. Below is the boxplot graph. It can be clearly seen that the median MPG is higher for the cars with automatic transmission.

```
p2 <- ggplot(data = mtcars, aes(factor(am),mpg)) + geom_boxplot() + labs(x= "Transmission", y = "MPG", t
p2
```



Inference

Are the differences in mean mpg between automatic and manual is significant? Let's use T-test to verify.

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

```
##
##  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 0 mean in group 1
##        17.14737        24.39231
```

P-value from the t-test is very small which suggest that our null hypothesis is false, hence suggesting that the difference in mean mpg between automatic and manual is pretty significant.

Regression Analysis

Checking to see the relationship between MPG and Transmission

Linear Regression

```
fit_lm <- lm(mpg ~ am, data=mtcars)
summary(fit_lm)
```

```
##
## Call:
## lm(formula = mpg ~ am, data = mtcars)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -9.3923 -3.0923 -0.2974  3.2439  9.5077
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   17.147      1.125  15.247 1.13e-15 ***
## am1            7.245      1.764   4.106 0.000285 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4.902 on 30 degrees of freedom
## Multiple R-squared:  0.3598, Adjusted R-squared:  0.3385
## F-statistic: 16.86 on 1 and 30 DF,  p-value: 0.000285
```

Linear regression model predicts that when the car is automatic, it increases the mpg by approximately 7 miles. Intercept and the coefficients are significant and the variables explain approximately 36% (R-squared 0.3598) of the variation in MPG which is not a good model since 35% R-squared value is not good enough.

Other Regression Models

Below are some other models that has some higher R-squared ratio. For the purposes of this report, only the R-squared values will be extracted from the report.

```
summary(lm(mpg~wt*factor(cyl),data=mtcars))$r.squared
```

```
## [1] 0.861561
```

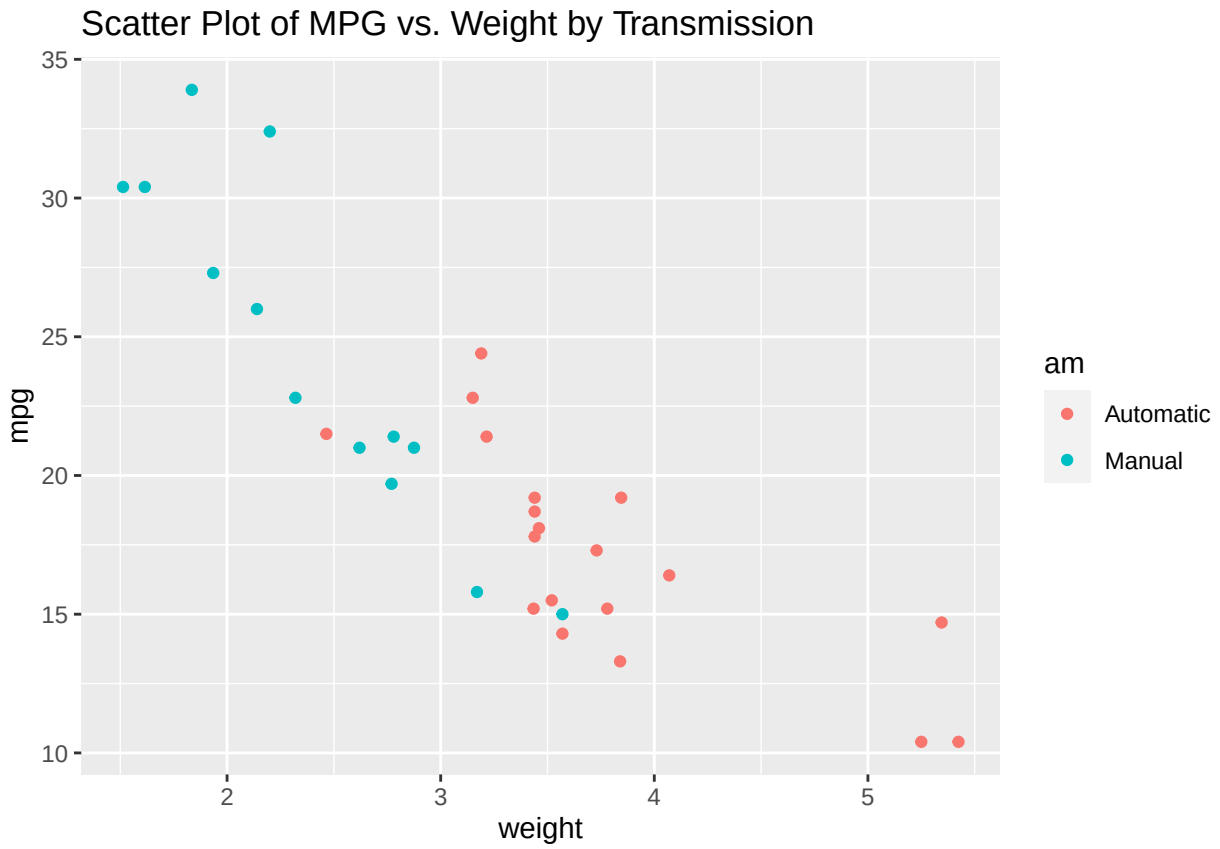
```
summary(lm(mpg~wt+factor(cyl),data=mtcars))$r.squared
```

```
## [1] 0.8374325
```

Appendix

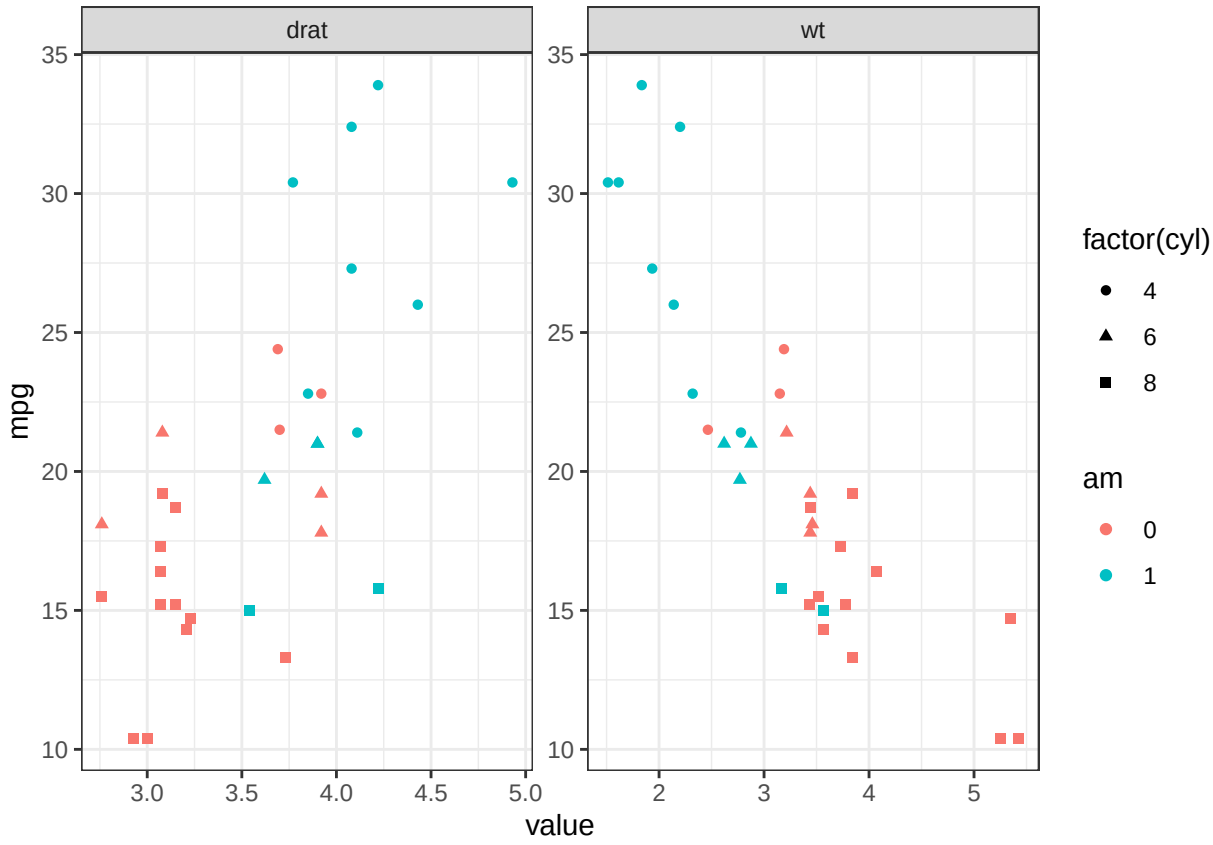
```
ggplot(mtcars, aes(x=wt, cyl, drat, y=mpg, group=am, color=am, height=3, width=3)) + geom_point() +
scale_colour_discrete(labels=c("Automatic", "Manual")) +
xlab("weight") + ggtitle("Scatter Plot of MPG vs. Weight by Transmission")
```

```
## Warning: Duplicated aesthetics after name standardisation:
```



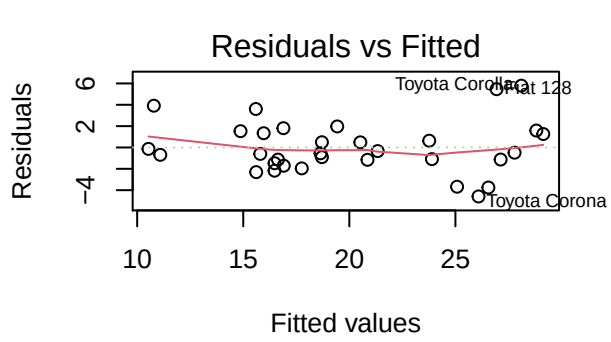

```
mtcars_subset <- subset(mtcars, select = c(mpg, cyl, wt, drat, am))
```

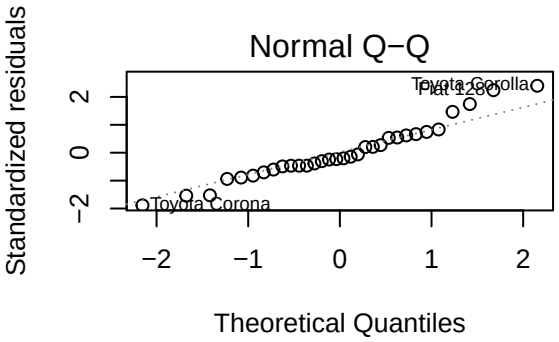
```
mtcars_subset %>%
    gather(-mpg, -am, -cyl, key="var", value = "value") %>%
    ggplot(aes(x = value, y = mpg, color = am, shape = factor(cyl))) +
    geom_point() +
    facet_wrap(~ var, scales = "free") +
    theme_bw()
```

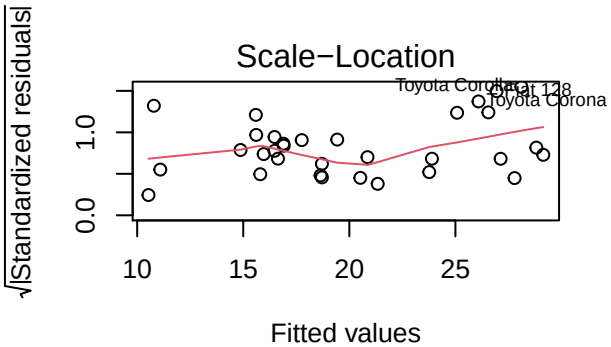


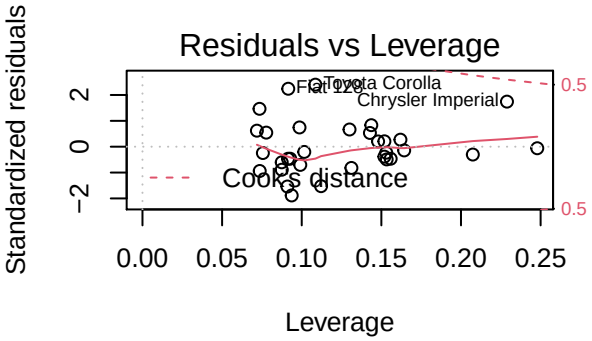
Residual Plot for the best model

```
fit_1 <- lm(mpg~wt+factor(cyl),data=mtcars)
par(mfrow = c(2,2))
plot(fit_1)
```


Residuals vs Fitted
Residuals
Fitted values
Toyota Corolla
Fiat 128
Toyota Corona
10
15
20
25
−4
2
6


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


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


Residuals vs Leverage
Standardized residuals
Leverage
Toyota Corolla
Fiat 128
Chrysler Imperial
Cook's distance
0.5
0.5
0.00
0.05
0.10
0.15
0.20
0.25
−2
0
2