Regression Models Course Project

Vedant Naik

26/08/2020

Executive Summary

This is a report prepared as part of the coursework required for the Coursera Regression Models course. The instructions for this report assignment state as follows:

You work for Motor Trend, a magazine about the automobile industry. Looking at a data set of a collection of cars, they are interested in exploring the relationship between a set of variables and miles per gallon (MPG) (outcome). They are particularly interested in the following two questions:

- Is an automatic or manual transmission better for MPG?

- Quantify the MPG difference between automatic and manual transmissions

We will use the mtcars dataset, as documented at the following link: https://stat.ethz.ch/R-manual/R-devel/library/datasets/html/mtcars.html

Our analysis demonstrates the following:

1.Manual transmission will yield better miles per gallon, when compared with Automatic. On average, a manual car will achieve 24 mpg, versus 17 mpg for automatics.

2.Further analysis shows a correlation between MPG and the following confounding variables:

-wt (Weight). The greater the weight of the car, the less MPG

-cyl (number of engine cylinders)

Data analysis

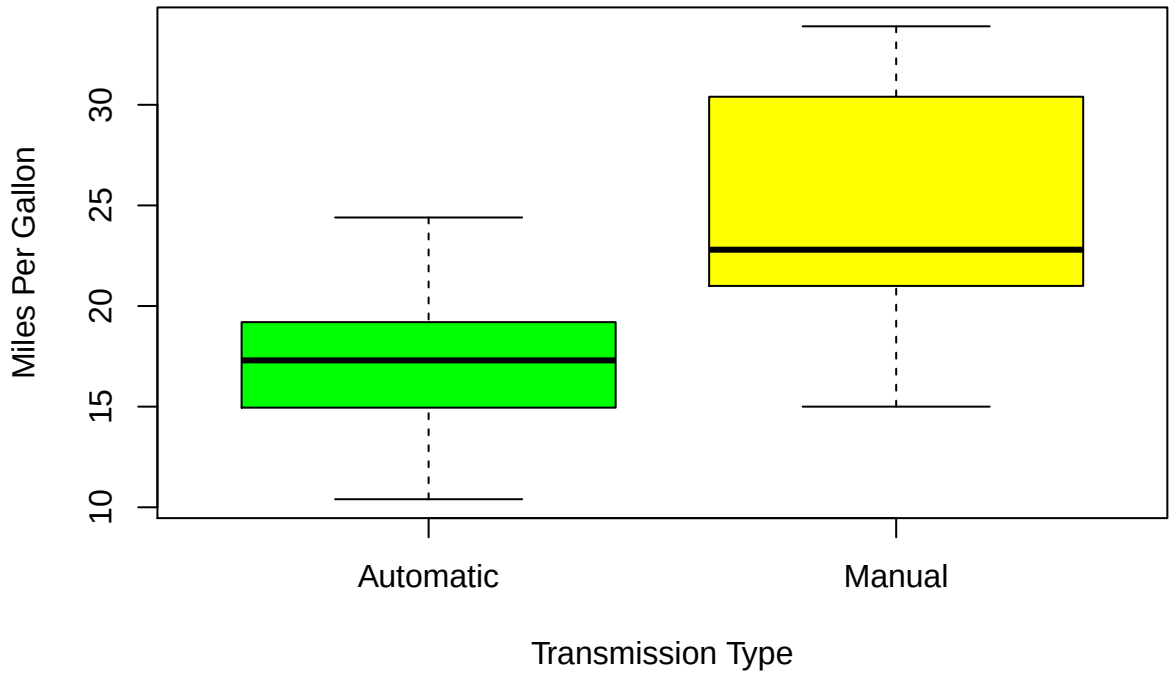
We load the data set, and perform an initial plot of Transmission Types:

```
library(ggplot2)
data(mtcars)
mtcars$vs <- factor(mtcars$vs)
mtcars$am.label <- factor(mtcars$am, labels=c("Automatic","Manual")) # 0=automatic, 1=manual
mtcars$gear <- factor(mtcars$gear)
mtcars$carb <- factor(mtcars$carb)
head(mtcars)
```

```
##                   mpg cyl disp  hp drat    wt  qsec vs am gear carb  am.label
## Mazda RX4         21.0   6  160 110 3.90 2.620 16.46  0  1    4    4    Manual
## Mazda RX4 Wag     21.0   6  160 110 3.90 2.875 17.02  0  1    4    4    Manual
## Datsun 710        22.8   4  108  93 3.85 2.320 18.61  1  1    4    1    Manual
```

```
## Hornet 4 Drive    21.4   6  258 110 3.08 3.215 19.44  1  0    3    1 Automatic
## Hornet Sportabout 18.7   8  360 175 3.15 3.440 17.02  0  0    3    2 Automatic
## Valiant           18.1   6  225 105 2.76 3.460 20.22  1  0    3    1 Automatic
```

```
boxplot(mpg ~ am.label, data = mtcars, col = (c("green","yellow")), ylab = "Miles Per Gallon", xlab = "
```



We can see from the boxplot that Manual Transmission provides better MPG. We will analyze this further in the remaining sections

Regression Analysis

We can also calculate mean MPG values for cars with Automatic and Manual transmission as follows:

```
aggregate(mtcars$mpg,by=list(mtcars$am.label),FUN=mean)
```

```
##     Group.1        x
## 1 Automatic 17.14737
## 2    Manual 24.39231
```

We can see again that Manual transmission yields on average 7 MPG more than Automatic, Let's now test this hypothesis with a Simple Linear Regression Test:

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

```
##
## Call:
## lm(formula = mpg ~ factor(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 ***
## factor(am)1    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
```

The p-value is less than 0.0003, so we will not reject the hypothesis. However, the R-squared value for this test is only ~= .35, suggesting that only a third or so of variance in MPG can be attributed to transmission type alone. Let's perform an Analysis of Variance for the data:

```
T_variance_analysis <- aov(mpg ~ ., data = mtcars)
summary(T_variance_analysis)
```

```
##             Df Sum Sq Mean Sq F value  Pr(>F)
## cyl          1  817.7   817.7 102.591 2.3e-08 ***
## disp         1   37.6    37.6   4.717 0.04525 *
## hp           1    9.4     9.4   1.176 0.29430
## drat         1   16.5    16.5   2.066 0.16988
## wt           1   77.5    77.5   9.720 0.00663 **
## qsec         1    3.9     3.9   0.495 0.49161
## vs           1    0.1     0.1   0.016 0.90006
## am           1   14.5    14.5   1.816 0.19657
## gear         2    2.3     1.2   0.145 0.86578
## carb         5   19.0     3.8   0.477 0.78789
## Residuals   16  127.5     8.0
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

From the above Analysis of Variance, we can look for p-values of less than .5. This gives us cyl, disp, and wt to consider in addition to transmission type (am)

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

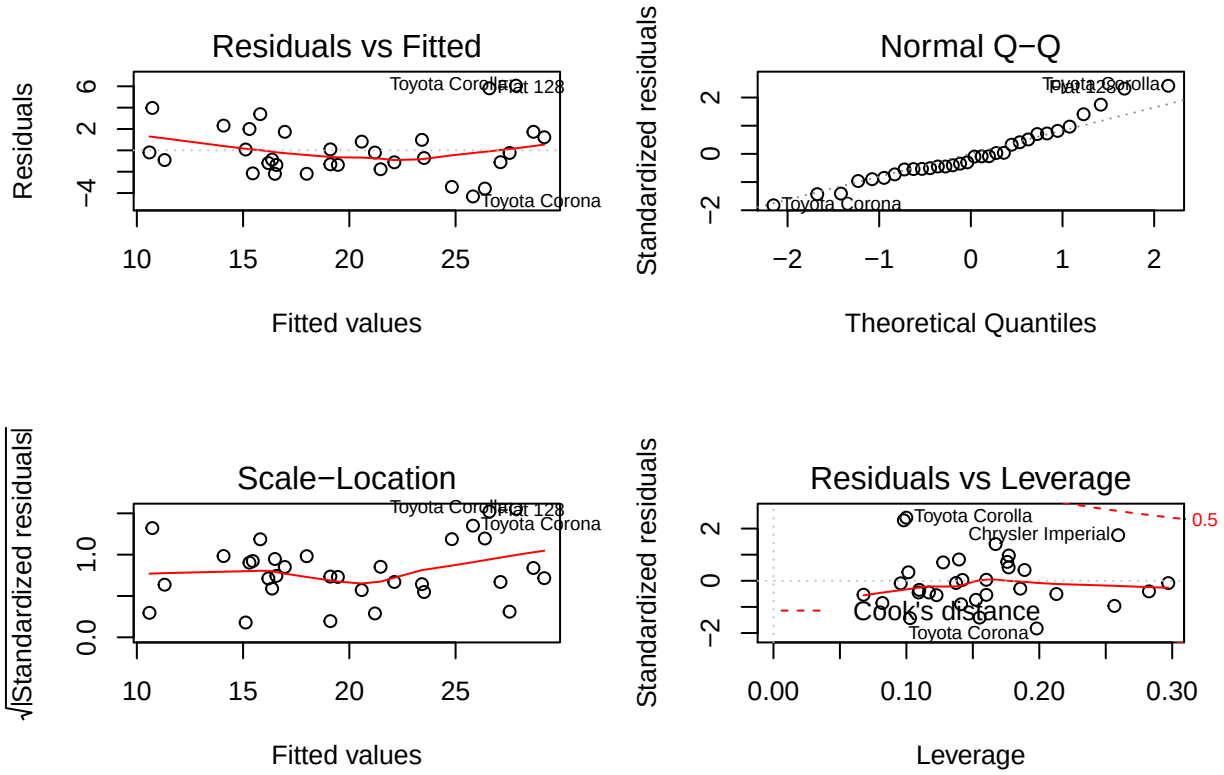
```
##
```

```
## Call:
## lm(formula = mpg ~ cyl + disp + wt + am, data = mtcars)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -4.318 -1.362 -0.479  1.354  6.059
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 40.898313   3.601540  11.356 8.68e-12 ***
## cyl         -1.784173   0.618192  -2.886  0.00758 **
## disp         0.007404   0.012081   0.613  0.54509
## wt          -3.583425   1.186504  -3.020  0.00547 **
## am           0.129066   1.321512   0.098  0.92292
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.642 on 27 degrees of freedom
## Multiple R-squared:  0.8327, Adjusted R-squared:  0.8079
## F-statistic: 33.59 on 4 and 27 DF,  p-value: 4.038e-10
```

This Multivariable Regression test now gives us an R-squared value of over .83, suggesting that 83% or more of variance can be explained by the multivariable model. P-values for cyl (number of cylinders) and weight are below 0.5, suggesting that these are confounding variables in the relation between car Transmission Type and Miles per Gallon.

Residual Plot and analysis

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



The "Residuals vs Fitted" plot here shows us that the residuals are homoscedastic. We can also see that they are normally distributed, with the exception of a few outliers.