Regression Models Project

Jill Beck

April 3, 2016

Background

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?"

Executive Summary

The transmission of the car certainly plays a role in the car's MPG. A 95% T test of the transmission of the cars to mpg shows that they are not the same and is significantly significant. In addition, a model for mpg using the transmission, weight and horsepower for the dependent variables can compensate for about 84% of the variation. The sample size used is limited and is using data from 1974. It is not indicative of present-day autos.

Exploratory Data Analysis

Load data and convert into factors.

```
library(ggplot2)
require(gridExtra)
```

```
## Loading required package: gridExtra
```

```
## Warning in library(package, lib.loc = lib.loc, character.only = TRUE,
## logical.return = TRUE, : there is no package called 'gridExtra'
```

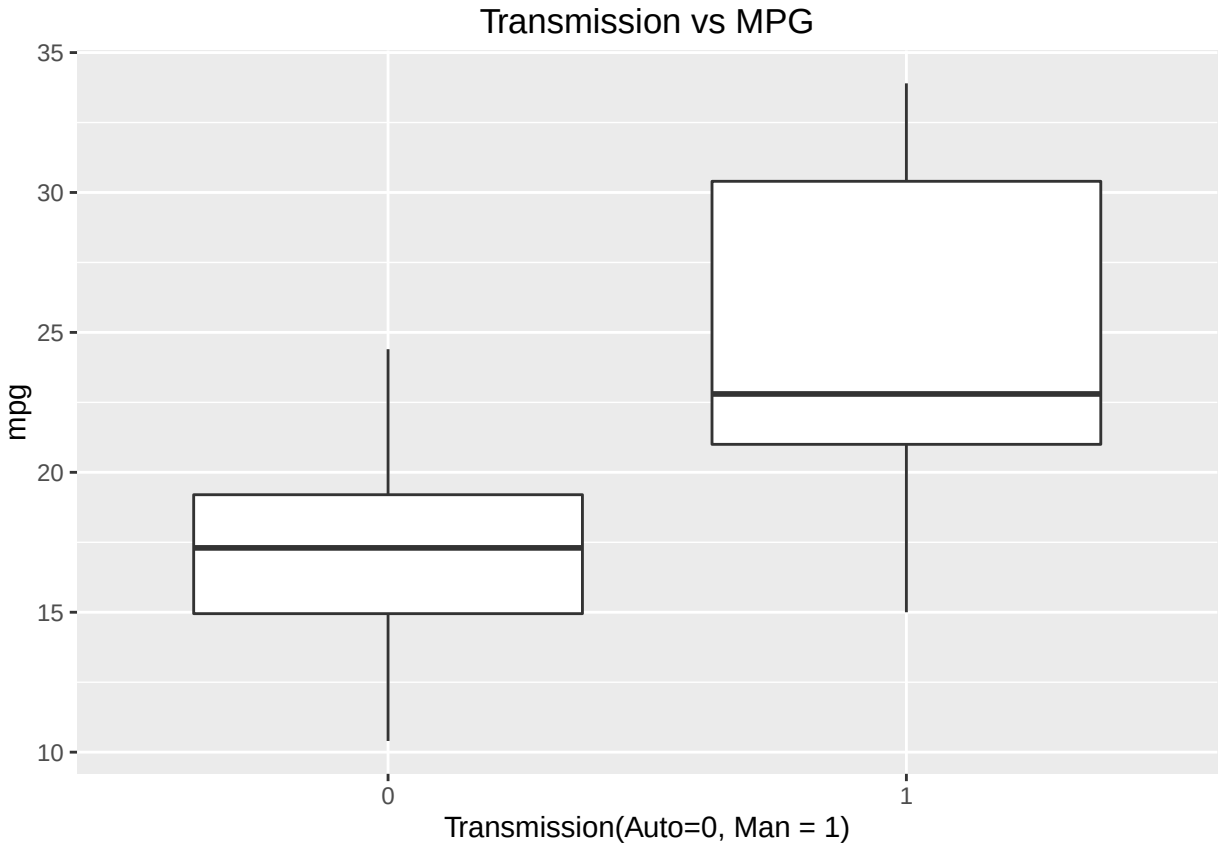
```
data(mtcars)

mtcars$am = as.factor(mtcars$am)
mtcars$cyl = as.factor(mtcars$cyl)
mtcars$gear = as.factor(mtcars$gear)
mtcars$car = as.factor(mtcars$carb)
mtcars$vs = as.factor(mtcars$vs)

auto = subset(mtcars, mtcars$am == 0)
man = subset(mtcars, mtcars$am == 1)
```

A quick plot is created to see how the data is distributed amongst transmission type and MPG.

```
ggplot(mtcars, aes(x=am, y=mpg)) + geom_boxplot(data=mtcars) + labs(title='Transmission vs MPG', x='Tra
```



As can be seen in the figure above, manual cars appear to have a higher maximum MPG and minimum MPG. A significant delta exists in MPG with manual cars compared to automatic cars.

```
t.test(man$mpg, auto$mpg)
```

```
##
##  Welch Two Sample t-test
##
## data:  man$mpg and auto$mpg
## 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:
##   3.209684 11.280194
## sample estimates:
## mean of x mean of y
##  24.39231  17.14737
```

In reviewing the two item T test of both the manual and automatic transmissions, a 95% confidence interval of 3.21-11.28 exists demonstrating a likely difference between manual and automatic transmissions. The p value is low enough to reject the notion that no difference exists between mpg amongst transmissions and that manual is better for MPG than automatic. In addition, the difference in the means can be easily seen with manual autos having an average MPG of 24.39 and automatics having an average MPG of 17.1.

Regression Modeling

```
model1 = lm(mpg ~ ., data=mtcars)
summary(model1)
```

```
##
## Call:
## lm(formula = mpg ~ ., data = mtcars)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3.5087 -1.3584 -0.0948  0.7745  4.6251
##
## Coefficients: (1 not defined because of singularities)
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 22.84336   19.99148   1.143   0.2711
## cyl6        -2.64870    3.04089  -0.871   0.3975
## cyl8        -0.33616    7.15954  -0.047   0.9632
## disp         0.03555    0.03190   1.114   0.2827
## hp          -0.07051    0.03943  -1.788   0.0939 .
## drat         1.18283    2.48348   0.476   0.6407
## wt          -4.52978    2.53875  -1.784   0.0946 .
## qsec         0.36784    0.93540   0.393   0.6997
## vs1          1.93085    2.87126   0.672   0.5115
## am1          1.21212    3.21355   0.377   0.7113
## gear4        1.11435    3.79952   0.293   0.7733
## gear5        2.52840    3.73636   0.677   0.5089
## carb         1.03577    1.19437   0.867   0.3995
## car2        -2.01513    2.20142  -0.915   0.3745
## car3         0.92809    3.40346   0.273   0.7888
## car4        -2.01590    2.89087  -0.697   0.4963
## car6        -0.70130    4.25377  -0.165   0.8713
## car8              NA         NA      NA       NA
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.833 on 15 degrees of freedom
## Multiple R-squared:  0.8931, Adjusted R-squared:  0.779
## F-statistic:  7.83 on 16 and 15 DF,  p-value: 0.000124
```

A preliminary linear model on data(mtcars) blindly checking the effect other variables would have on the MPG shows that MPG is not highly dependent on any of the independent variables. The coffecient of am is about 2.52023, which means that it has a greater weight in determining the MPG, as the value goes higher (car is manual).

```
data(mtcars)
sort(cor(mtcars)[1,])
```

```
##         wt        cyl       disp         hp       carb       qsec
## -0.8676594 -0.8521620 -0.8475514 -0.7761684 -0.5509251  0.4186840
##       gear         am         vs       drat        mpg
##  0.4802848  0.5998324  0.6640389  0.6811719  1.0000000
```

The correlation of the data is checked to see which variables are related to MPG. wt, cyl, disp, and hp all appear to be highly correlated to MPG.

- disp and cyl appear correlated to one another and would be as higher cylinders in a engine would be capable of greater displacement.
- wt and hp would generally be typical logical guesses to indicators of MPG.

```
model2 = lm(mpg ~ am + wt + hp, data=mtcars)
summary(model2)
```

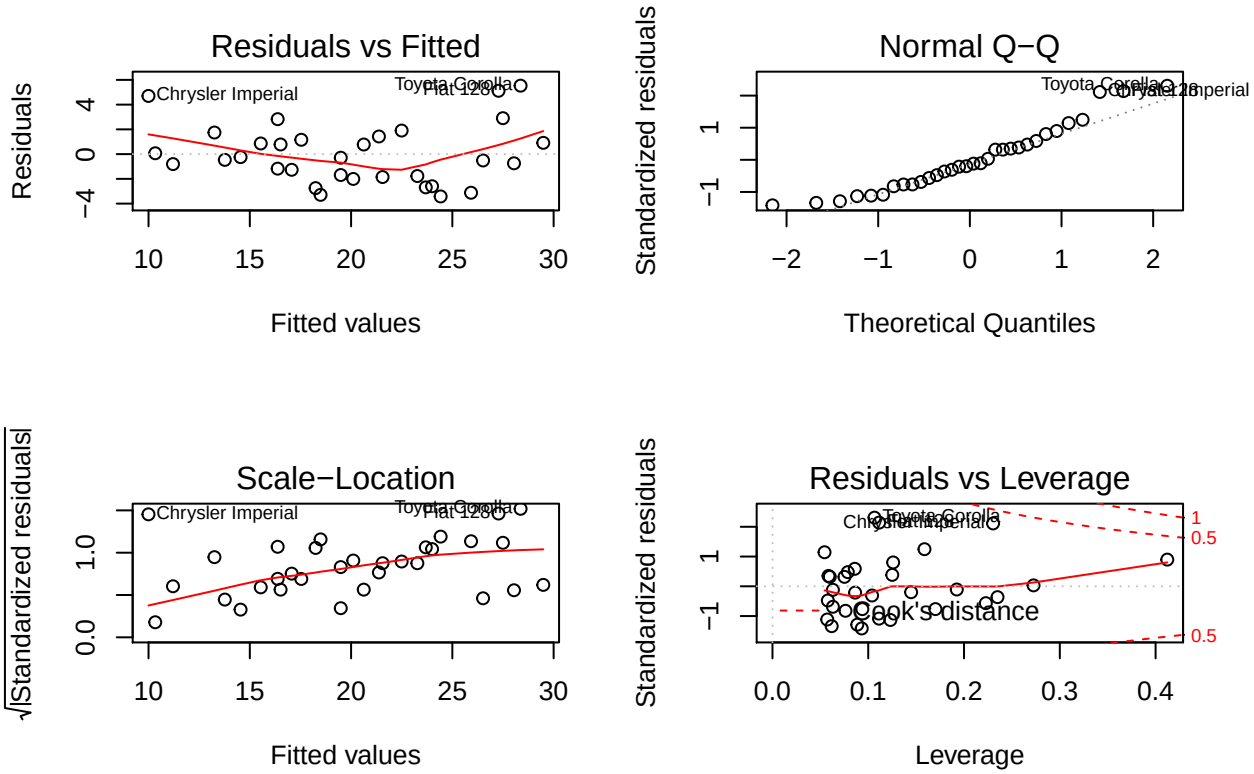
```
##
## Call:
## lm(formula = mpg ~ am + wt + hp, data = mtcars)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3.4221 -1.7924 -0.3788  1.2249  5.5317
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 34.002875   2.642659  12.867 2.82e-13 ***
## am           2.083710   1.376420   1.514 0.141268
## wt          -2.878575   0.904971  -3.181 0.003574 **
## hp          -0.037479   0.009605  -3.902 0.000546 ***
## ---
## 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
```

```
anova(model1, model2)
```

```
## Analysis of Variance Table
##
## Model 1: mpg ~ cyl + disp + hp + drat + wt + qsec + vs + am + gear + carb +
##     car
## Model 2: mpg ~ am + wt + hp
##   Res.Df    RSS  Df Sum of Sq      F Pr(>F)
## 1     15 120.40
## 2     28 180.29 -13   -59.888 0.5739 0.8394
```

Model3 is not signficantly better than the first model. The variables in determining the MPG are individually much more significant to determing the actual MPG.

```
par(mfrow = c(2,2))
plot(model2)
```



The residuals appear normally distributed on the Q-Q graph, and no obvious patterns exist on the residuals vs fitted on the distribution of residuals.