Is Transmission type better for MPG

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Executive Summary

The purpose of this paper is to explore the relationship between a set of variables and miles per gallon(mpg) as part of a class project using the mtcars dataset. It will focus on answering two questions: "Is an automatic or manual transmission better for MPG" and "Quantify the MPG difference between automatic and manual transmissions". Based on the analysis below there is a relationsip between MPG and transmission type.

Data Analysis

EDA

First we'll start by exploring relationships in the data. We'll do this by creating a correlation matrix and pairwise plots of all of the variabes. (See appendix). Interestingly enough all the variables seem to have strong correlations with mpg. It's also noted that we will need to convert several of the variables from numeric to factor variables prior to feeding into a regression model.

From there we will work to build a regression model to determine determine how Transmission (0 = automatic, 1 = manual) relates to MPG.

Variable Selection and model building

To get started with variable selection we start with a simple model of transmission vs. mpg.

```
fit1 <- lm(mpg~am,data=regdata)
```

The model is significant with a p-value of 0.000285020744. However, given the lower R-squared 0.33846 we'll work to include more predictors to get a better explaination of the variable in mpg. To do this we'll run a stepwise regression and compare the models.

```
fit2 <- lm(mpg~cyl+disp+hp+drat+wt+qsec+vs+am+gear+carb,data=regdata)
stepModel <- step(fit2, k=log(nrow(regdata)))
```

From the stepwise regression, we find a signifcant model with a pvalue of 1.2e-11 and a much better R-squared, 0.83356.

Comparing the two models using the anova function we also verify that adding in wt and qsec is than just am.

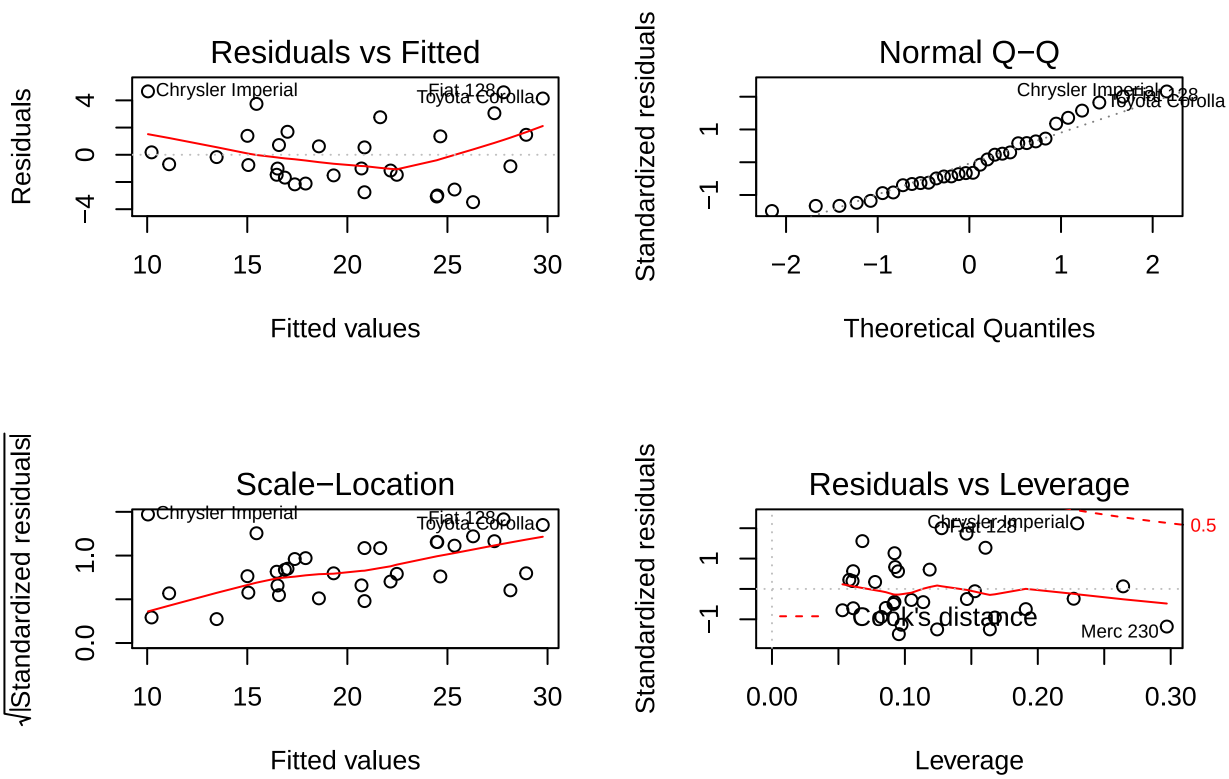
```
anova(fit1,stepModel)
```

```
## Analysis of Variance Table
##
## Model 1: mpg ~ am
## Model 2: mpg ~ wt + qsec + am
```

```
##   Res.Df RSS Df Sum of Sq    F  Pr(>F)
## 1     30 721
## 2     28 169  2       552 45.6 1.6e-09 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

With a model selected lets do some quick diagnostic plots.

```r
par(mfrow=c(2,2))
plot(stepModel)
```



Looking at the plot of the fit values vs. the residuals, there does not seem to be any heteroskedasticity and the errors center around zero. The Normal Q-Q plot also doesn't show any strong depatures from normality. The Scale Location and Residuals vs. Leverage

Lastly, to answer the given questions, we can execute a T-test on the transition parameter,am, from the model. From this we can find that the paramater is moderately signifcant, 0.04672. Thus, a manual transmission provides 2.93584 more miles per gallon keeping in mind there is a lot variation around the estimate. The 95% CI for the interval is [0.04573,5.82594].

Appendix

Plots

```r
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
```

```r
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 ...
```

```r
cor(mtcars)
```

```
##            mpg        cyl       disp         hp        drat         wt        qsec
## mpg   1.00000 -0.85216 -0.84755 -0.77617  0.681172 -0.86766  0.418684
## cyl  -0.85216  1.00000  0.90203  0.83245 -0.699938  0.78250 -0.591242
## disp -0.84755  0.90203  1.00000  0.79095 -0.710214  0.88798 -0.433698
## hp   -0.77617  0.83245  0.79095  1.00000 -0.448759  0.65875 -0.708223
## drat  0.68117 -0.69994 -0.71021 -0.44876  1.000000 -0.71244  0.091205
## wt   -0.86766  0.78250  0.88798  0.65875 -0.712441  1.00000 -0.174716
## qsec  0.41868 -0.59124 -0.43370 -0.70822  0.091205 -0.17472  1.000000
## vs    0.66404 -0.81081 -0.71042 -0.72310  0.440278 -0.55492  0.744535
## am    0.59983 -0.52261 -0.59123 -0.24320  0.712711 -0.69250 -0.229861
## gear  0.48028 -0.49269 -0.55557 -0.12570  0.699610 -0.58329 -0.212682
## carb -0.55093  0.52699  0.39498  0.74981 -0.090790  0.42761 -0.656249
##            vs         am      gear       carb
## mpg   0.66404  0.599832  0.48028 -0.550925
## cyl  -0.81081 -0.522607 -0.49269  0.526988
## disp -0.71042 -0.591227 -0.55557  0.394977
## hp   -0.72310 -0.243204 -0.12570  0.749812
## drat  0.44028  0.712711  0.69961 -0.090790
## wt   -0.55492 -0.692495 -0.58329  0.427606
## qsec  0.74454 -0.229861 -0.21268 -0.656249
## vs    1.00000  0.168345  0.20602 -0.569607
## am    0.16835  1.000000  0.79406  0.057534
## gear  0.20602  0.794059  1.00000  0.274073
## carb -0.56961  0.057534  0.27407  1.000000
```

```r
pairs(mtcars, panel=panel.smooth)
```