Automatic Transmition Impact on MPG

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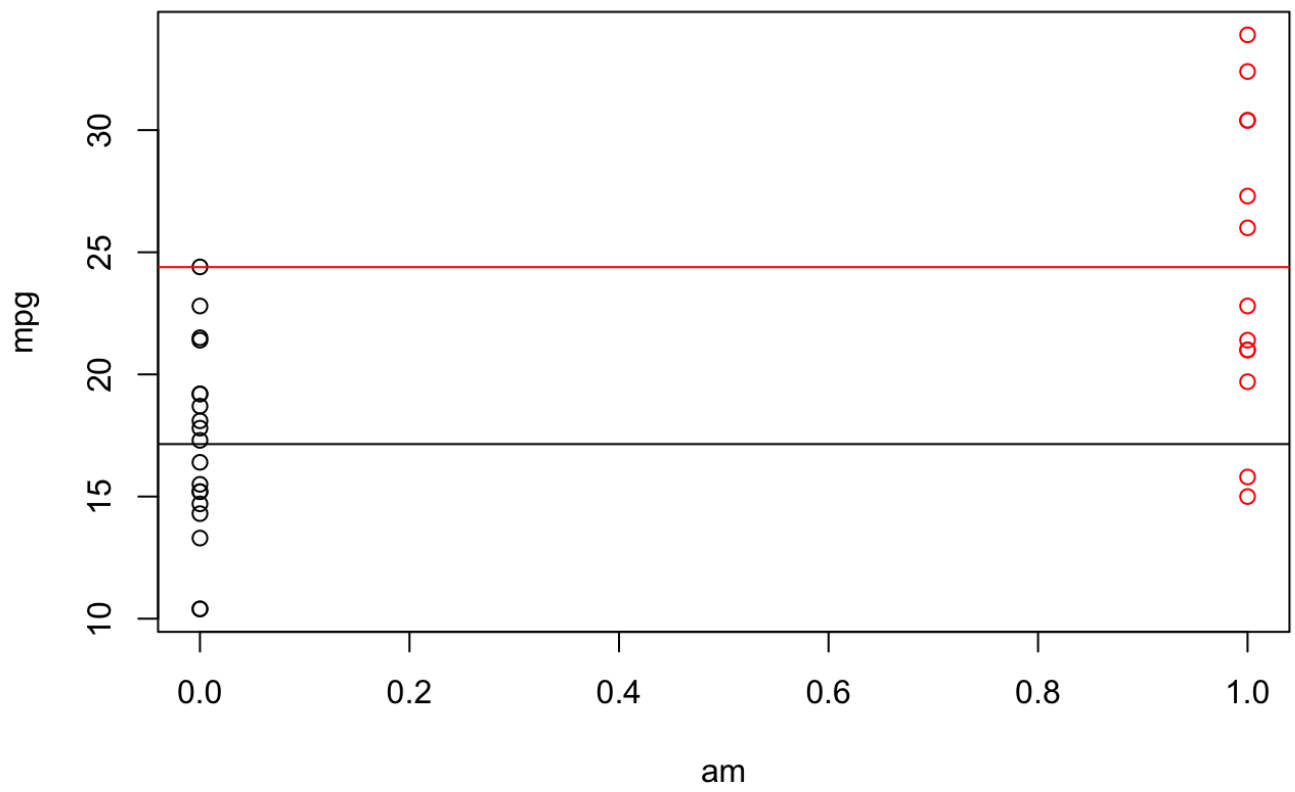
Executive Summary

It is not possible to quantify the MPG difference between automatic and manual transmissions in a given data set. There is no evidence in data to substantiate the claim that any kind of transmission is better for MPG. The superficial relation between MPG and transsmission type can be entirely explained by the weight of an engine.

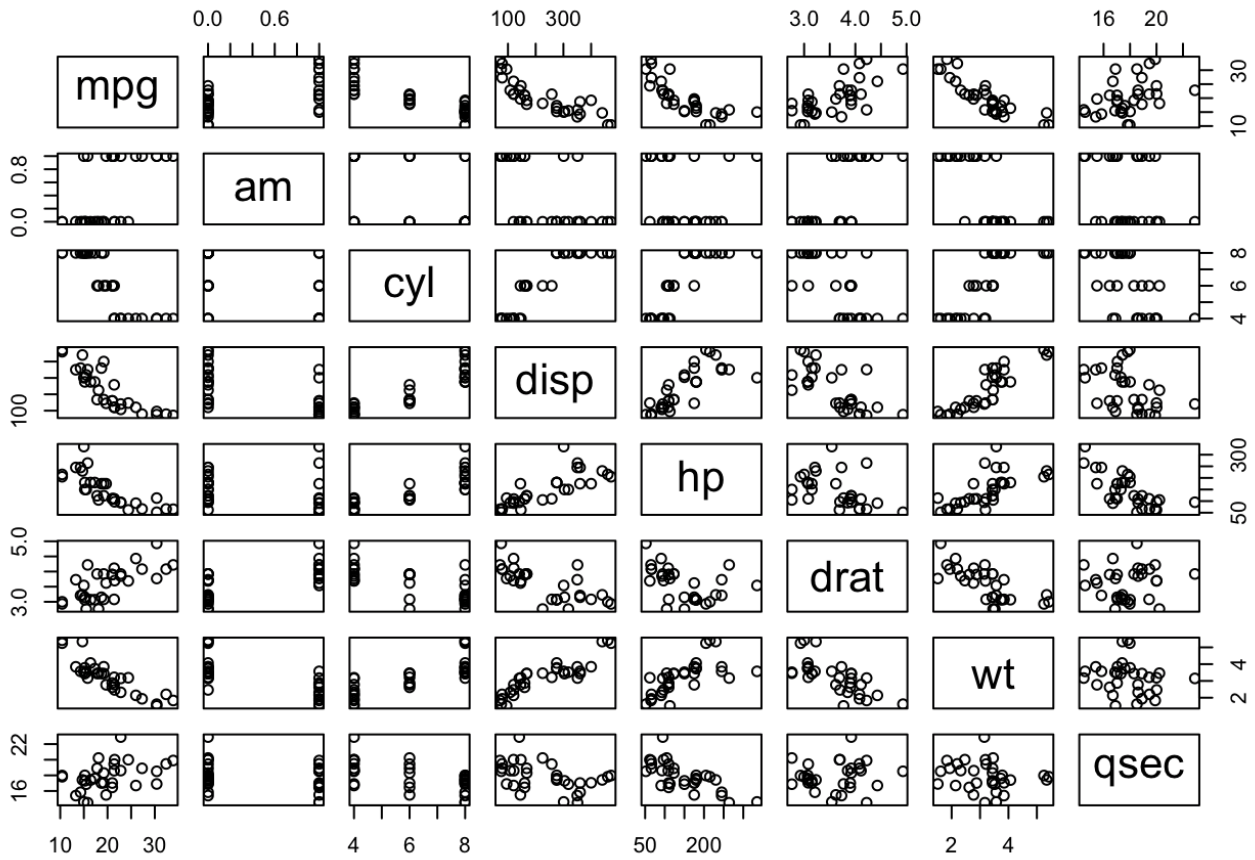
However there is a corelation between weight of an engine and a transmision type. Probably, the enginees with automatic transmission are heavier (or maybe data set is skewed).

Data Exploration

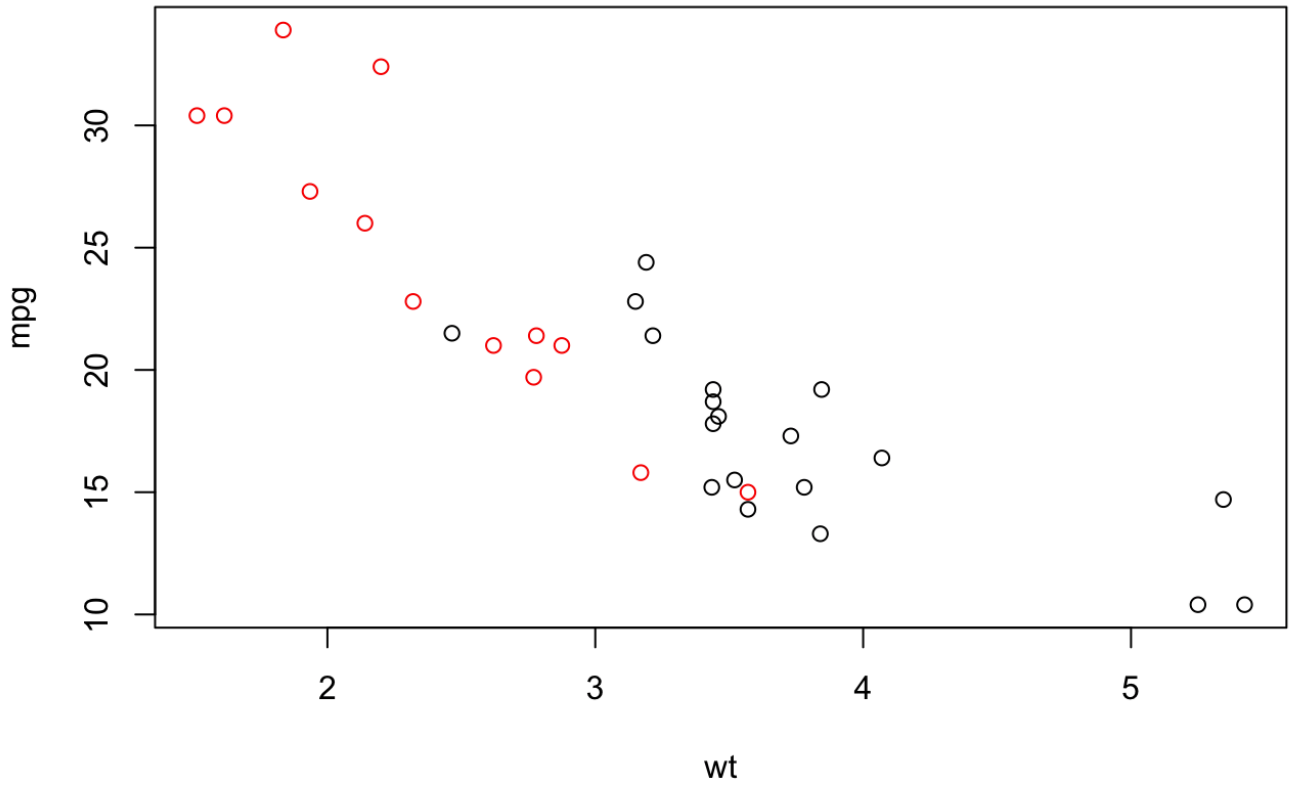
At a first glance on a data we can see that the average MPG for the automatic transmition (black) is lower than form manual transmition (red). Is that enough to draw a conclusion? No. Let's take a look on other columns.



We can see that there is high corellation between MPG and other columns - wegith, number of cylinders, displacement etc. So, the corelation between the transmition mode can be explained by other data.



Further more there is correlation between weight and type of transmition. The heavier enigines in data set have also automatic transmission. Maybe there is casual relation or maybe the data set is skewed? It is hard to determine.

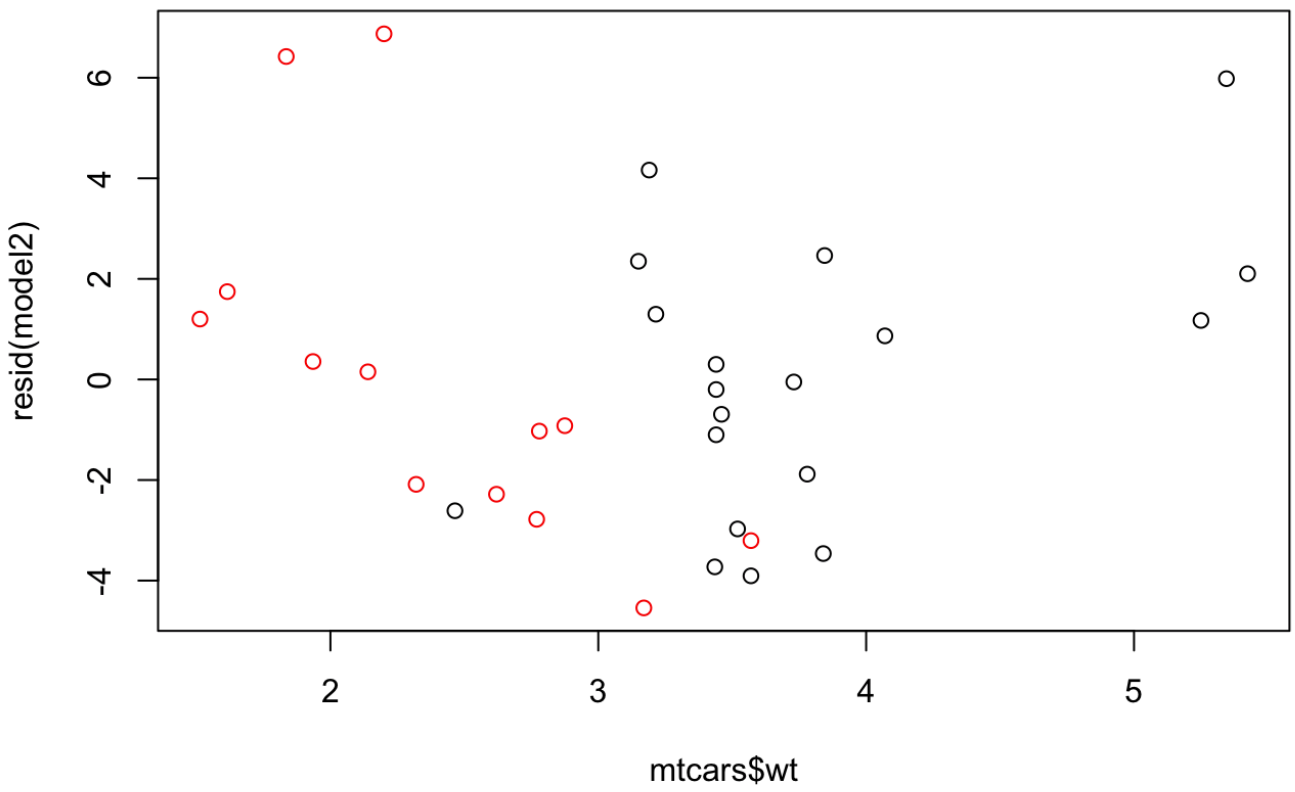


Model selection.

First, I tried to use all avilable fields to explain MPG. The results are explained in Appendix 1. The most significant results were for weight. Still, the p value was above 0.05. I decided to try the model solelly based on this param.

```
##
## Call:
## lm(formula = mpg ~ wt, data = mtcars)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -4.5432 -2.3647 -0.1252  1.4096  6.8727
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  37.2851     1.8776  19.858  < 2e-16 ***
## wt           -5.3445     0.5591  -9.559 1.29e-10 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.046 on 30 degrees of freedom
## Multiple R-squared:  0.7528, Adjusted R-squared:  0.7446
## F-statistic: 91.38 on 1 and 30 DF,  p-value: 1.294e-10
```

And perform the residual analysis - the forementioned corelation between weight and transmision type is still visible.



At last, I performed the analysis of model based on weight and transmission type:

```
##
## Call:
## lm(formula = mpg ~ wt + am, data = mtcars)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -4.5295 -2.3619 -0.1317  1.4025  6.8782
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 37.32155    3.05464  12.218 5.84e-13 ***
## wt          -5.35281    0.78824  -6.791 1.87e-07 ***
## am          -0.02362    1.54565  -0.015    0.988
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.098 on 29 degrees of freedom
## Multiple R-squared:  0.7528, Adjusted R-squared:  0.7358
## F-statistic: 44.17 on 2 and 29 DF,  p-value: 1.579e-09
```

There significance level for the relation between weight and transmission type is very low (p = 0.988). There is no way to draw a conclusion about the relation from the data. The relation between MPG and transmission type can be sollely explained by weight (with high significance level). The drop of MPG per 1 thousand lb is 5.35281 with standard error 0.78824.

Appendix

Appendix 1 - Full Model

```
##
## Call:
## lm(formula = mpg ~ ., data = mtcars)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3.4506 -1.6044 -0.1196  1.2193  4.6271
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 12.30337   18.71788   0.657   0.5181
## cyl         -0.11144    1.04502  -0.107   0.9161
## disp         0.01334    0.01786   0.747   0.4635
## hp          -0.02148    0.02177  -0.987   0.3350
## drat         0.78711    1.63537   0.481   0.6353
## wt          -3.71530    1.89441  -1.961   0.0633 .
## qsec         0.82104    0.73084   1.123   0.2739
## vs           0.31776    2.10451   0.151   0.8814
## am           2.52023    2.05665   1.225   0.2340
## gear         0.65541    1.49326   0.439   0.6652
## carb        -0.19942    0.82875  -0.241   0.8122
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.65 on 21 degrees of freedom
## Multiple R-squared:  0.869,  Adjusted R-squared:  0.8066
## F-statistic: 13.93 on 10 and 21 DF,  p-value: 3.793e-07
```