

Analysis of the Relationship between MPG and Type of Transmission

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Executive Summary

This report seeks to explore the relationship between miles per gallon (mpg) and type of transmission (automatic or manual). Manual transmission cars were found to be better for mpg than automatic transmission cars.

Summary of data

The set of variables which we consider in this analysis are the number of cylinders (cyl), engine displacement (disp), gross horsepower (hp), rear axle ratio (drat), weight of car (wt), quarter mile time (qsec), vehicle shape (vs), transmission type (am), number of forward gears (gear) and number of carburetors (carb).

From the summary plots given in Appendix 1, we can observe that there seems to be a linear relationship between mpg and cyl, disp, hp, wt and carb. In addition, it also seems that there is a difference in mpg for different vehicle shape and type of transmission.

Analysis

For the analysis, we fit regression models to identify variables which are associated with mpg. A variable with a p-value of less than 0.05 is considered to be significant. If there are more than one variable which are significantly associated with mpg, we will proceed to fit a multivariable regression model with all the significant variables. We will use the stepwise selection method to retain significant variables in the multivariable regression model, and remove variables which are not. From the multivariable model, the variable with the largest p-value will be removed first, and the model refitted with the remaining variables. The process of removing the variable with the largest p-value will be carried out iteratively till the variables left in the multivariable model are all significant.

Results from regression models

We fitted regression models for each variable with mpg separately. The p-values for all the variables fitted were less than 0.05, indicating that all the variables were significantly associated with mpg. In particular, we show the results of the regression model with type of transmission as the explanatory variable in the table below.

| | Estimate | Std. Error | t value | Pr(> t) |
|-------------|----------|------------|---------|----------|
| (Intercept) | 17.1474 | 1.1246 | 15.25 | 0.0000 |
| am | 7.2449 | 1.7644 | 4.11 | 0.0003 |

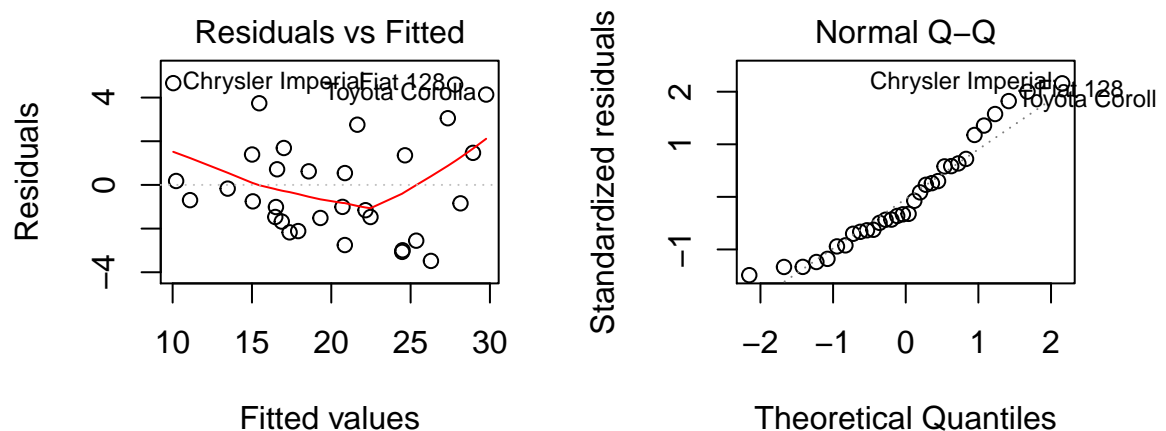
From the results, we estimate an expected 7.24 increase in mpg when comparing a manual transmission car to an automatic transmission car. This seems to suggest that a manual transmission car is better for mpg, as compared to an automatic transmission car.

We fit a multivariable regression model next, following the steps outlined previously to only retain significant variables in the final model. The final multivariable regression model had the variables car weight (wt), quarter mile time (qsec) and type of transmission (am) in the model. The coefficients from the model with the associated p-values are shown in the table below.

| | Estimate | Std. Error | t value | Pr(> t) |
|-------------|----------|------------|---------|----------|
| (Intercept) | 9.6178 | 6.9596 | 1.38 | 0.1779 |
| wt | -3.9165 | 0.7112 | -5.51 | 0.0000 |
| qsec | 1.2259 | 0.2887 | 4.25 | 0.0002 |
| am | 2.9358 | 1.4109 | 2.08 | 0.0467 |

From the results, we estimate an expected -3.92 decrease in mpg for every 1000 lbs increase in car weight, while holding the remaining variables constant. We also estimate an expected 1.23 increase in mpg for every second increase in quarter mile time, while holding the remaining variables constant. For type of transmission, we estimate an expected 2.94 increase in mpg for manual transmission cars when compared to automatic transmission cars, while holding the remaining variables constant.

Residual and diagnostic plots



plot-1.pdf

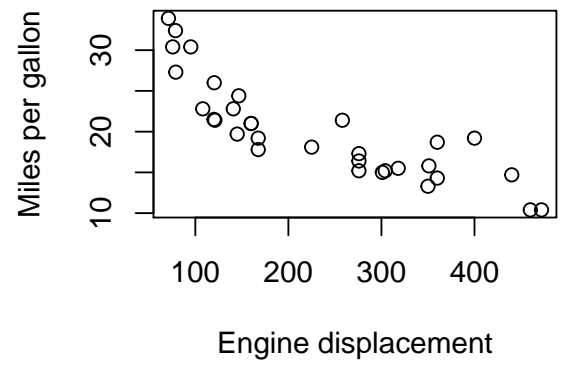
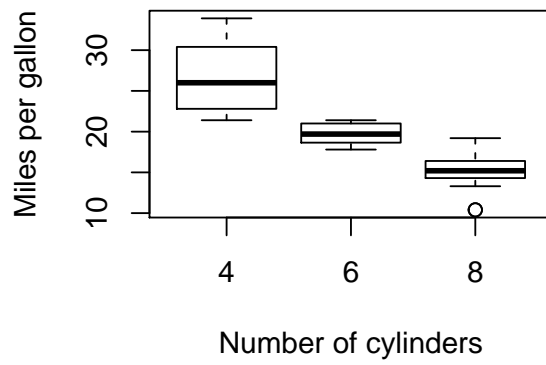
The residuals versus fitted plot for the multivariable regression model indicate that there is some correlation between the residuals and fitted values. The normal Q-Q plot seem to deviate from normality at the ends.

Conclusion

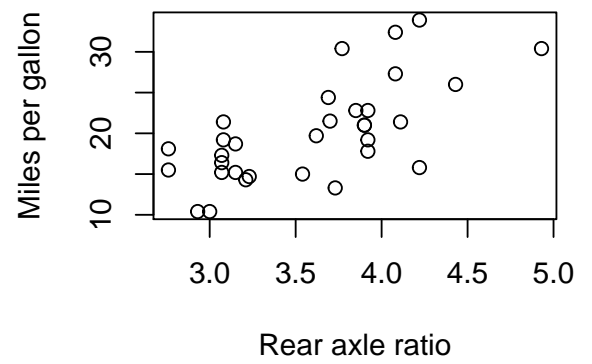
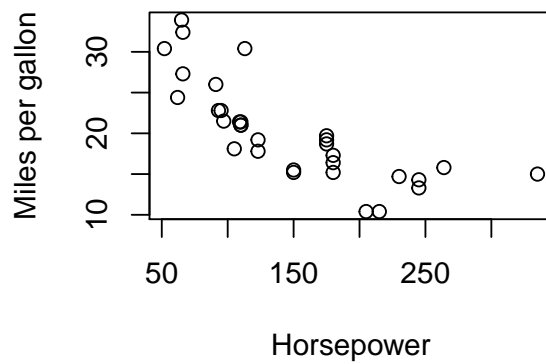
In this study, we found that manual transmission was better for mpg than automatic transmission, even after adjusting for weight of car and quarter mil time which were significantly associated with mpg. Manual transmission cars were able to travel 2.94 mpg more than automatic transmission cars.

Note: This report was authored in R Markdown and compiled to pdf via knitr). To view the raw source, please visit the GitHub repo associated with this project at the following link:<https://github.com/cindylim/MotorTrend>

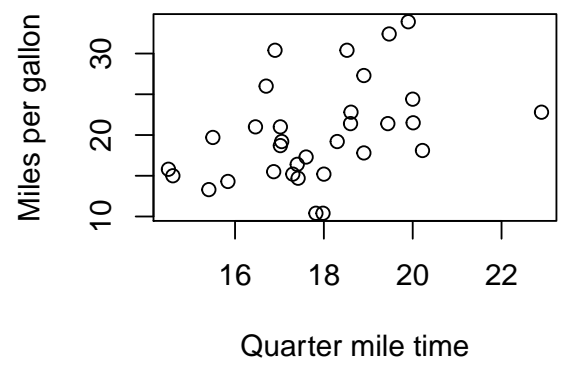
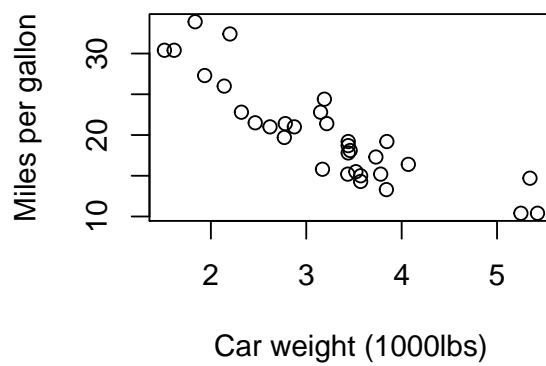
Appendix 1: Exploratory Analysis Plots



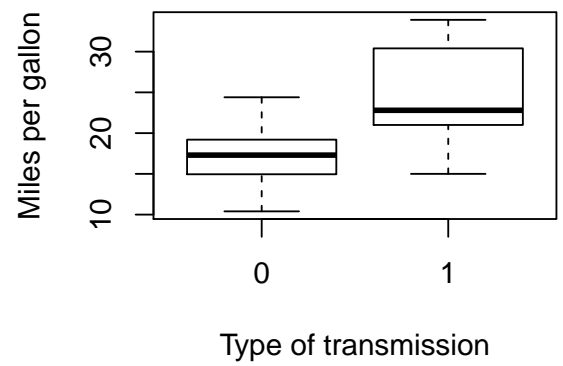
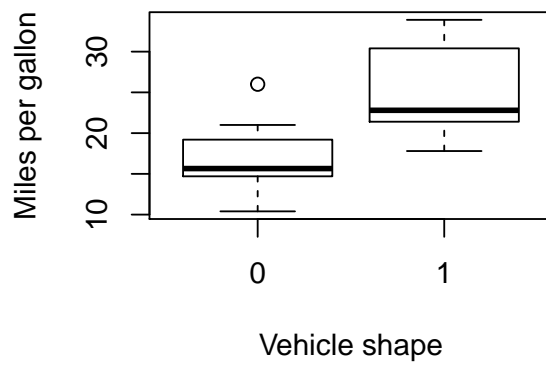
plot-1.pdf



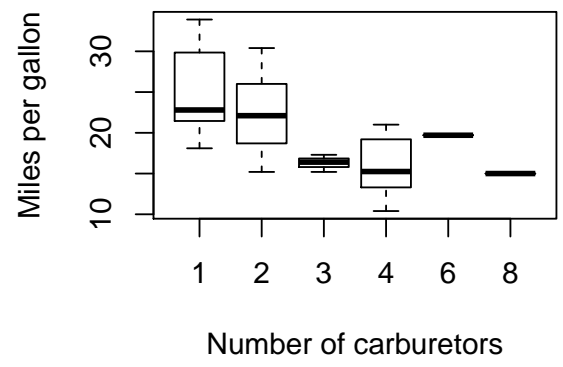
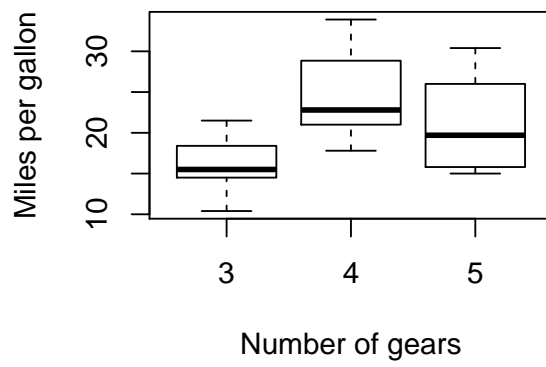
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