Regression Models: Week-4 Course Project

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Synopsis This report was made in the context of the course "Regression models" delivered by Johns Hopkins University (Coursera.) This report aims at answering the following questions: Looking at a data set of a collection of cars, explore the relationship between a set of variables and miles per gallon (MPG) (outcome).

1- Is an automatic or manual transmission better for MPG?

2- Quantify the MPG difference between automatic and manual transmissions.

The data was extracted from the 1974 Motor Trend US magazine, and comprises fuel consumption and 10 aspects of automobile design and performance for 32 automobiles (1973-74 models). Source: Henderson and Velleman (1981), Building multiple regression models interactively. Biometrics, 37, 391-411. #### Load Data Load the dataset and convert categorical variables to factors.

```
library(ggplot2)
```

```
## Warning: package 'ggplot2' was built under R version 4.0.3
```

```
data(mtcars)
head(mtcars, n=3)
dim(mtcars)
mtcars$cyl <- as.factor(mtcars$cyl)
mtcars$vs <- as.factor(mtcars$vs)
mtcars$am <- factor(mtcars$am)
mtcars$gear <- factor(mtcars$gear)
mtcars$carb <- factor(mtcars$carb)
attach(mtcars)
```

Exploratory Analysis **See Appendix Figure I** Exploratory Box graph that compares Automatic and Manual transmission MPG. The graph leads us to believe that there is a significant increase in MPG when for vehicles with a manual transmission vs automatic.

Statistical Inference T-Test transmission type and MPG

```
testResults <- t.test(mpg ~ am)
testResults$p.value
```

```
## [1] 0.001373638
```

The T-Test rejects the null hypothesis that the difference between transmission types is 0.

```r
testResults$estimate
```

```
## mean in group 0 mean in group 1
##        17.14737        24.39231
```

The difference estimate between the 2 transmissions is 7.24494 MPG in favor of manual.

Regression Analysis Fit the full model of the data

```r
fullModelFit <- lm(mpg ~ ., data = mtcars)
summary(fullModelFit)  # results hidden
summary(fullModelFit)$coeff  # results hidden
```

Since none of the coefficients have a p-value less than 0.05 we cannot conclude which variables are more statistically significant.

Backward selection to determine which variables are most statistically significant

```r
stepFit <- step(fullModelFit)
summary(stepFit) # results hidden
summary(stepFit)$coeff # results hidden
```

The new model has 4 variables (cylinders, horsepower, weight, transmission). The R-squared value of 0.8659 confirms that this model explains about 87% of the variance in MPG. The p-values also are statistically significantly because they have a p-value less than 0.05. The coefficients conclude that increasing the number of cylinders from 4 to 6 with decrease the MPG by 3.03. Further increasing the cylinders to 8 with decrease the MPG by 2.16. Increasing the horsepower is decreases MPG 3.21 for every 100 horsepower. Weight decreases the MPG by 2.5 for each 1000 lbs increase. A Manual transmission improves the MPG by 1.81.

Residuals & Diagnostics Residual Plot **See Appendix Figure II**

The plots conclude:

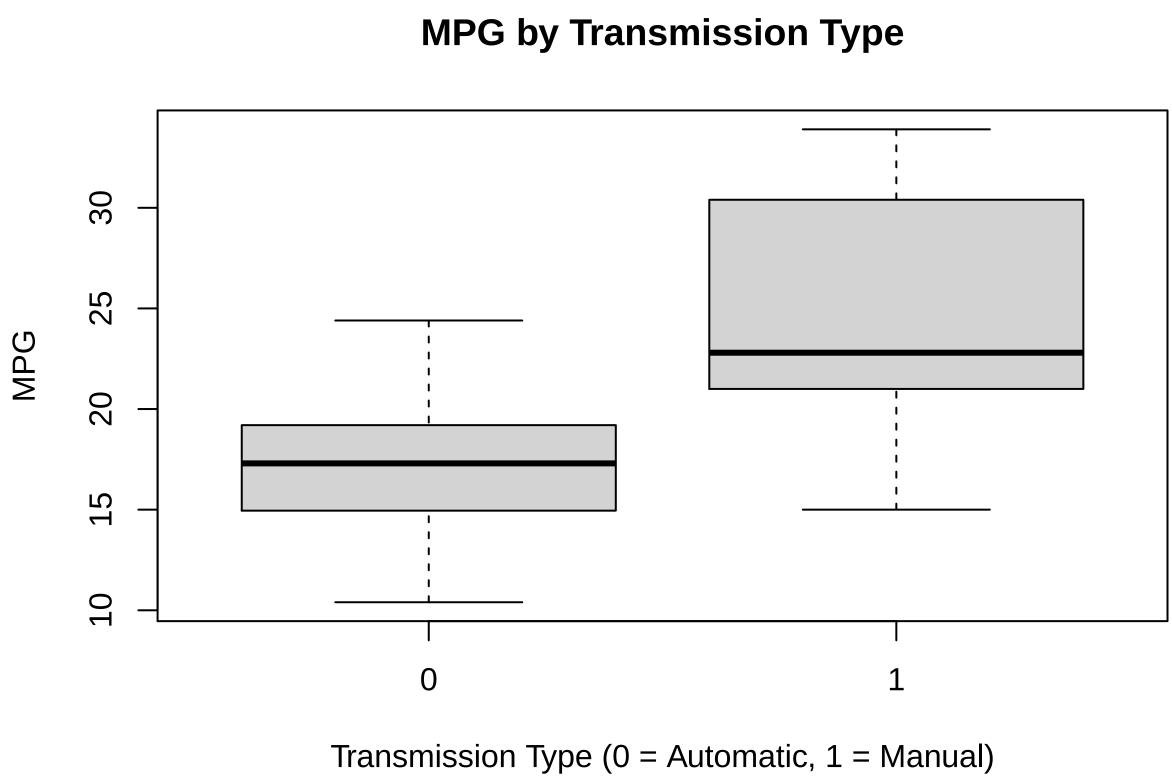
1. The randomness of the Residuals vs. Fitted plot supports the assumption of independence
2. The points of the Normal Q-Q plot following closely to the line conclude that the distribution of residuals is normal
3. The Scale-Location plot random distribution confirms the constant variance assumption
4. Since all points are within the 0.05 lines, the Residuals vs. Leverage concludes that there are no outliers

```r
sum((abs(dfbetas(stepFit)))>1)
```

```
## [1] 0
```

Conclusion There is a difference in MPG based on transmission type. A manual transmission will have a slight MPG boost. However, it seems that weight, horsepower, & number of cylinders are more statistically significant when determining MPG.

Appendix Figures



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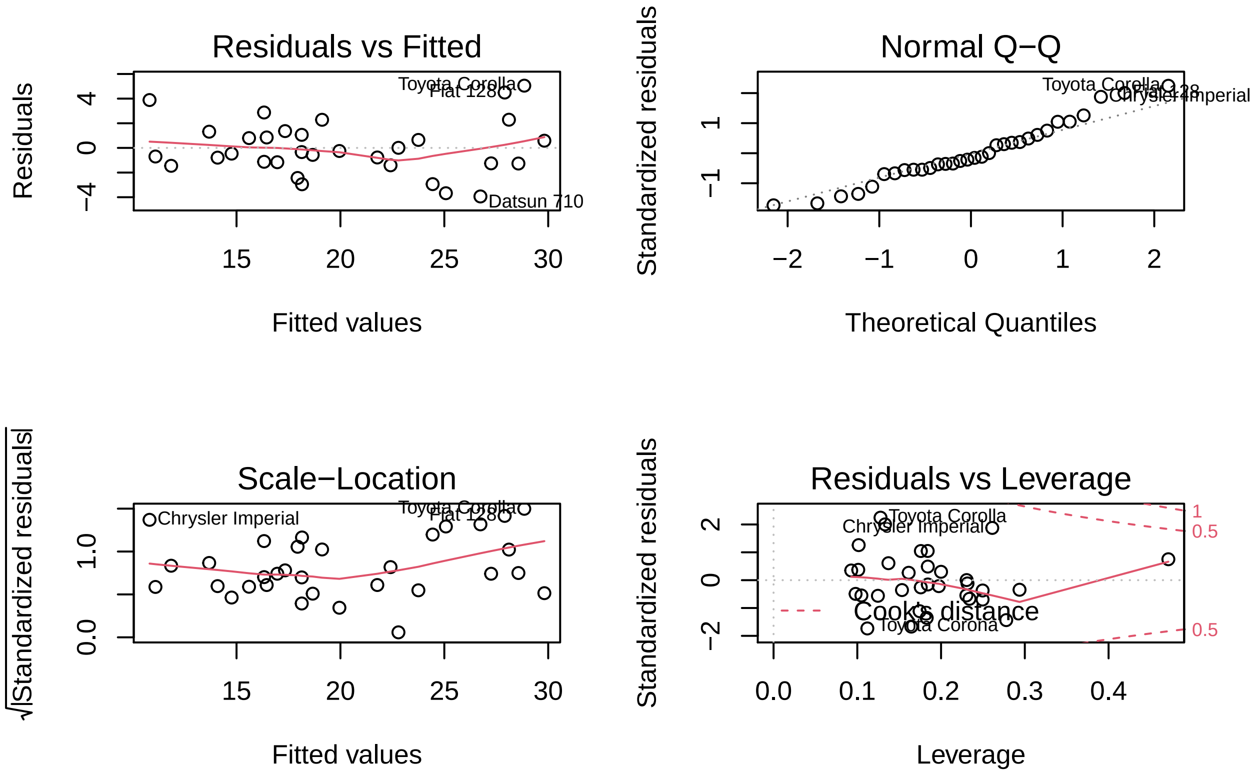
Residuals vs Fitted
Residuals
Fitted values
Toyota Corolla
Fiat 128
Datsun 710
Normal Q−Q
Standardized residuals
Theoretical Quantiles
Toyota Corolla
Chrysler Imperial
Scale−Location
√|Standardized residuals|
Fitted values
Chrysler Imperial
Toyota Corolla
Fiat 128
Residuals vs Leverage
Standardized residuals
Leverage
Toyota Corolla
Chrysler Imperial
Toyota Corona
Cook's distance
1
0.5
0.5

II