Regression Models: Cars And MPG

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May 27, 2016

Executive Summary

Scenario: 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

This brief analysis considers cars fuel economy and a set of variables, in particular the car transmission (automatic versus manual). We use mtcars dataset made available by Motor Trend Magazine.
Technically, we evaluate this relationship using linear regression. ——— Based on the dataset we show that the manual transmission has an advantage over the automatic one when it comes to MPG (miles per gallon) - see Figure 1.

The Data - performing data exploration

Loading the mtcars dataset, data frame with 32 observations on 11 variables (source: https://stat.ethz.ch/R-manual/R-devel/library/datasets/html/mtcars.html).

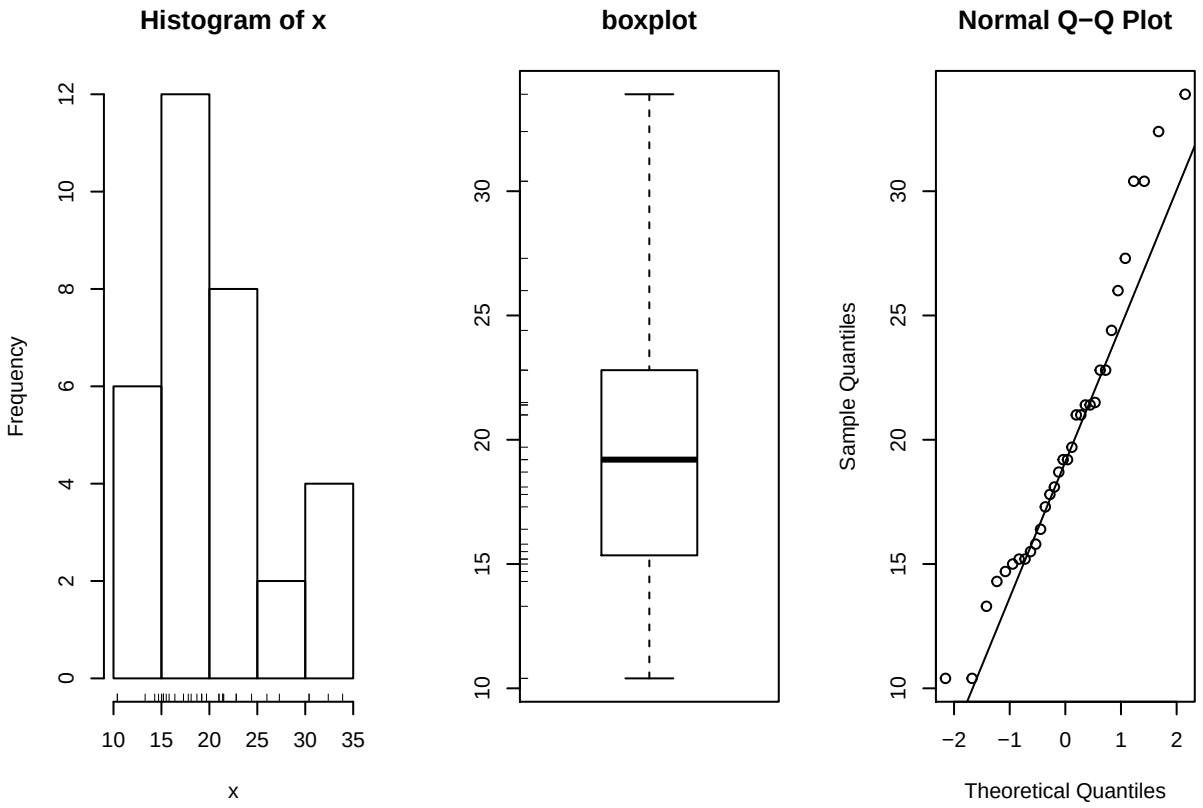
[, 1] mpg Miles/(US) gallon
[, 2] cyl Number of cylinders
[, 3] disp Displacement (cu.in.)
[, 4] hp Gross horsepower
[, 5] drat Rear axle ratio
[, 6] wt Weight (1000 lbs)
[, 7] qsec 1/4 mile time
[, 8] vs V/S
[, 9] am Transmission (0 = automatic, 1 = manual)
[,10] gear Number of forward gears
[,11] carb Number of carburetors

Loading the libraries and supressing the feedback messages.

```
library(ggplot2)
library(UsingR)
data(mtcars)
```

Looking a bit into how the mpg variable is distributed using some normal probablity plots.

```
simple.eda(mtcars$mpg)
```



We see in the above plots that:
- the cars within 15 to 25 mpg are more frequent (histogram)
- the mpg is symetrically distributed with a regular tale, as opposed to skewed (boxplot)
- the QQ plot indicates that we can aproximate this distribution as normal

Shapiro-Wilk Test - checking on population

Using Shapiro-Wilk Normality Test and getting a p-value = 0.1229 which tranlates in the fact that we cannot reject reject the NULL hypothesis that the samples came from a normal distribution.

```
shapiro.test(mtcars$mpg)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  mtcars$mpg
## W = 0.9476, p-value = 0.1229
```

T-test - comparing the means of MPG and type of transmission

We get a very small p-value which translates in the fact that the difference in means is not by chance but indeed there is clear difference in these two populations. So we reject the NULL hypothesis: “these two samples have the same means.”

```r
t.test(mtcars$mpg, mtcars$am, var.equal=TRUE, paired=FALSE)
```

```
##
##  Two Sample t-test
##
## data:  mtcars$mpg and mtcars$am
## t = 18.4126, df = 62, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  17.54734 21.82141
## sample estimates:
## mean of x mean of y
##  20.09062   0.40625
```

Regression Models

Building a regression model using Backward Stepwise Regression (starting with all predictors and removes the ones that are not statistically significant).

```r
initial.model <- lm(mpg ~., data= mtcars)
best.model <- step(initial.model, direction = "both")
```

Sumarizing the best regression model

The most significant variables are idenfied as being:
- the weight of the car (wt)
- the 1/4 mile time (qsec) The trasnmission seems to be of a lower importance as predictor of MPG.

We see a really small p-value (1.21e-11 musch smaller than 0.05) meaning a good model. We also see an decent R-squared: 0.8497 which tranlates to outcome variance explained by this model.

```r
summary(best.model)
```

```
##
## Call:
## lm(formula = mpg ~ wt + qsec + am, data = mtcars)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3.4811 -1.5555 -0.7257  1.4110  4.6610
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   9.6178     6.9596   1.382 0.177915
## wt           -3.9165     0.7112  -5.507 6.95e-06 ***
## qsec          1.2259     0.2887   4.247 0.000216 ***
## am            2.9358     1.4109   2.081 0.046716 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
```

```
## Residual standard error: 2.459 on 28 degrees of freedom
## Multiple R-squared:  0.8497, Adjusted R-squared:  0.8336
## F-statistic: 52.75 on 3 and 28 DF,  p-value: 1.21e-11
```

Appendix

Figure 1: Which transmission achieves better mileage (Miles per Gallon)?
As we can see from the boxplot below there is a distinct difference that favors the manual transmission over the automatic when it comes to get better millage.