# Regmods-016 Assignment

*Lili Sun*

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## Executive Summary

When considering mpg and am alone, we fit it to a linear model and find the coefficient is about 7.245. That shows the manual transmission cars are 7.2 mpg more efficient than the automatics. When considering mpg with other variables, we found the most significant varible is `am`

## Basic Analysis

The relationship of interest is that between `mpg` and transmission `am`. The boxplot (appendix 1, fig. 1) shows a clear increase in the median mpg for manual transmission over automatic transmission. The normal q-q plots (appendix 1, fig. 2) show that the mpg of automatic and manual transmission cars in the data set is approximately normally distributed. The Welch Two Sample t-test suggests a significant difference between the means of the two groups (P = 0.0014, two sided).

## Simple Model

```
simple <- lm(mpg ~ am, data = mtcars)
simple$coefficients
```

```
## (Intercept)          am
##   17.147368    7.244939
```

The relationsip shown above can be expressed as a simple linear model: $mpg = 7.245am + 17.147$. The model resulting in an intercept of 17.147, which is the mean mpg of automatic type. The coefficient is 7.245, which is the increase of manual type over automatic type.

## Full Model

```
full <- lm(mpg ~ ., data = mtcars)
full$coefficients
```

```
## (Intercept)         cyl        disp          hp        drat          wt
## 12.30337416 -0.11144048  0.01333524 -0.02148212  0.78711097 -3.71530393
##        qsec          vs          am        gear        carb
##  0.82104075  0.31776281  2.52022689  0.65541302 -0.19941925
```

The relationship shown above can be expressed as simple linear model: $mpg = \Sigma_i \beta_i x_i + c$, here $x_i$ is the variables, and $\beta_i$ is their responding coefficient. As shown above, the most significant variable is `am`.

## Stepwise Regression

```
stepFarward <- step(simple, direction="forward", trace = 0,  scope=(~ cyl + disp + hp + drat + wt +
stepBackward <- step(full, direction = "backward", trace = 0)
stepFarward$coefficients
```

```
## (Intercept)          am          hp          wt        qsec
## 17.44019110  2.92550394 -0.01764654 -3.23809682  0.81060254
```

```
stepBackward$coefficients
```

```
## (Intercept)          wt        qsec          am
##    9.617781   -3.916504    1.225886    2.935837
```

We use forward and backward regressor selection. The forward results in a model: `mpg ~ am+hp+wt+qsec`. While the backward results in a model: `mpg ~ wt+qsec+am`

## Model Selection

Here we use the result of farward reression.

## Diagnostics

```
round(dfbetas(stepFarward),4)
```

```
##                     (Intercept)      am      hp      wt    qsec
## Mazda RX4               -0.2452 -0.1409  0.2982 -0.1913  0.2820
## Mazda RX4 Wag           -0.1114 -0.1987  0.2287 -0.2239  0.1592
## Datsun 710               0.1362 -0.3036  0.0088 -0.0614 -0.1357
## Hornet 4 Drive          -0.0007 -0.0342  0.0009 -0.0178  0.0119
## Hornet Sportabout        0.1219 -0.1759  0.0000 -0.0961 -0.0898
## Valiant                  0.1479  0.0512 -0.0324 -0.0038 -0.1816
## Duster 360              -0.0044  0.0131 -0.0105  0.0136  0.0016
## Merc 240D                0.0901 -0.1182 -0.1977  0.0674 -0.0609
## Merc 230                 0.5442 -0.0474 -0.4045  0.1805 -0.6125
## Merc 280                 0.0146 -0.0163 -0.0131  0.0008 -0.0120
## Merc 280C               -0.0273  0.0883  0.0323  0.0115  0.0063
## Merc 450SE               0.0366 -0.0372 -0.0313  0.0371 -0.0410
## Merc 450SL               0.0139 -0.0488  0.0159 -0.0224 -0.0055
## Merc 450SLC              0.0194  0.0607 -0.0533  0.0360 -0.0325
## Cadillac Fleetwood       0.0735 -0.1182  0.0522 -0.2064 -0.0223
## Lincoln Continental      0.0108 -0.0179  0.0072 -0.0301 -0.0031
## Chrysler Imperial       -0.3635  0.5495 -0.1326  0.9277  0.1138
## Fiat 128                -0.2866  0.4765 -0.0407  0.1270  0.2929
## Honda Civic              0.0535  0.0134 -0.0535 -0.0384 -0.0312
## Toyota Corolla          -0.4526  0.3616  0.2727 -0.2126  0.5404
## Toyota Corona            0.0559  0.3451 -0.2193  0.4092 -0.1953
## Dodge Challenger        -0.2073  0.1636  0.1341  0.0020  0.1914
## AMC Javelin             -0.2380  0.2464  0.1199  0.0575  0.2014
## Camaro Z28               0.0099 -0.0143  0.0059 -0.0101 -0.0080
## Pontiac Firebird         0.2404 -0.2232 -0.1366  0.0319 -0.2299
## Fiat X1-9                0.0108 -0.0510  0.0158  0.0080 -0.0205
## Porsche 914-2            0.0774  0.0104 -0.0716  0.0163 -0.0769
```

```
## Lotus Europa             0.2298 -0.1473  0.0928 -0.4228 -0.1170
## Ford Pantera L           0.0344 -0.1004 -0.1726  0.0709 -0.0209
## Ferrari Dino            -0.0705 -0.0566  0.0294 -0.0180  0.0815
## Maserati Bora           -0.0787  0.0532  0.1305 -0.0471  0.0746
## Volvo 142E               0.2209 -0.4277  0.0246 -0.2222 -0.1715
```

```
round(hatvalues(stepFarward),4)
```

```
##           Mazda RX4       Mazda RX4 Wag          Datsun 710
##              0.1573              0.1530              0.0955
##      Hornet 4 Drive   Hornet Sportabout             Valiant
##              0.0776              0.0927              0.0982
##          Duster 360           Merc 240D            Merc 230
##              0.1935              0.1295              0.4603
##            Merc 280           Merc 280C          Merc 450SE
##              0.0768              0.0632              0.0646
##          Merc 450SL         Merc 450SLC  Cadillac Fleetwood
##              0.0601              0.0606              0.2367
## Lincoln Continental   Chrysler Imperial            Fiat 128
##              0.2745              0.2323              0.1280
##         Honda Civic      Toyota Corolla       Toyota Corona
##              0.1284              0.1600              0.1940
##    Dodge Challenger         AMC Javelin          Camaro Z28
##              0.1259              0.0934              0.1621
##    Pontiac Firebird           Fiat X1-9       Porsche 914-2
##              0.0755              0.1062              0.1515
##        Lotus Europa      Ford Pantera L        Ferrari Dino
##              0.1639              0.2236              0.1168
##       Maserati Bora          Volvo 142E
##              0.5197              0.1246
```

# Appendix 1: Plots

### Simple comparison

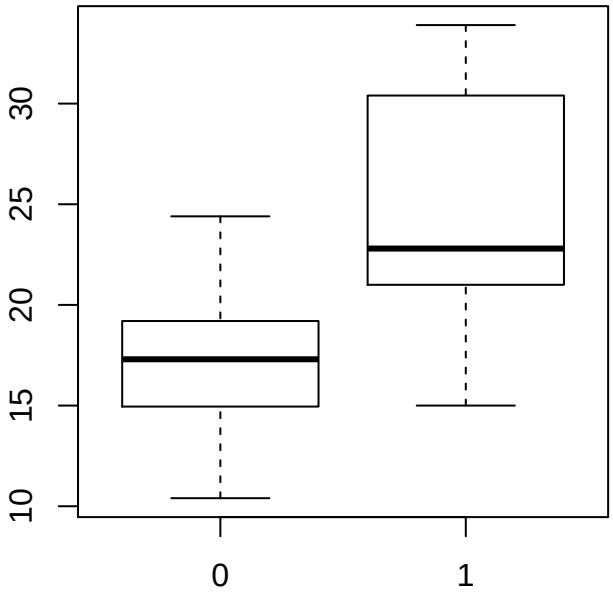


Figure 1: Boxplot for MPG by am

### Normal q-q plot

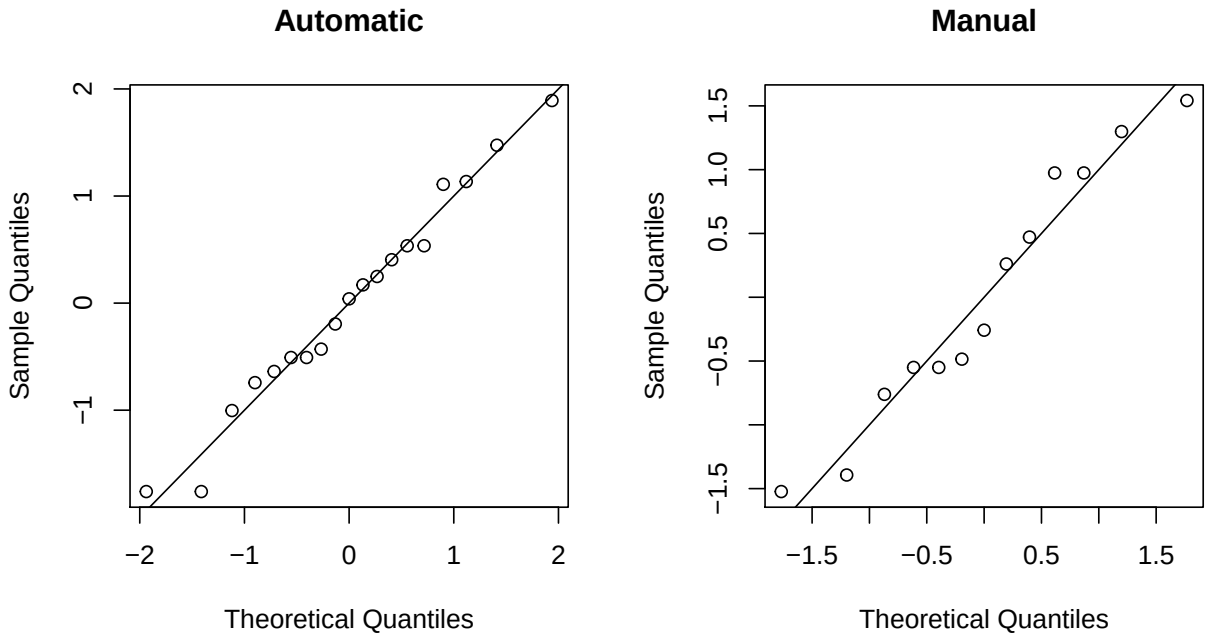


Figure 2: Normal q-q plot for MPG by transmission type

**Diagnostic plots**