Regression_Models_Course_Project

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Question

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"

Quick answers

- An manual transmission better for MPG
- Weight and drive speed affect mpg
  - Weight increase leads to mpg decrease
    - With weight increase 1000 lbs, the mpg decease by about 4 for automatic cars, and about 6 for manual cars
  - Drive speed increase ledas to mpg increase
    - With speed increase 1 second per 1/4 mile, the mpg increase about 0.8 for automatic cars, and about 1.4 for manual cars

Enviroment settings

```
library(car)
```

```
## Loading required package: carData
```

```
data(mtcars)
head(mtcars)
```

```
##                   mpg cyl disp  hp drat    wt  qsec vs am gear carb
## Mazda RX4         21.0   6  160 110 3.90 2.620 16.46  0  1    4    4
## Mazda RX4 Wag     21.0   6  160 110 3.90 2.875 17.02  0  1    4    4
## Datsun 710        22.8   4  108  93 3.85 2.320 18.61  1  1    4    1
## Hornet 4 Drive    21.4   6  258 110 3.08 3.215 19.44  1  0    3    1
## Hornet Sportabout 18.7   8  360 175 3.15 3.440 17.02  0  0    3    2
## Valiant           18.1   6  225 105 2.76 3.460 20.22  1  0    3    1
```

And each column class is following

```
str(mtcars)
```

```
## 'data.frame':    32 obs. of  11 variables:
##  $ mpg : num  21 21 22.8 21.4 18.7 18.1 14.3 24.4 22.8 19.2 ...
##  $ cyl : num  6 6 4 6 8 6 8 4 4 6 ...
##  $ disp: num  160 160 108 258 360 ...
##  $ hp  : num  110 110 93 110 175 105 245 62 95 123 ...
```

```
##  $ drat: num  3.9 3.9 3.85 3.08 3.15 2.76 3.21 3.69 3.92 3.92 ...
##  $ wt  : num  2.62 2.88 2.32 3.21 3.44 ...
##  $ qsec: num  16.5 17 18.6 19.4 17 ...
##  $ vs  : num  0 0 1 1 0 1 0 1 1 1 ...
##  $ am  : num  1 1 1 0 0 0 0 0 0 0 ...
##  $ gear: num  4 4 4 3 3 3 3 4 4 4 ...
##  $ carb: num  4 4 1 1 2 1 4 2 2 4 ...
```

EDA

There are 10 variables that may effect dependent variable `mpg`,we first check the correlations

```
cor(mtcars$mpg, mtcars[,-1])
```

```
##            cyl       disp         hp      drat         wt     qsec        vs
## [1,] -0.852162 -0.8475514 -0.7761684 0.6811719 -0.8676594 0.418684 0.6640389
##             am      gear       carb
## [1,] 0.5998324 0.4802848 -0.5509251
```

So that for the 10 independent variables - 5 may be positively related, including drat, qsec, vs, am, gear - 5 may be negatively related, including cyl, disp, hp, wt, carb

Which transmission is better for MPG

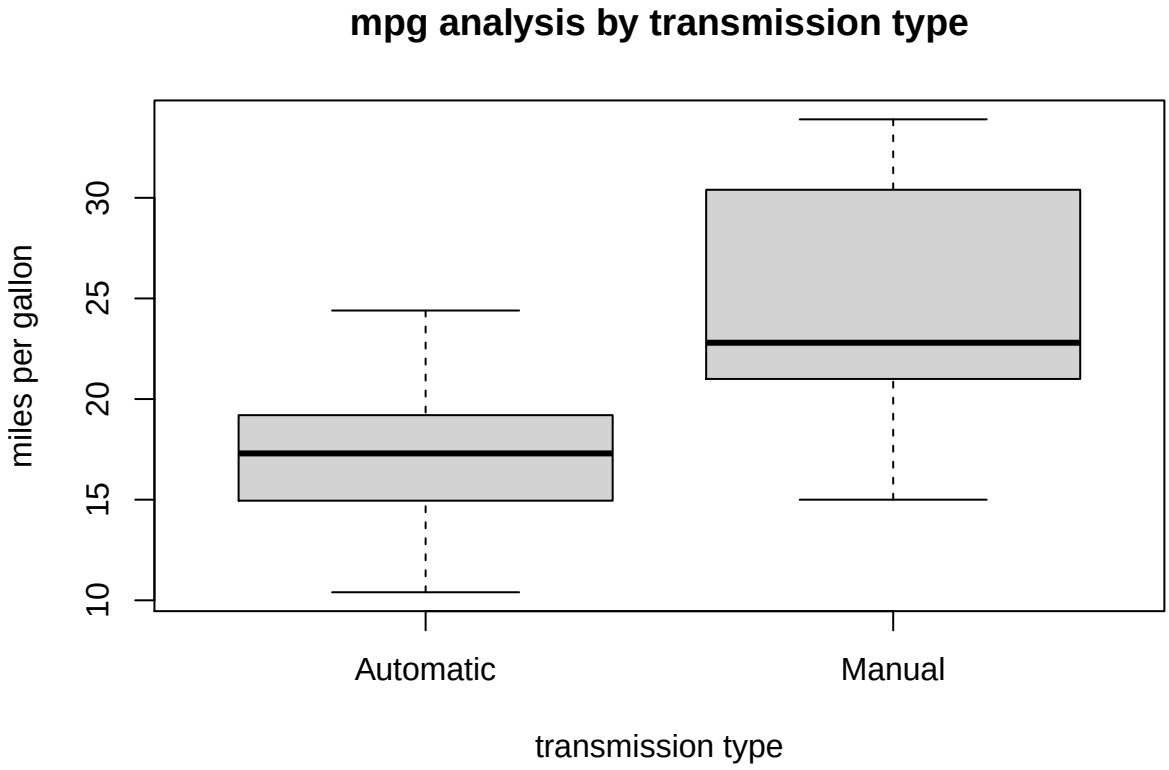
We need to change `am` class from numeric to factor

Besides, check column meanings using `?mtcars`, we see am=0 denotes automatic transmission, and am=1 for manual transmission

```
mtcars$am = factor(mtcars$am)
levels(mtcars$am) <- c("Automatic", "Manual")
```

Conclusion: A box plot with transmission type in x axis and mpg in y axis shows that in genral, the **manual type autos drive more miles per gallon.**

```
boxplot(mtcars$mpg ~ mtcars$am, data = mtcars, xlab="transmission type", ylab="miles per gallon", main =
```



MPG difference between automatic and manual transmissions - Quantify analysis

```
fit <-  step(lm(mpg ~ . , data = mtcars), trace = 0, steps = 10000)
summary(fit)
```

```
##
## 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 ***
## amManual      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
```

So that we get 3 out of 10 independent variables of importance to mpg change: wt, qsec, and am, with $R^2 = 0.85$

Furthermore, we examine mpg ~ wt + qest correlation with am

```r
fit2 <- lm(mpg ~ am:wt + am:qsec, data = mtcars)
summary(fit2)
```

```
##
## Call:
## lm(formula = mpg ~ am:wt + am:qsec, data = mtcars)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3.9361 -1.4017 -0.1551  1.2695  3.8862
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)       13.9692     5.7756   2.419  0.02259 *
## amAutomatic:wt    -3.1759     0.6362  -4.992 3.11e-05 ***
## amManual:wt       -6.0992     0.9685  -6.297 9.70e-07 ***
## amAutomatic:qsec   0.8338     0.2602   3.205  0.00346 **
## amManual:qsec      1.4464     0.2692   5.373 1.12e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.097 on 27 degrees of freedom
## Multiple R-squared:  0.8946, Adjusted R-squared:  0.879
## F-statistic: 57.28 on 4 and 27 DF,  p-value: 8.424e-13
```

With total R^2 of 90%, all the coefficients are significant, and we have the following conclusions

- Weight increase leads to mpg decrease
  - With weight increase 1000 lbs, the mpg decease by about 4 for automatic cars, and about 6 for manual cars
- Drive speed increase ledas to mpg increase
  - With speed increase 1 second per 1/4 mile, the mpg increase about 0.8 for automatic cars, and about 1.4 for manual cars