Regression models course project

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1. Introduction

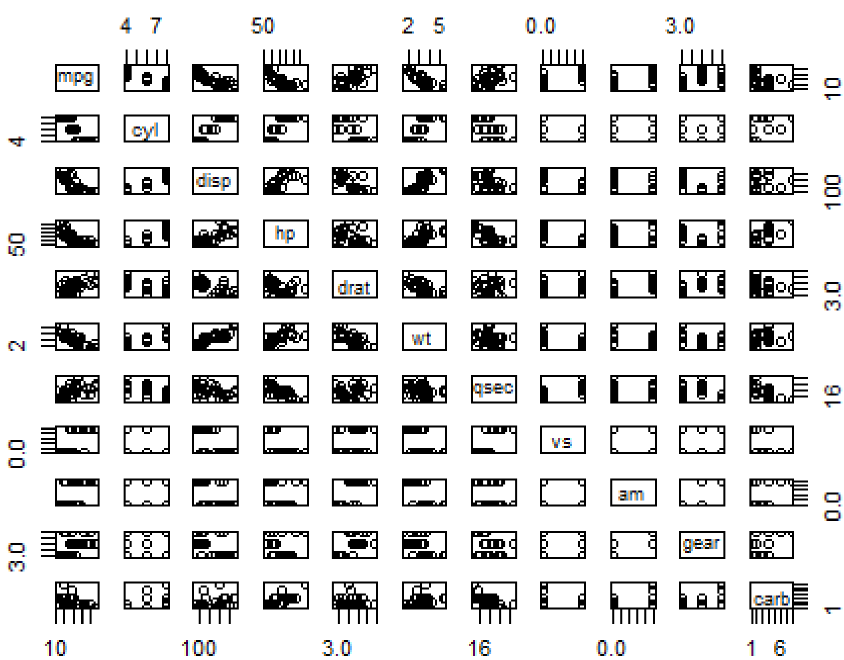
You work for Motor Trend, a magazine about the automobile industry. Looking at a data set of a collection of cars, they are interested in exploring the relationship between a set of variables and miles per gallon (MPG) (outcome). They are particularly interested in the following two questions:

“Is an automatic or manual transmission better for MPG” "Quantify the MPG difference between automatic and manual transmissions"

2. Exploration

`mtcars` counts 32 observations on 11 variables. pairs() allows us to sketch a rapid idea of the relations between the variables that we would like to explore in the second part of the analysis.

```
pairs(mtcars)
```



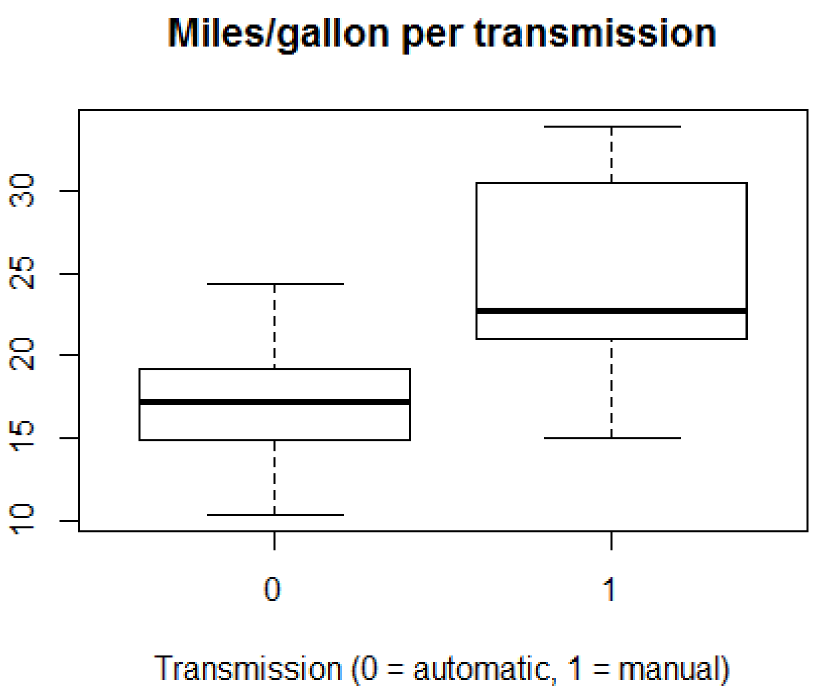
Operativelly, we explore the relationship between miles-per-gallon (MPG) and other variables in the `mtcars` data set.

```
dim(mtcars)

## [1] 32 11

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 ...

summary(mtcars)

##       mpg             cyl             disp             hp       
##  Min.   :10.40   Min.   :4.000   Min.   : 71.1   Min.   : 52.0  
##  1st Qu.:15.43   1st Qu.:4.000   1st Qu.:120.8   1st Qu.: 96.5  
##  Median :19.20   Median :6.000   Median :196.3   Median :123.0  
##  Mean   :20.09   Mean   :6.188   Mean   :230.7   Mean   :146.7  
##  3rd Qu.:22.80   3rd Qu.:8.000   3rd Qu.:326.0   3rd Qu.:180.0  
##  Max.   :33.90   Max.   :8.000   Max.   :472.0   Max.   :335.0  
##       drat             wt             qsec             vs        
##  Min.   :2.760   Min.   :1.513   Min.   :14.50   Min.   :0.0000  
##  1st Qu.:3.080   1st Qu.:2.581   1st Qu.:16.89   1st Qu.:0.0000  
##  Median :3.695   Median :3.325   Median :17.71   Median :0.0000  
##  Mean   :3.597   Mean   :3.217   Mean   :17.85   Mean   :0.4375  
##  3rd Qu.:3.920   3rd Qu.:3.610   3rd Qu.:18.90   3rd Qu.:1.0000  
##  Max.   :4.930   Max.   :5.424   Max.   :22.90   Max.   :1.0000  
##        am              gear            carb      
##  Min.   :0.0000   Min.   :3.000   Min.   :1.000  
##  1st Qu.:0.0000   1st Qu.:3.000   1st Qu.:2.000  
##  Median :0.0000   Median :4.000   Median :2.000  
##  Mean   :0.4062   Mean   :3.688   Mean   :2.812  
##  3rd Qu.:1.0000   3rd Qu.:4.000   3rd Qu.:4.000  
##  Max.   :1.0000   Max.   :5.000   Max.   :8.000  
```

3. Analysis

As told before, we focus on the relationship between `mpg` (Miles/(US) gallon) and `am` (Transmission).

```r
data(mtcars)
boxplot(mpg ~ am, data = mtcars, xlab = "Transmission (0 = automatic, 1 =
manual)", main = "Miles/gallon per transmission")
```



Manual transmission has, in appearance, a role in favorably increase the average vehicle consumption.

To have a further confirm, we have to have an idea of the other predictors of the dataset. An ANOVA model can turn in use.

```r
anova1 <- aov(mpg ~ ., data = mtcars)
summary(anova1)

##             Df Sum Sq Mean Sq F value   Pr(>F)    
## cyl          1  817.7   817.7 116.425 5.03e-10 ***
## disp         1   37.6    37.6   5.353  0.03091 *  
## hp           1    9.4     9.4   1.334  0.26103    
## drat         1   16.5    16.5   2.345  0.14064    
## wt           1   77.5    77.5  11.031  0.00324 ** 
## qsec         1    3.9     3.9   0.562  0.46166    
## vs           1    0.1     0.1   0.018  0.89317    
## am           1   14.5    14.5   2.061  0.16586    
## gear         1    1.0     1.0   0.138  0.71365    
## carb         1    0.4     0.4   0.058  0.81218    
## Residuals   21  147.5     7.0                     
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Because of the low p-value (below 0.05), we will consider the variables `cyl`, `disp`, `wt`, `drat`, `am` as more interesting predictor variables.

```
lm1 <- lm(mpg ~ cyl + disp + wt + drat + am, data = mtcars)
summary(lm1)

##
## Call:
## lm(formula = mpg ~ cyl + disp + wt + drat + am, data = mtcars)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -4.3176 -1.3829 -0.4728  1.3229  6.0596
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 41.296380   7.538394   5.478 9.56e-06 ***
## cyl         -1.793995   0.650540  -2.758  0.01051 *
## disp         0.007375   0.012319   0.599  0.55462
## wt          -3.587041   1.210500  -2.963  0.00643 **
## drat        -0.093628   1.548780  -0.060  0.95226
## am           0.172981   1.530043   0.113  0.91085
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.692 on 26 degrees of freedom
## Multiple R-squared:  0.8327, Adjusted R-squared:  0.8005
## F-statistic: 25.88 on 5 and 26 DF,  p-value: 2.528e-09
```

`drat` and `disp` has a really high coefficient, they could be of some disturb. We try to make the approach more precise by cutting uit from the model.

```
lm2 <- lm(mpg ~ cyl + wt + am, data = mtcars)
summary(lm2)

##
## Call:
## lm(formula = mpg ~ cyl + wt + am, data = mtcars)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -4.1735 -1.5340 -0.5386  1.5864  6.0812
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  39.4179     2.6415  14.923 7.42e-15 ***
## cyl          -1.5102     0.4223  -3.576  0.00129 **
## wt           -3.1251     0.9109  -3.431  0.00189 **
## am            0.1765     1.3045   0.135  0.89334
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
```

```
## Residual standard error: 2.612 on 28 degrees of freedom
## Multiple R-squared:  0.8303, Adjusted R-squared:  0.8122
## F-statistic: 45.68 on 3 and 28 DF,  p-value: 6.51e-11
```

The adjusted r-squared is 0.83. We cannot reject the hypothesis that the coefficient of am is 0.

4. Diagnosis

```r
par(mfrow = c(2, 2))
plot(lm2)
```

Appearently, there is not a relevant pattern found according to upper left graph. The `normal Q-Q` suggests the model mets the normality assumption. `Scale-Location` shows constant variance assumption are satisfied. We can conclude that weight and number of cylinders play important role to determination of `mpg`.