Regression Models - Automatic vs manual transmissions

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Synopsis

In this week project, we will explore a data set containing a collection of cars and try to determine if there is a difference between automatic and manual transmissions in term of MPG. (The code of this document is available on Github)

Data

The data used for this project is the mtcars (Motor Trend Car Road Tests) dataset. It contains **32** cars (rows) and **11** columns (**mpg, cyl, disp, hp, drat, wt, qsec, vs, am, gear, carb**).
We will just convert AM and VS to factors.

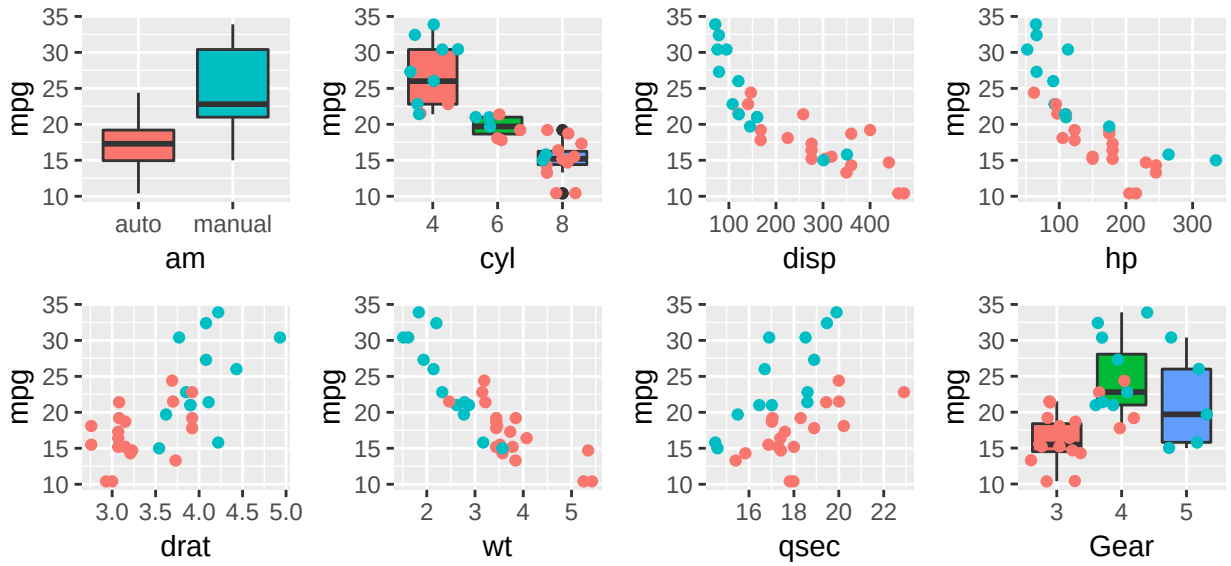
```
mtcars$am <- factor(mtcars$am, levels = c(0, 1), labels = c("auto", "manual"))
mtcars$vs <- factor(mtcars$vs)
```

Exploratory analysis

The **str** and **summary** function results are in the appendix. The repartition automatic and manual is the following:

```
##        count percentage
## auto      19     59.375
## manual    13     40.625
```

If we check the MPG value compared to the other column:



MPG is highly correlated to some features. The complete correlation plot is on appendix.

```
##   cyl  disp    hp  drat    wt  qsec  gear  carb
## -0.91 -0.91 -0.89  0.65 -0.89  0.47  0.54 -0.66
```

MPG vs AM

From the first graph, there seems to have a difference in MPG between the 2 transmissions.

```
t<- t.test( mpg~am, data = mtcars,
            alternative = "two.sided", paired = FALSE, var.equal = FALSE, conf.level = 0.95)
```

The p-value is **0.0014** and the 95% interval does not contains 0, so we can say that there is a difference in MPG between these 2 transmission types. if we create a model from this feature only :

```
fitam <- lm(mpg~am, mtcars)
summary(fitam)$coefficient
```

```
##              Estimate Std. Error   t value     Pr(>|t|)
## (Intercept) 17.147368   1.124603 15.247492 1.133983e-15
## ammanual     7.244939   1.764422  4.106127 2.850207e-04
```

Even if there is a difference between the 2 transmissions (manual having a **7.24** higher MPG), this feature only is not a very good predictor : the Adjusted R-squared value is **0.338** . Let's check if we can find a better model using the other features.

Feature selection using step

In the feature selection video, the **step** function was indroduced. We will try to use it to find a better model and see if the transmission is part of it.I used : http://www.stat.columbia.edu/~martin/W2024/R10.pdf as a starter code.

```
fit.null<-lm(mpg~1, data=mtcars)
fit.full<-lm(mpg~., data=mtcars)
# trying the 3 ways
step_fw <- step(fit.null, scope=list(lower=fit.null, upper=fit.full), direction="forward", trace=0)
step_bc <- step(fit.full, data=mtcars, direction="backward", trace=0)
step_bo <- step(fit.null, scope = list(upper=fit.full), data=mtcars, direction="both", trace=0)
```

direction	formula	Adjusted R-squared
forward	mpg ~ wt + cyl + hp	0.826
backward	mpg ~ wt + qsec + am	0.834
both	mpg ~ wt + cyl + hp	0.826

Conclusion

If we pick the backward step result as our final model : **mpg ~ wt + qsec + am**, Manual transmissions have a slightly better MPG (**2.94**) than the automatic ones (in the 1974's).

```
summary(step_bc)$coefficient
```

```
##              Estimate Std. Error   t value     Pr(>|t|)
## (Intercept)  9.617781  6.9595930  1.381946 1.779152e-01
## wt          -3.916504  0.7112016 -5.506882 6.952711e-06
## qsec         1.225886  0.2886696  4.246676 2.161737e-04
## ammanual     2.935837  1.4109045  2.080819 4.671551e-02
```

Appendix

Exploratory analysis

```r
str(mtcars)
```

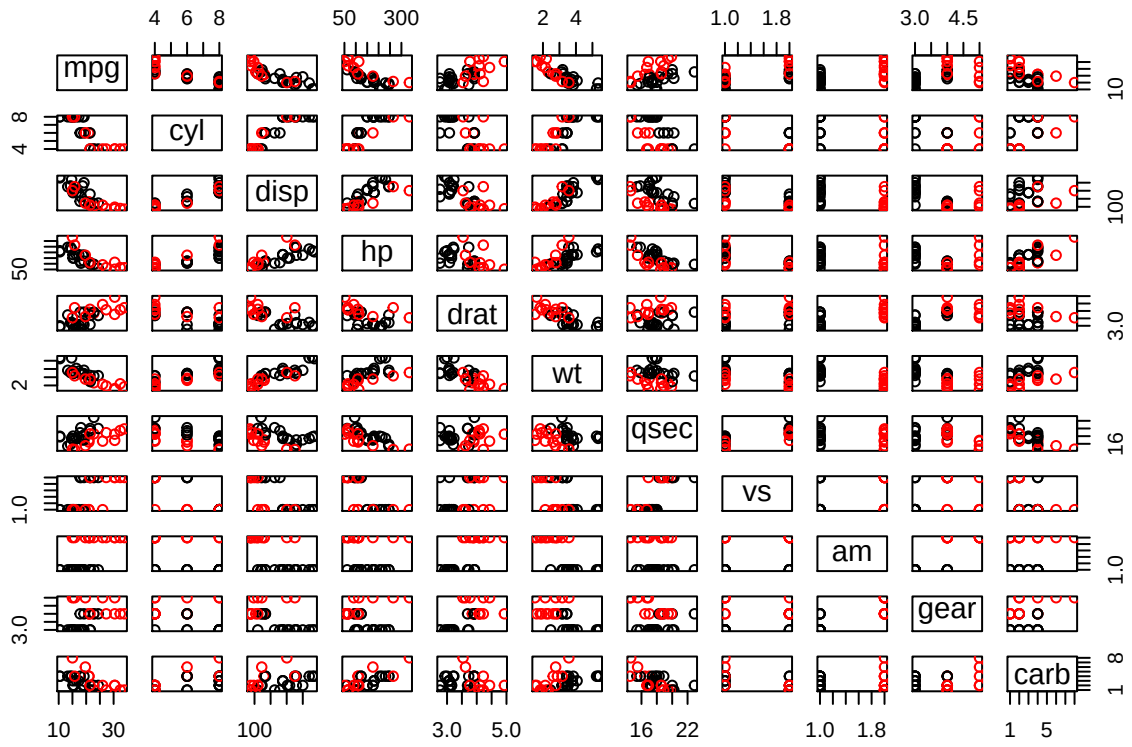
```
## 'data.frame':    32 obs. of  11 variables:
##  $ mpg : num  21 21 22.8 21.4 18.7 18.1 14.3 24.4 22.8 19.2 ...
##  $ cyl : num  6 6 4 6 8 6 8 4 4 6 ...
##  $ disp: num  160 160 108 258 360 ...
##  $ hp  : num  110 110 93 110 175 105 245 62 95 123 ...
##  $ drat: num  3.9 3.9 3.85 3.08 3.15 2.76 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  : Factor w/ 2 levels "0","1": 1 1 2 2 1 2 1 2 2 2 ...
##  $ am  : Factor w/ 2 levels "auto","manual": 2 2 2 1 1 1 1 1 1 1 ...
##  $ gear: num  4 4 4 3 3 3 3 4 4 4 ...
##  $ carb: num  4 4 1 1 2 1 4 2 2 4 ...
```

```r
summary(mtcars[, sapply(mtcars, class) == "numeric"])
```

```
##       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             gear      
##  Min.   :2.760   Min.   :1.513   Min.   :14.50   Min.   :3.000  
##  1st Qu.:3.080   1st Qu.:2.581   1st Qu.:16.89   1st Qu.:3.000  
##  Median :3.695   Median :3.325   Median :17.71   Median :4.000  
##  Mean   :3.597   Mean   :3.217   Mean   :17.85   Mean   :3.688  
##  3rd Qu.:3.920   3rd Qu.:3.610   3rd Qu.:18.90   3rd Qu.:4.000  
##  Max.   :4.930   Max.   :5.424   Max.   :22.90   Max.   :5.000  
##       carb      
##  Min.   :1.000  
##  1st Qu.:2.000  
##  Median :2.000  
##  Mean   :2.812  
##  3rd Qu.:4.000  
##  Max.   :8.000
```

Pair plot:

```
pairs(mpg~., data=mtcars, col=mtcars$am)
```



Correlation plot:

```
library(corrplot)
```

```
## corrplot 0.84 loaded
```

```
corrplot(correlations, method="circle")
```