# Carsera

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## Does manual transmission save fuel?

### Executive summary

We look at the influence of automatic transmission on fuel economy across a broad range of vehicle types. On the surface, selecting manual transmission might seem the economic choice, as these vehicles generally exhibit better fuel-saving than their automatic counterparts. However, dig beneath the surface and a more complex picture emerges. Automatic transmission is mstly fitted to bigger, heavier vehicles. Bigger, heavier vehicles are notorious gas-guzzlers. The data examined does not support the conclusion that automatic transmission by itself reduces fuel economy. This is not to say there is no effect, but that in order to establish a conclusive link, more data would need to be included in the study, particularly in relation to small automatics and larger manuals.

### Analysis

#### MPG v Automatic/Manual

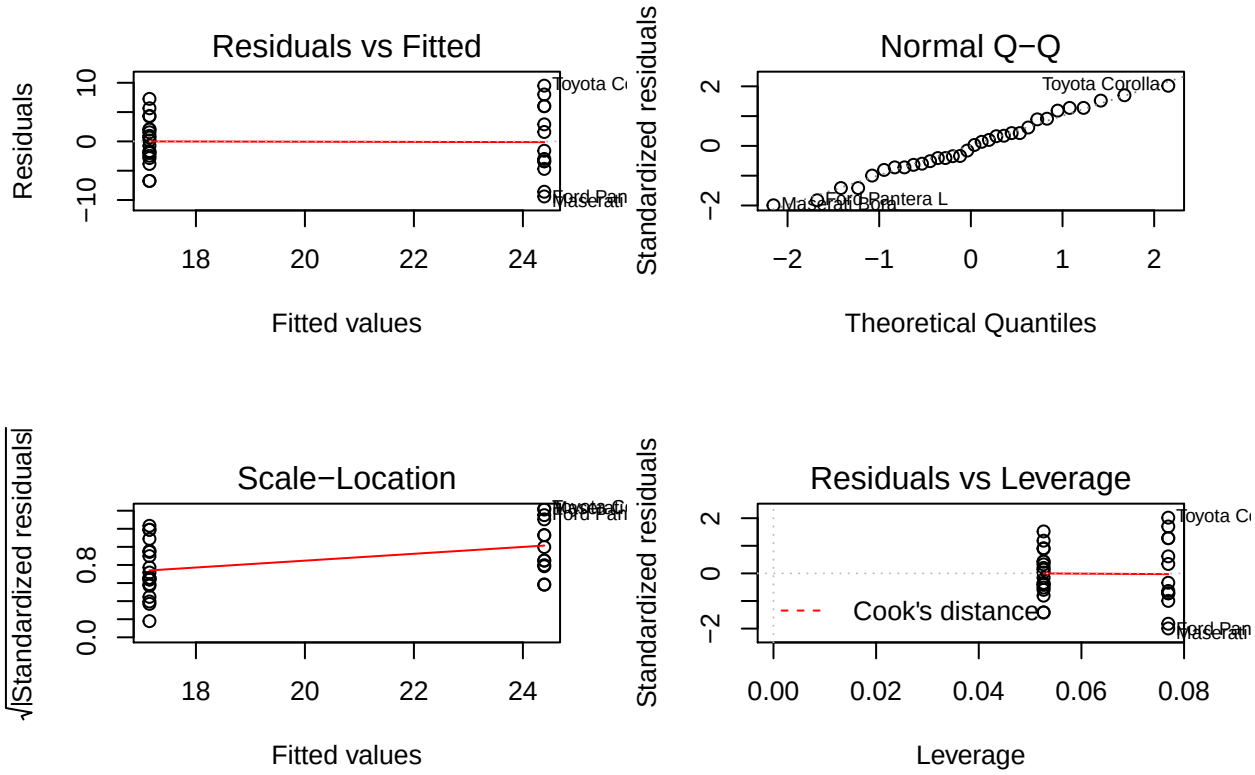
Let's start with a simple side-by-side comparison. How does the choice of transmission allow us to predict fuel consumption? Using a simple linear model, we attempt to answer this question using a model of two variables.

```
fit1 <- lm(mpg ~ am , data = mtcars)
summary(fit1)$coeff
```

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

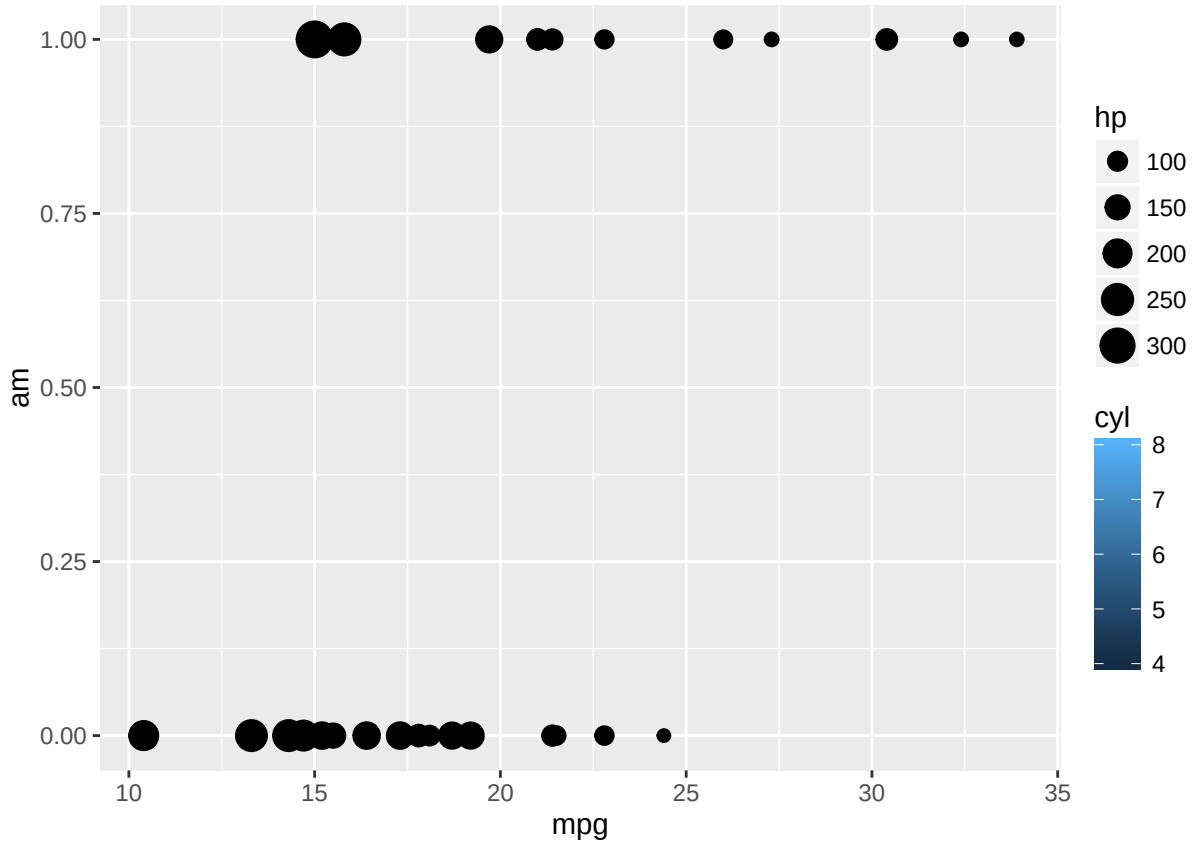
Looks good for those of us using a gearstick, right? Switching from automatic to manual is worth and extra seven US miles per gallon of fuel used. Let's look at some diagnostics..

```
par(mfrow = c(2, 2))
plot(fit1)
```

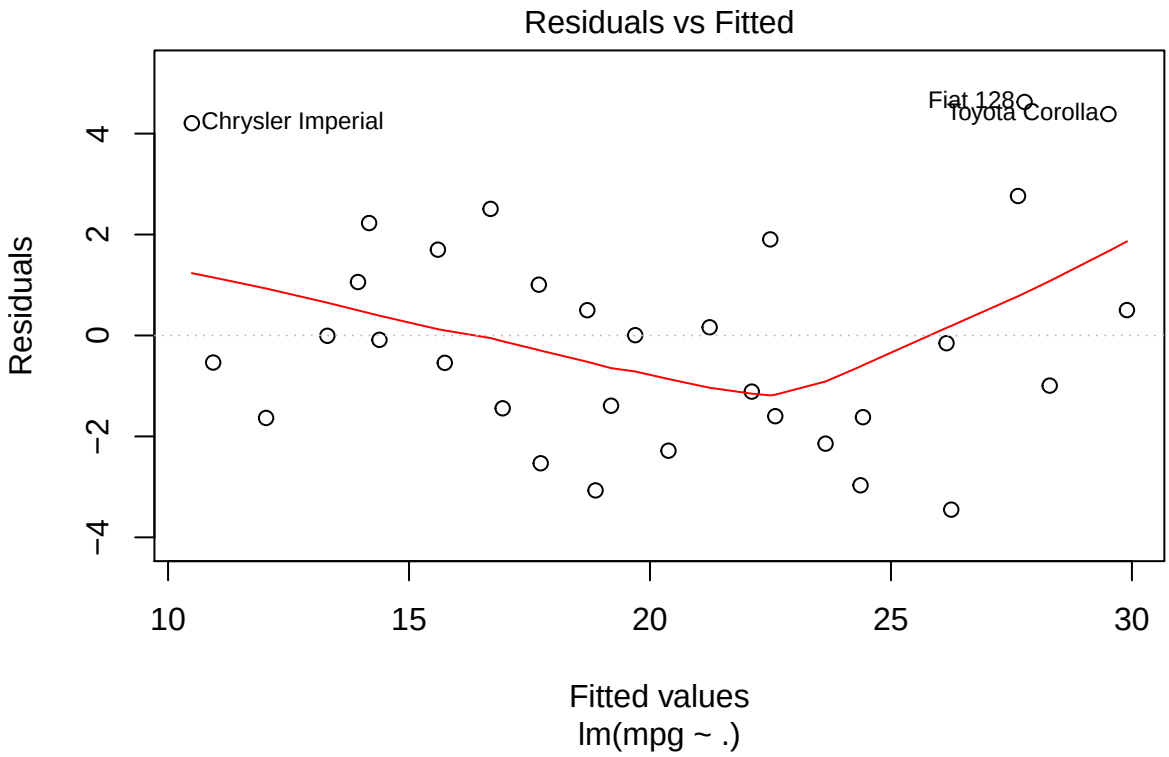


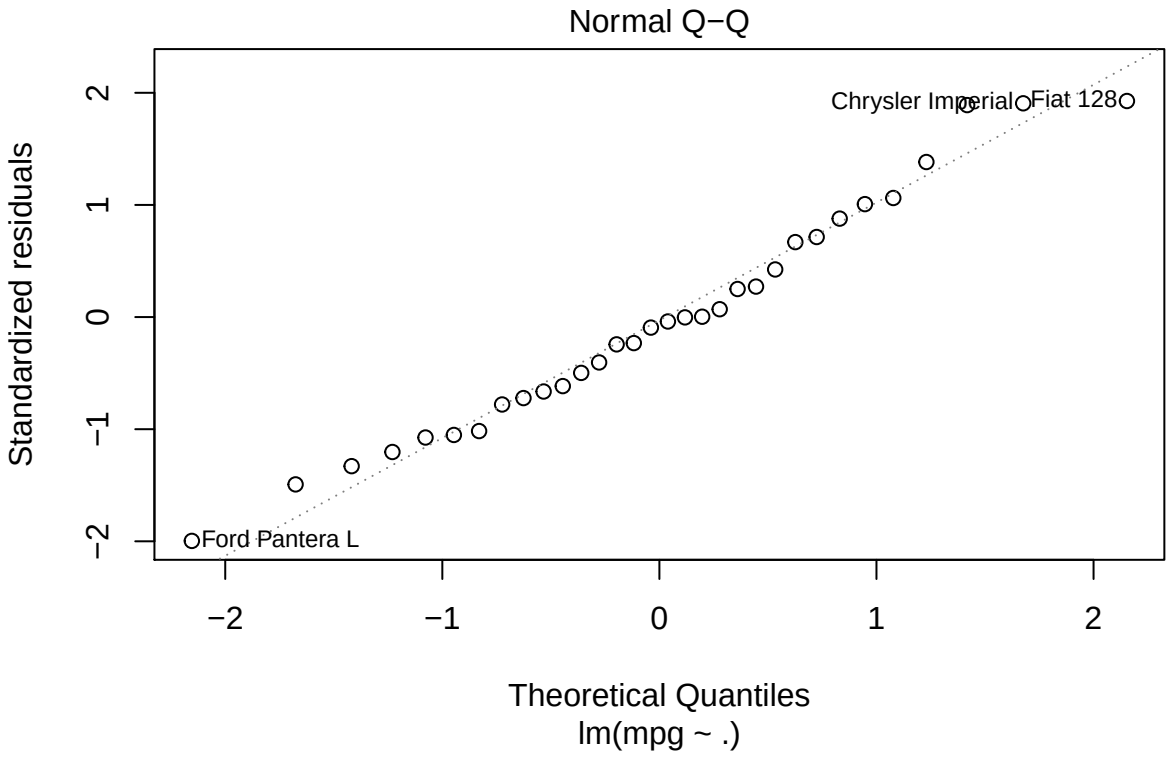

# Appendix 1

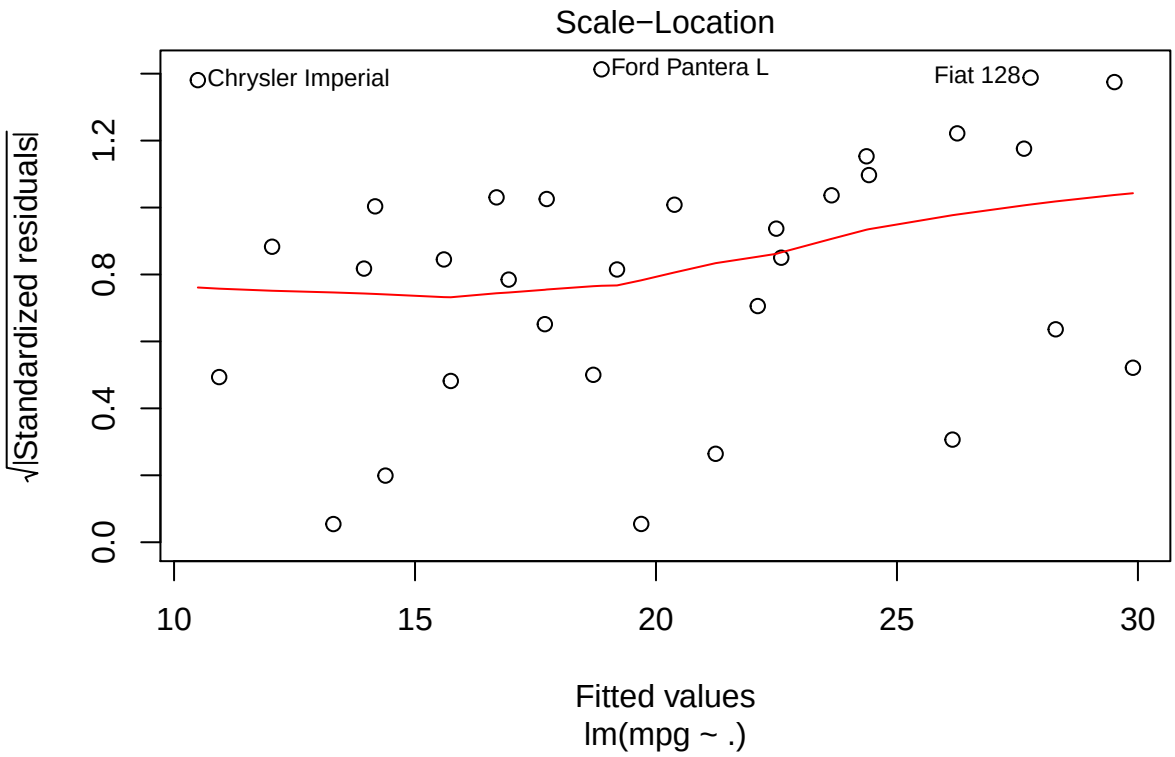
```
library(ggplot2)
ggplot(mtcars, aes(mpg, am, fill=cyl, size=hp)) +
    geom_point()
```

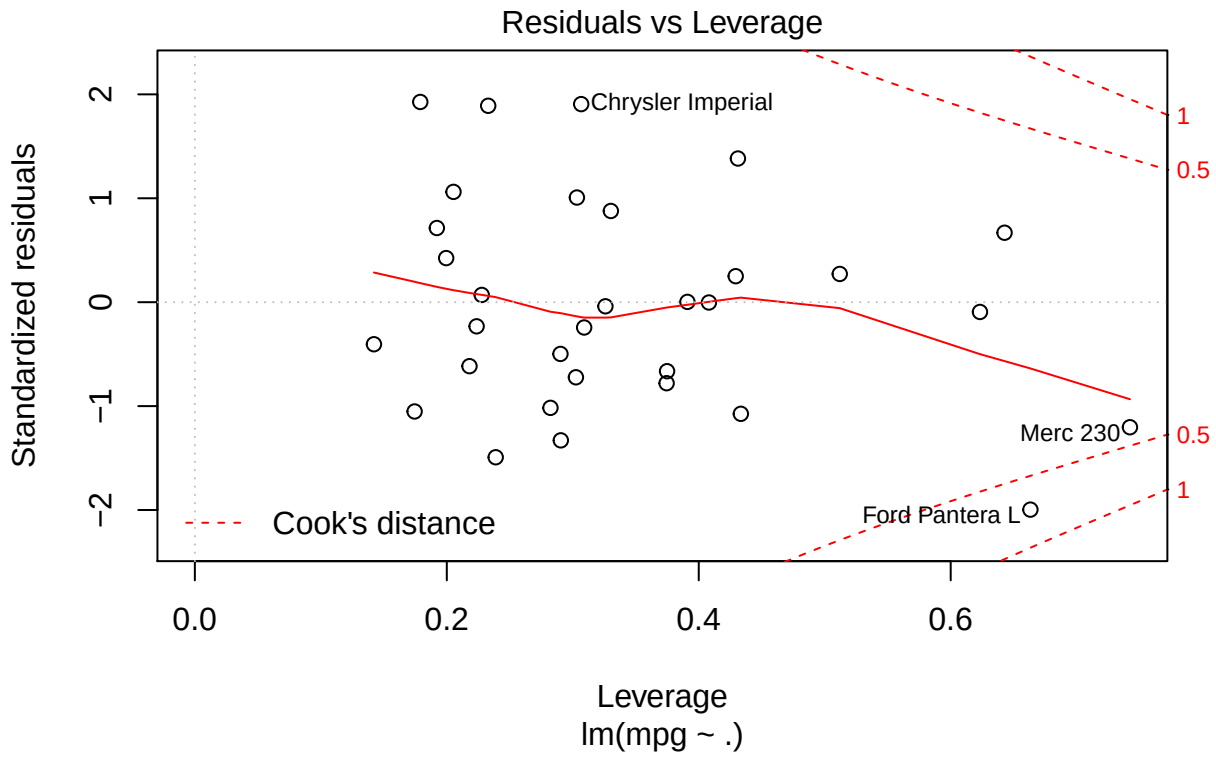



```
plot(lm(mpg ~ . , data = mtcars))
```

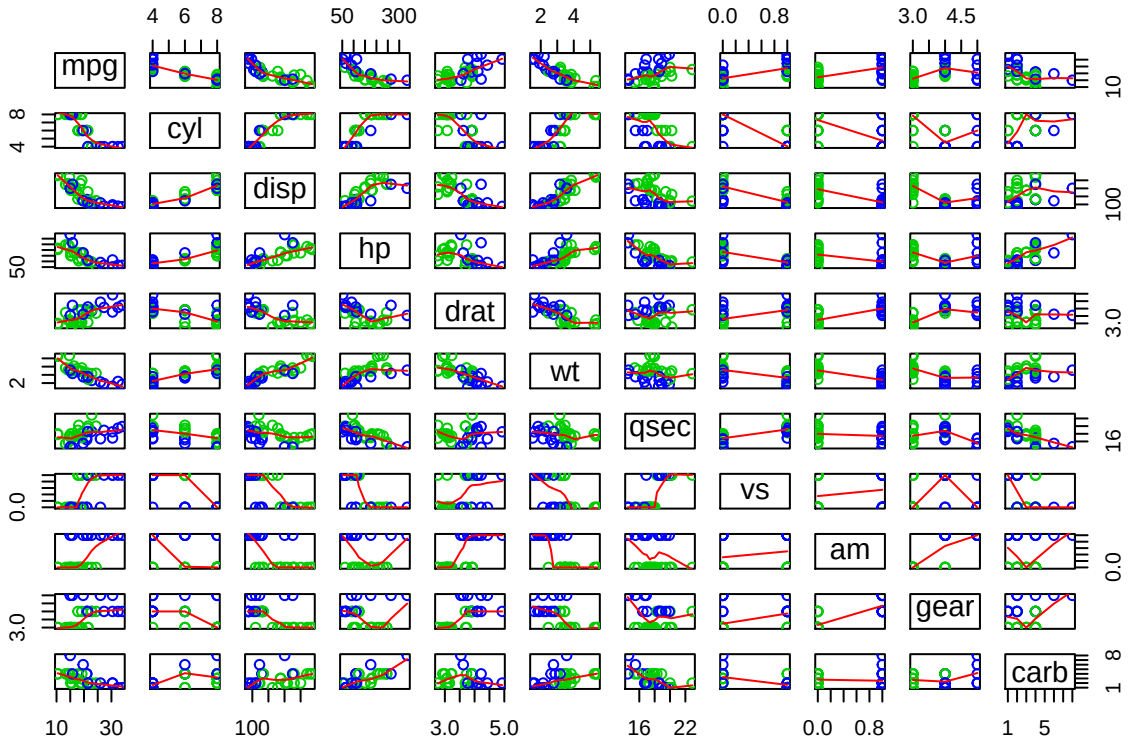

Residuals vs Fitted
Chrysler Imperial
Fiat 128
Toyota Corolla
Residuals
Fitted values
lm(mpg ~ .)


Normal Q−Q
Chrysler Imperial
Fiat 128
Ford Pantera L
Standardized residuals
Theoretical Quantiles
lm(mpg ~ .)

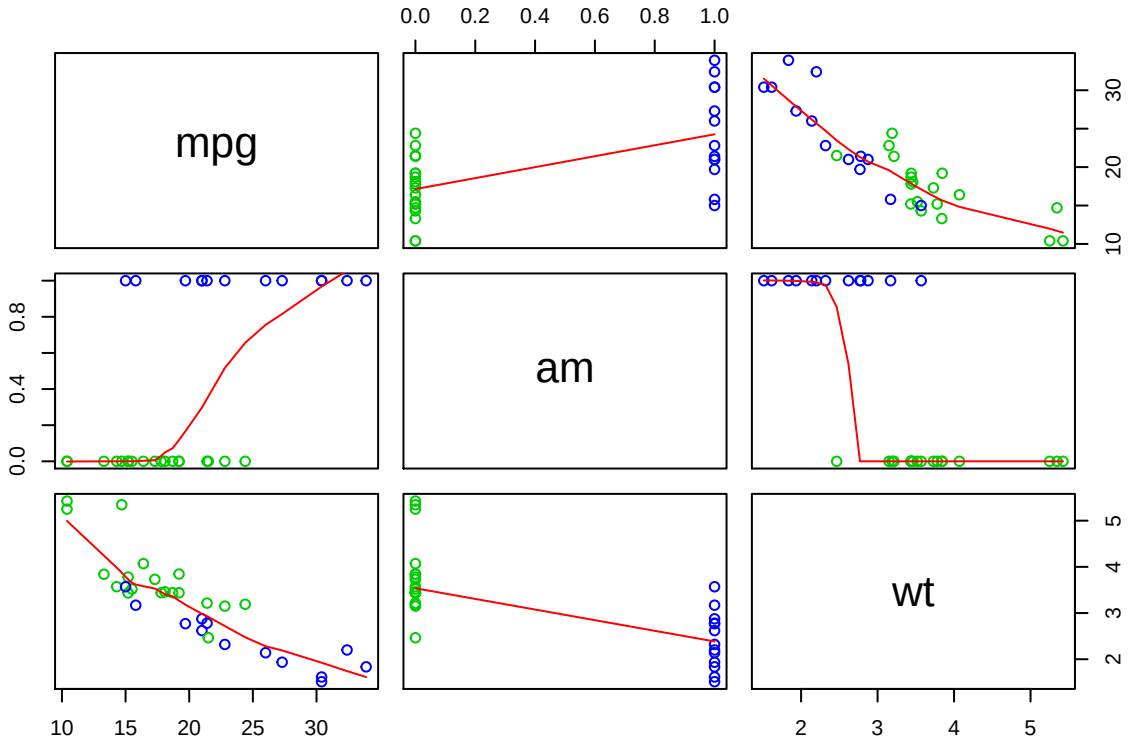

Scale−Location
Chrysler Imperial
Ford Pantera L
Fiat 128
√|Standardized residuals|
0.0
0.4
0.8
1.2
10
15
20
25
30
Fitted values
lm(mpg ~ .)




```
pairs(mtcars, panel=panel.smooth,col=3+mtcars$am)
```




```
pairs(subset(mtcars,select=c(mpg,am,wt)), panel=panel.smooth,col=3+mtcars$am)
```




```
summary(lm(mpg ~ . , data = mtcars))
```

```
##
## Call:
## lm(formula = mpg ~ ., data = mtcars)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3.4506 -1.6044 -0.1196  1.2193  4.6271
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 12.30337   18.71788   0.657   0.5181
## cyl         -0.11144    1.04502  -0.107   0.9161
## disp         0.01334    0.01786   0.747   0.4635
## hp          -0.02148    0.02177  -0.987   0.3350
## drat         0.78711    1.63537   0.481   0.6353
## wt          -3.71530    1.89441  -1.961   0.0633 .
## qsec         0.82104    0.73084   1.123   0.2739
## vs           0.31776    2.10451   0.151   0.8814
## am           2.52023    2.05665   1.225   0.2340
## gear         0.65541    1.49326   0.439   0.6652
## carb        -0.19942    0.82875  -0.241   0.8122
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
```

```
## Residual standard error: 2.65 on 21 degrees of freedom
## Multiple R-squared:  0.869,  Adjusted R-squared:  0.8066
## F-statistic: 13.93 on 10 and 21 DF,  p-value: 3.793e-07
```

```
summary(lm(mpg ~ am , data = mtcars))
```

```
##
## Call:
## lm(formula = mpg ~ am, data = mtcars)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -9.3923 -3.0923 -0.2974  3.2439  9.5077
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   17.147      1.125  15.247 1.13e-15 ***
## am             7.245      1.764   4.106 0.000285 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4.902 on 30 degrees of freedom
## Multiple R-squared:  0.3598, Adjusted R-squared:  0.3385
## F-statistic: 16.86 on 1 and 30 DF,  p-value: 0.000285
```

```
fit1 <- lm(mpg ~ am , data = mtcars)

fit2 <- lm(mpg ~ am  + wt, data = mtcars)
anova(fit1, fit2)
```

```
## Analysis of Variance Table
##
## Model 1: mpg ~ am
## Model 2: mpg ~ am + wt
##   Res.Df    RSS Df Sum of Sq      F    Pr(>F)
## 1     30 720.90
## 2     29 278.32  1    442.58 46.115 1.867e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```