The following project reviews a dataset from Motor Trend magazine, which consists of a collection of cars with either automatic transmissions or manual transmissions. The data will be explored to answer two very interesting and necessary questions. The first question is whether an automatic or a manual transmission is best for MPG (miles per gallon). The second question is how different is the MPG between automatic and manual transmissions.

Codes from mtcars are as follows:

A data frame with 32 observations on 11 variables.

mpg	Miles/(US) gallon
cyl	Number of cylinders
disp	Displacement (cu.in.)
hp	Gross horsepower
drat	Rear axle ratio
wt	Weight (lb/1000)
qsec	1/4 mile time
vs	V/S
am	Transmission (0 = automatic, 1 = manual)
gear	Number of forward gears
carb	Number of carburetors

Exploratory Data:

FOR MPG

```
data(mtcars)
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 ...


mtcars$am
 [1] 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 0 0 0 0 0 1 1 1 1 1 1 1
```

```
auto <- mtcars[mtcars$am==0, ]
man <- mtcars[mtcars$am==1, ]
autoMPG <- auto$mpg
manMPG <- man$mpg
t.test(autoMPG, manMPG, alternative="two.sided")

        Welch Two Sample t-test

data:  autoMPG and manMPG
t = -3.7671, df = 18.332, p-value = 0.001374
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -11.280194  -3.209684
sample estimates:
mean of x mean of y
 17.14737  24.39231
```

Linear Model:

```
Linear <- lm(mpg ~ am, mtcars)
summary(Linear)$coef

            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

melted<- melt(mtcars, id=c("mpg", "am"))
Head(melted, 3)
    mpg am variable            value
1   21.0  1      cyl                6
2   21.0  1      cyl                6
3   22.8  1      cyl                4
```

Linear <- lm(mpg ~ am, mtcars)
summary(Linear)

```
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
```

summary(Linear)$coef

```
            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
```

Linear <- lm(mpg ~ am, mtcars)
plot(Linear)

transformed <- transform(mtcars,
+ mpg = factor(mpg),
+ am = factor(am, labels = c("automatic", "manual")),
+ cars = rownames(mtcars))
View(transformed)
library("lattice", lib.loc="~/Library/R/3.2/library")
library("latticeExtra", lib.loc="~/Library/R/3.2/library")

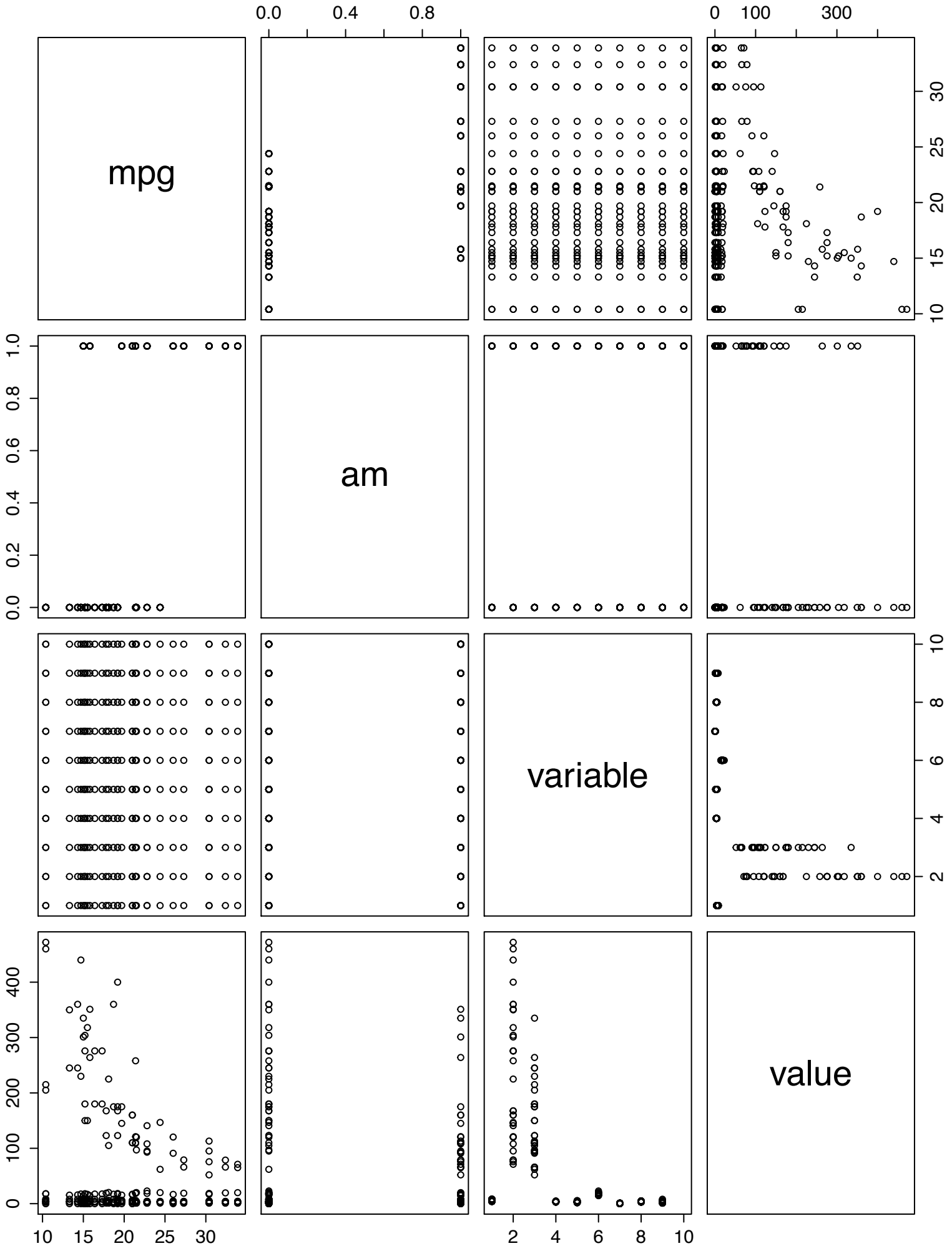
xyplot(mpg~wt|am, data = transformed)

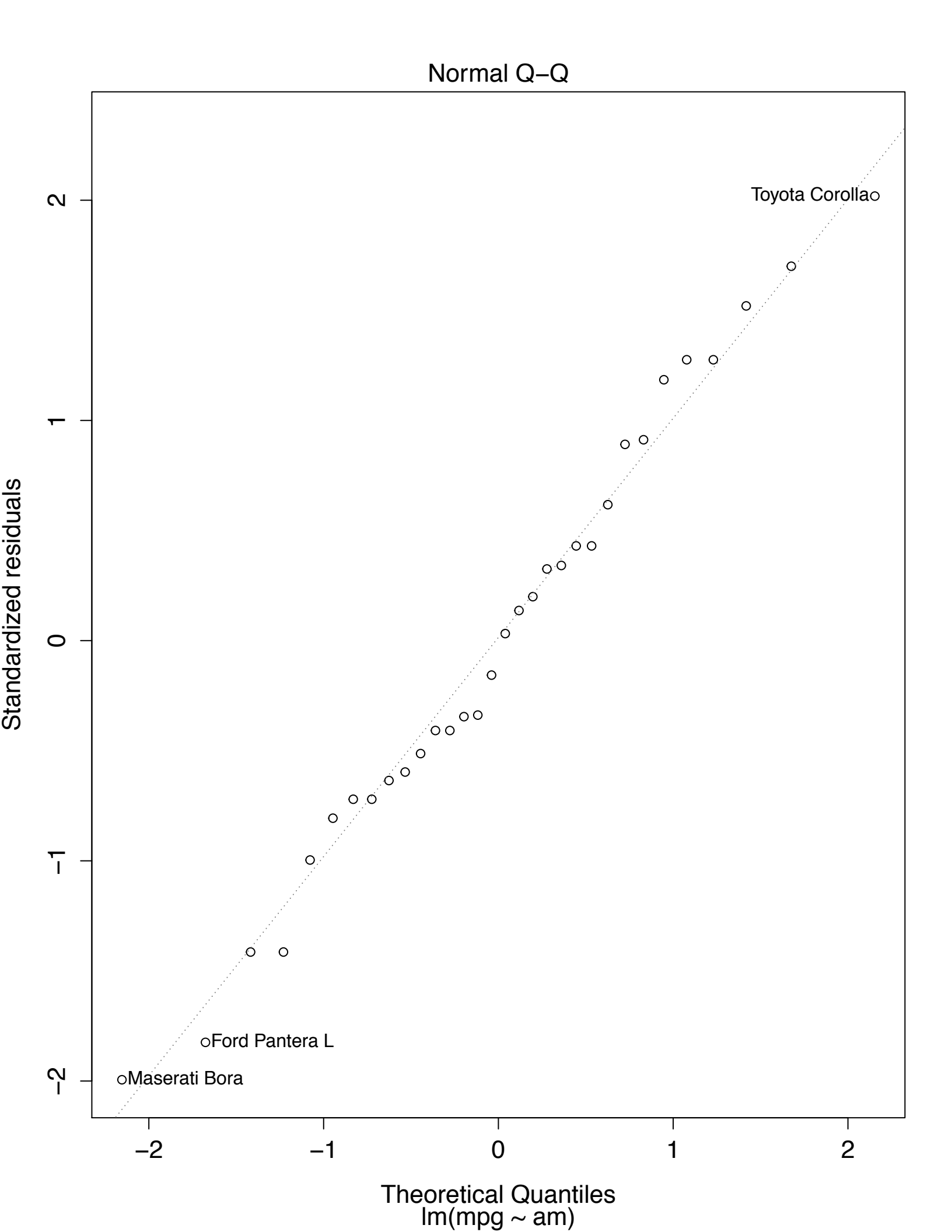
FOR WEIGHT

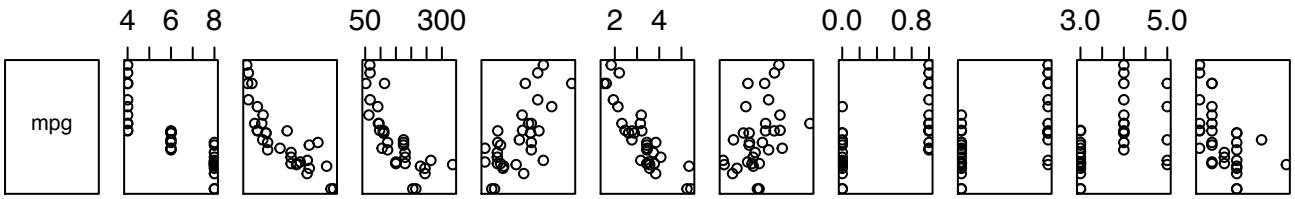
```
auto <- mtcars[mtcars$am==0, ]
man <- mtcars[mtcars$am==1, ]
autowt <- auto$wt
manwt <- man$wt
t.test(autowt, manwt, alternative="two.sided")

        Welch Two Sample t-test

data:  autowt and manwt
t = 5.4939, df = 29.234, p-value = 6.272e-06
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.8525632 1.8632262
sample estimates:
mean of x mean of y
 3.768895  2.411000
```

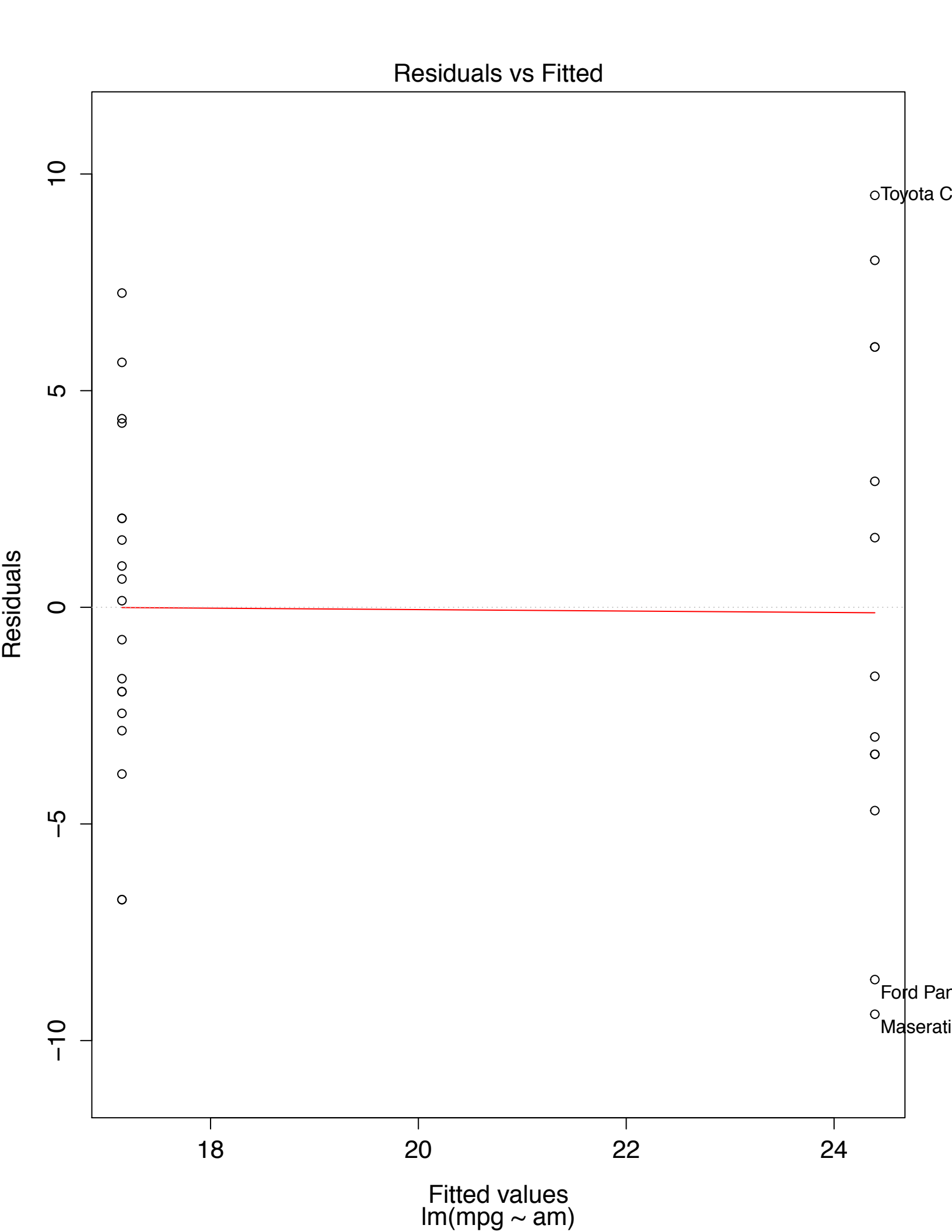
```
melted<- melt(mtcars, id=c("mpg", "am"))
plot(melted)
```

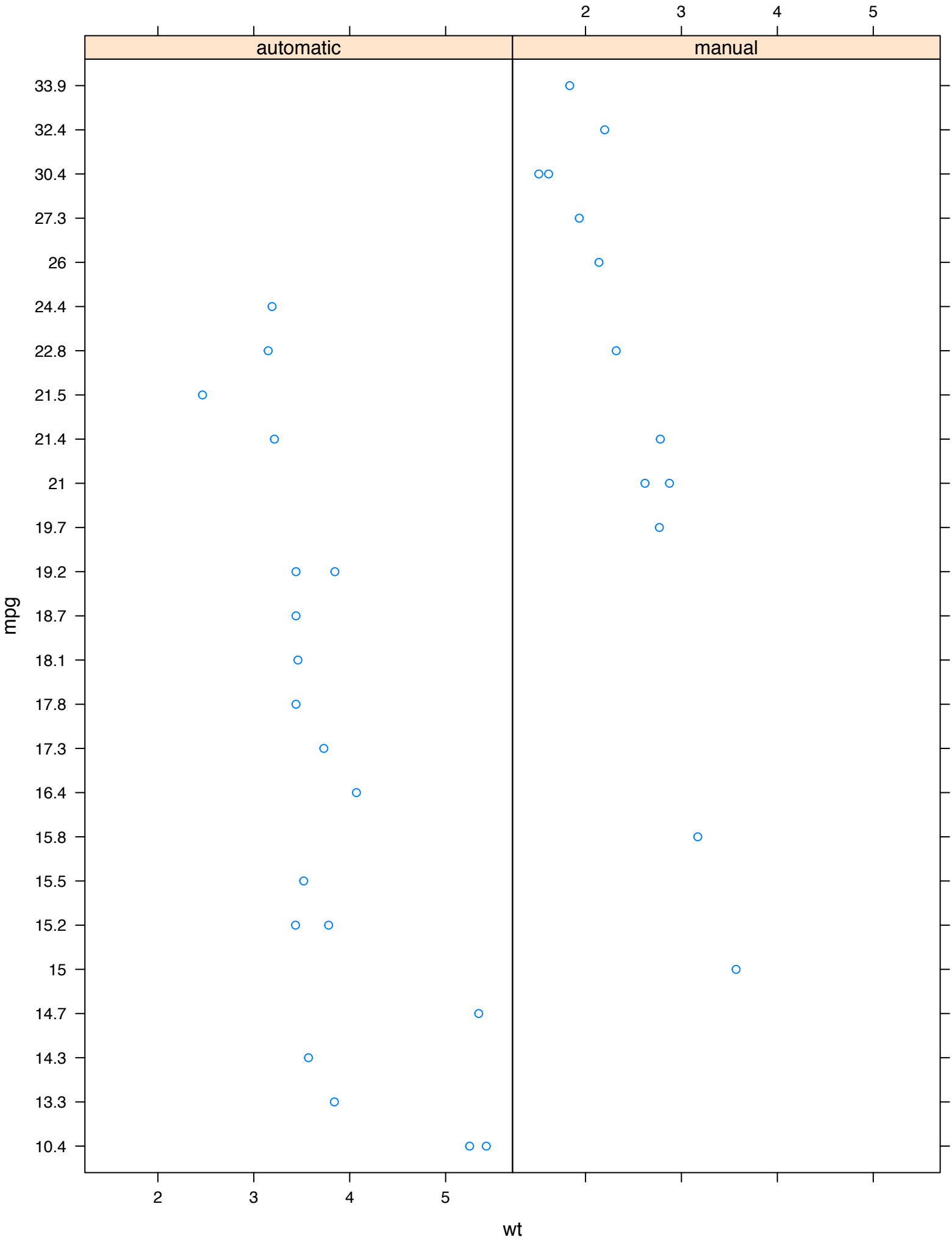

Conclusions: As shown by the above data analysis and exploration including but not limited to the t-distribution p value, there is in fact a significant difference in the miles per gallon between the cars with manual and the cars with automatic transmissions. This also shows that the manual transmission cars are more fuel-efficient. This may be due to the weight of the cars with automatic transmissions being much heavier as shown in the above analysis.


mpg
am
variable
value


Normal Q–Q
Standardized residuals
Theoretical Quantiles
lm(mpg ~ am)
Toyota Corolla
Ford Pantera L
Maserati Bora
2
1
0
−1
−2
−2
−1
0
1
2


4 6 8
50 300
2 4
0.0 0.8
3.0 5.0
mpg


Residuals vs Fitted
Residuals
10
5
0
−5
−10
Toyota C
Ford Par
Maserati
18
20
22
24
Fitted values
lm(mpg ~ am)


automatic
manual
mpg
wt
33.9
32.4
30.4
27.3
26
24.4
22.8
21.5
21.4
21
19.7
19.2
18.7
18.1
17.8
17.3
16.4
15.8
15.5
15.2
15
14.7
14.3
13.3
10.4
2
3
4
5