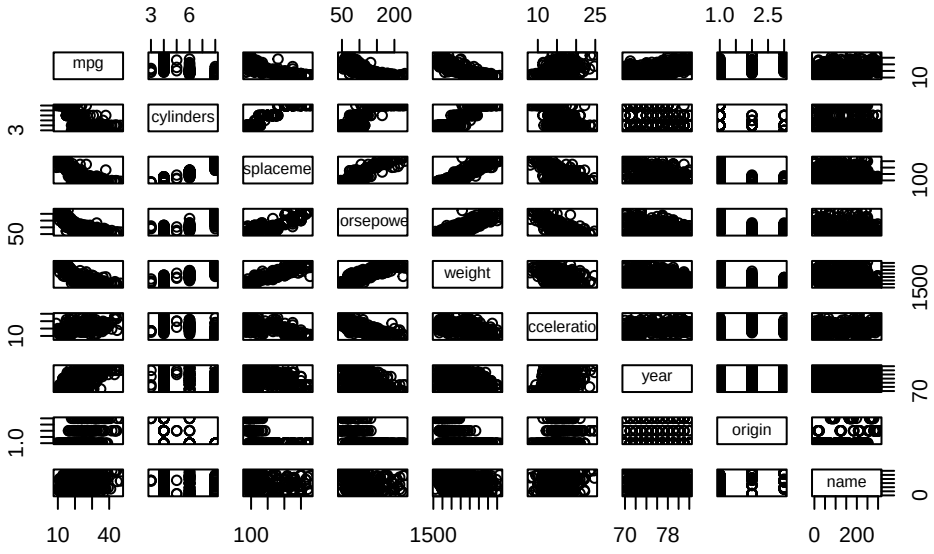
ISLR Exercise 3.7.9

9 This question involves the use of multiple linear regression on the Auto data set.

a) Produce a scatterplot matrix which includes all of the variables in the data set.

```
library(ISLR2)
attach(Auto)
pairs(Auto)
```



b) Compute the matrix of correlations between the variables using the function `cor()`. You will need to exclude the `name` variable, `cor()` which is qualitative.

```
Auto_noname <- subset(Auto, select=-name)
cor(Auto_noname)
```

```
                    mpg  cylinders displacement horsepower     weight
mpg           1.0000000 -0.7776175   -0.8051269 -0.7784268 -0.8322442
cylinders    -0.7776175  1.0000000    0.9508233  0.8429834  0.8975273
displacement -0.8051269  0.9508233    1.0000000  0.8972570  0.9329944
horsepower   -0.7784268  0.8429834    0.8972570  1.0000000  0.8645377
weight       -0.8322442  0.8975273    0.9329944  0.8645377  1.0000000
acceleration  0.4233285 -0.5046834   -0.5438005 -0.6891955 -0.4168392
year          0.5805410 -0.3456474   -0.3698552 -0.4163615 -0.3091199
origin        0.5652088 -0.5689316   -0.6145351 -0.4551715 -0.5850054
              acceleration       year     origin
mpg              0.4233285  0.5805410  0.5652088
cylinders       -0.5046834 -0.3456474 -0.5689316
displacement    -0.5438005 -0.3698552 -0.6145351
horsepower      -0.6891955 -0.4163615 -0.4551715
weight          -0.4168392 -0.3091199 -0.5850054
acceleration     1.0000000  0.2903161  0.2127458
year             0.2903161  1.0000000  0.1815277
origin           0.2127458  0.1815277  1.0000000
```

c) Use the `lm()` function to perform a multiple linear regression with `mpg` as the response and all other variables except `name` as the predictors. Use the `summary()` function to print the results. Comment on the output.

```
fit1 <- lm(mpg ~ . - name, data=Auto)
summary(fit1)
```

```
Call:
lm(formula = mpg ~ . - name, data = Auto)

Residuals:
    Min      1Q  Median      3Q     Max
-9.5903 -2.1565 -0.1169  1.8690 13.0604
```

```
Coefficients:
               Estimate Std. Error t value Pr(>|t|)
(Intercept)  -17.218435   4.644294  -3.707  0.00024 ***
cylinders     -0.493376   0.323282  -1.526  0.12780
displacement   0.019896   0.007515   2.647  0.00844 **
horsepower    -0.016951   0.013787  -1.230  0.21963
weight        -0.006474   0.000652  -9.929  < 2e-16 ***
acceleration   0.080576   0.098845   0.815  0.41548
year           0.750773   0.050973  14.729  < 2e-16 ***
origin         1.426141   0.278136   5.127 4.67e-07 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 3.328 on 384 degrees of freedom
Multiple R-squared:  0.8215,    Adjusted R-squared:  0.8182
F-statistic: 252.4 on 7 and 384 DF,  p-value: < 2.2e-16
```

i) Is there a relationship between the predictors and the response?

Yes? For example, we see that the p values for the intercept, `displacement`, `weight`, `year` and `origin` are significant. The rest not really. The R squared is high:

```
summary(fit1)$r.squared # = 0.821
```

```
[1] 0.8214781
```

ii) Which predictors appear to have a statistically significant relationship to the response

I responded here above.

iii) What does the coefficient for the `year` variable suggest?

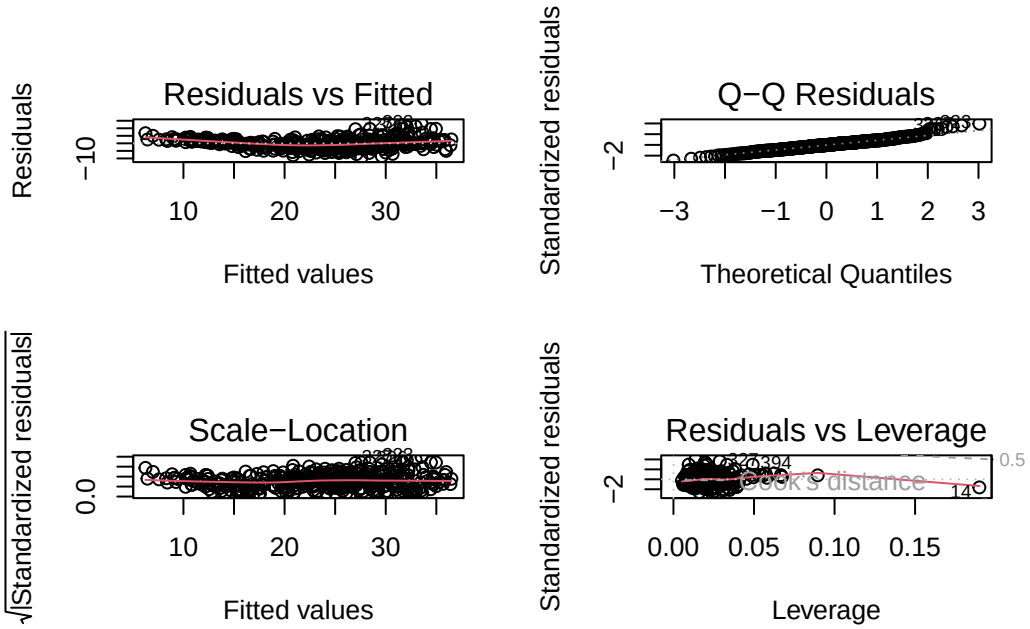
```
coefficients(fit1)[7] # = 0.7507727
```

```
     year
0.7507727
```

This suggests the newer the car, the higher the `mpg`.

d) Use `plot()` function to produce diagn. plots of the linear regression fit. What do you notice.

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



If you look at the residuals vs leverage plot, you see how the point 14 is completely screwed. Highish negative residual but strong positive leverage (cook's distance).. There are some larger outliers (points 327 and 394).

e) Use $*$ and $:$ to fit linear regression models with interaction effects.