Chapter 3 Problem 8

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a. Use the lm() function to perform a simple linear regression with mpg as the response and horsepower as the predictor. Comment on the output.

```
library(ISLR)
lm.fit=lm(mpg~horsepower,data=Auto)
summary(lm.fit)
```

```
##
## Call:
## lm(formula = mpg ~ horsepower, data = Auto)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -13.5710  -3.2592  -0.3435   2.7630  16.9240
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 39.935861   0.717499   55.66   <2e-16 ***
## horsepower  -0.157845   0.006446  -24.49   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4.906 on 390 degrees of freedom
## Multiple R-squared:  0.6059, Adjusted R-squared:  0.6049
## F-statistic: 599.7 on 1 and 390 DF,  p-value: < 2.2e-16
```

- Relationship between predictor and response?

H_o: No relationship between horsepower & mpg. vs. H_a: There is a relationship between horsepower & mpg.

We reject the null hypothesis. The low p-value associated with the horsepower parameter (β_1) suggests that there is a relationship between horsepower and mpg.

- How strong is the relationship between the predictor and the response?

r = sqrt(0.6059) = 0.7784

The correlation coefficient indicates a strong relationship, though not conventionally the strongest.

- Is the relationship between the predictor and the response positive or negative?

There is a negative relationship. With a one-unit increase in horsepower, mpg decreases by 0.1578.

- What is the predicted mpg with a horsepower of 98? What are the associated 95% CI and PI?

Our model is: mpg = 39.9359 - 0.1578(horsepower)

39.9359 - 0.1578(98) = 24.4715.

```
predict(lm.fit, data.frame(horsepower=c(98)),interval="confidence") #CI
```

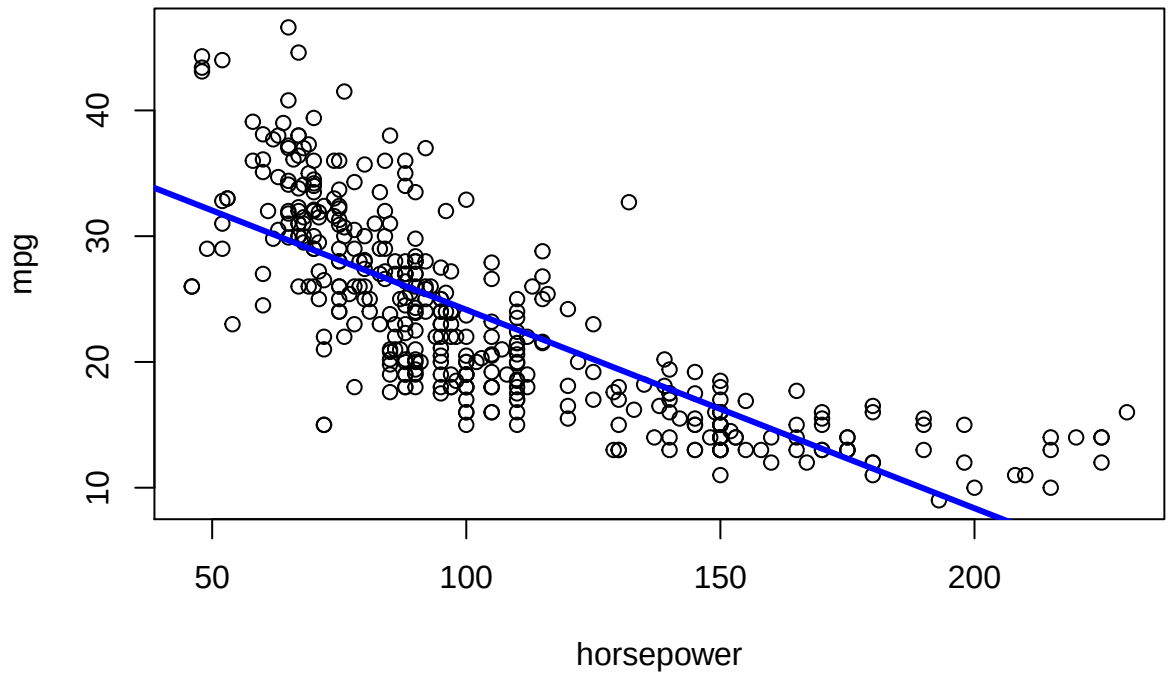
```
##        fit      lwr      upr
## 1 24.46708 23.97308 24.96108
```

```
predict(lm.fit, data.frame(horsepower=c(98)),interval="prediction") #PI
```

```
##        fit     lwr      upr
## 1 24.46708 14.8094 34.12476
```

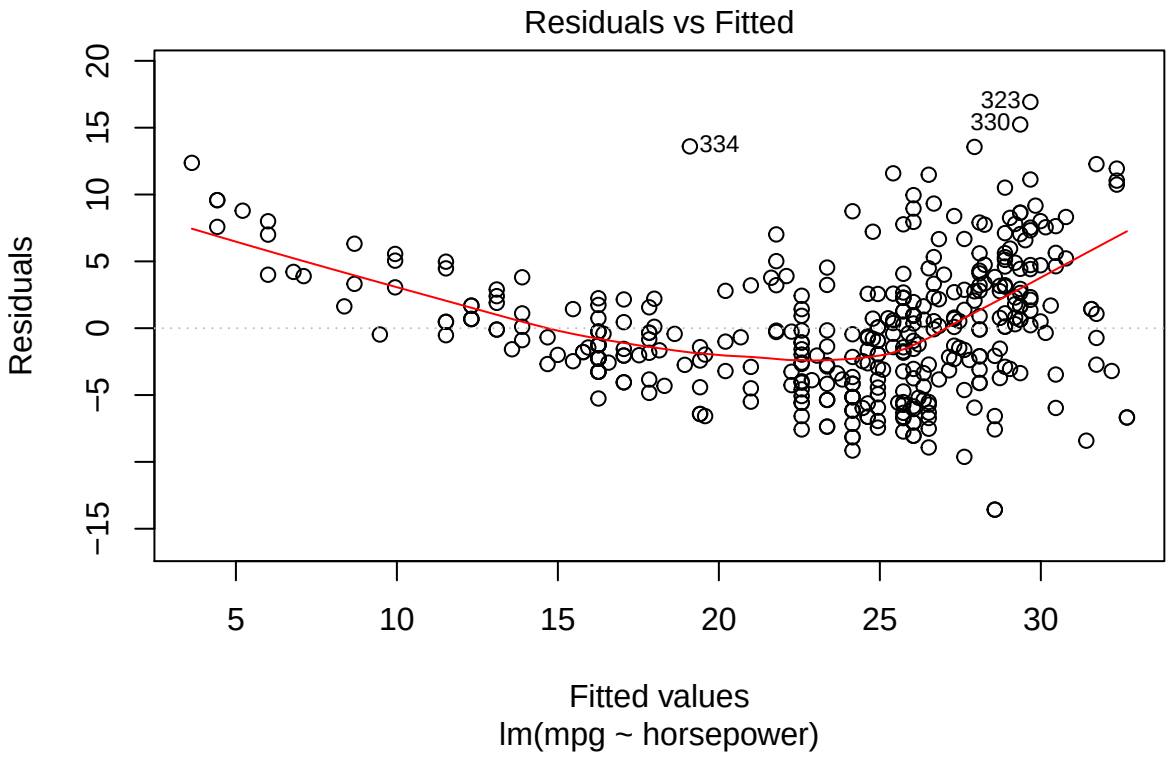
b. Plot the response and the predictor. Use the abline() function to display the least squares regression line.

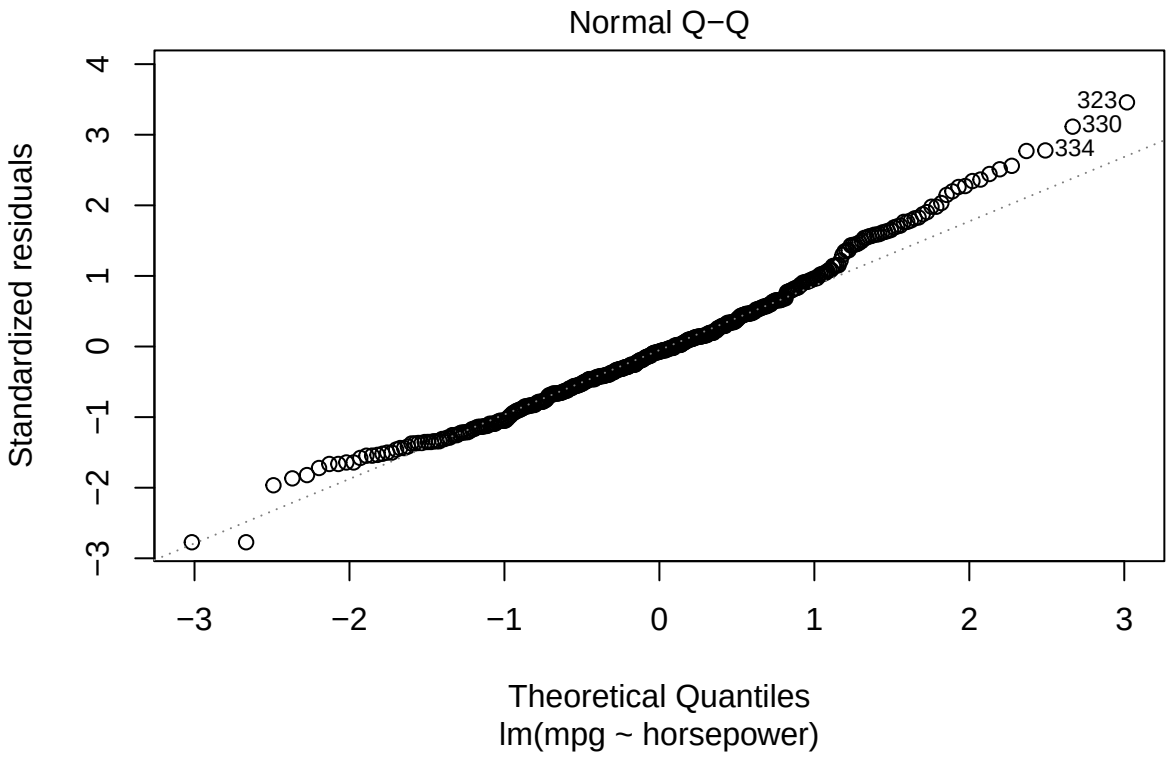
```
plot(Auto$horsepower,Auto$mpg,xlab="horsepower",ylab="mpg")
abline(lm.fit,lwd=3,col="blue")
```

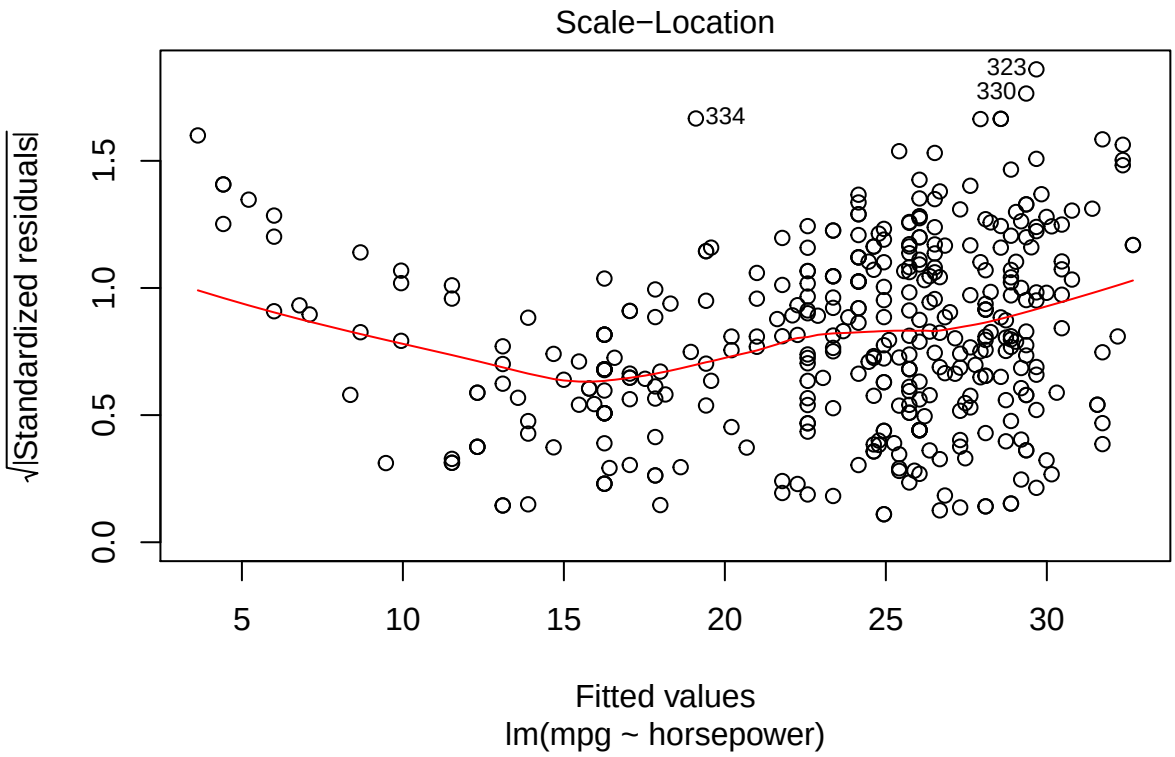


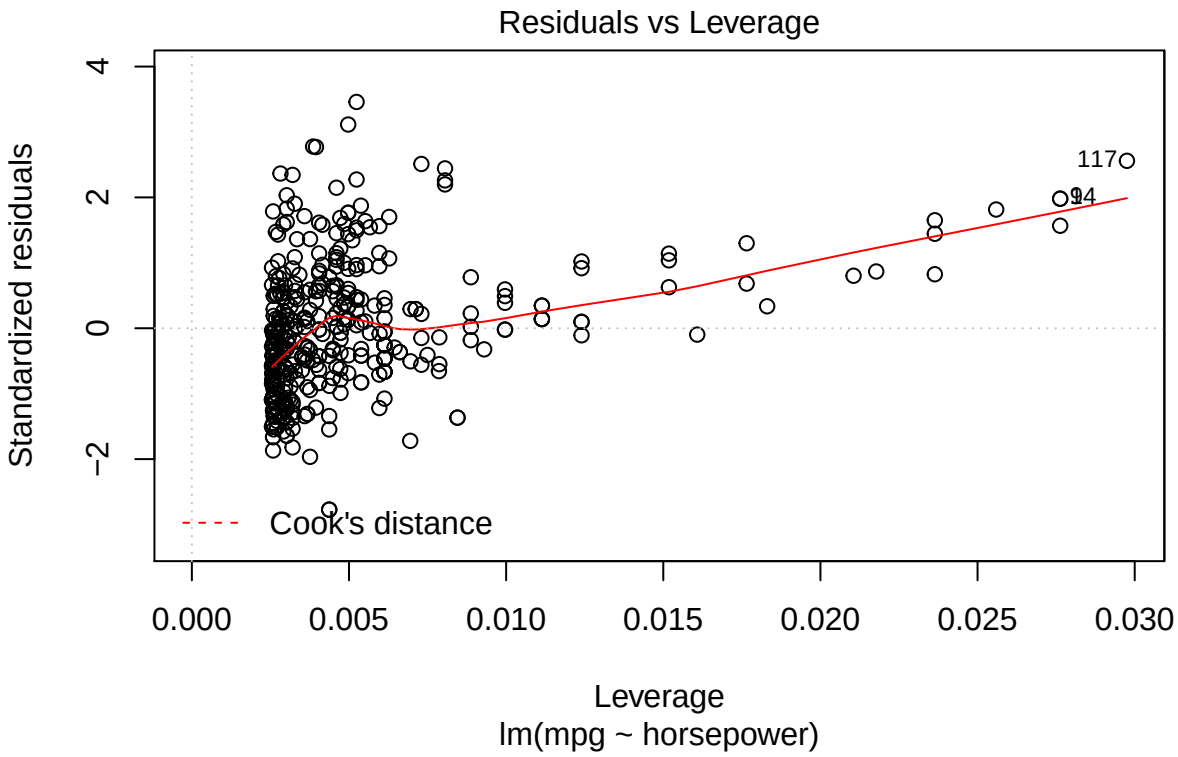
c. Use the plot() function to produce diagnostic plots of the least squares regression fit. Comment on any problems you see with the fit.

```
plot(lm.fit)
```


Residuals vs Fitted
Residuals
Fitted values
lm(mpg ~ horsepower)
323
330
334
20
15
10
5
0
−5
−15
5
10
15
20
25
30


Normal Q−Q
Standardized residuals
Theoretical Quantiles
lm(mpg ~ horsepower)
323
330
334
−3
−2
−1
0
1
2
3
4


Scale−Location
√|Standardized residuals|
0.0
0.5
1.0
1.5
5
10
15
20
25
30
323
330
334
Fitted values
lm(mpg ~ horsepower)



From the Residuals vs. Leverage plot, we see that there are some high leverage points (94, 117). The Residuals vs. Fitted plot follows a quadratic pattern, which could suggest non-linearity