HW6

Minh Luc, Devin Pham, Kyle Moore

Friday of Week 6, 05/06/2022

Contents

We all contributed equally for this homework.

Question 0

Member 1:

- Name: Minh Luc
- Student ID: A17209607

Member 2:

- Name: Kyle Moore
- Student ID: A14271413

Member 3:

- Name: Devin Pham
- Student ID: A17198936

Question 1

- **(a)**

```
library(ISLR2)

lm.fit = lm(mpg ~ acceleration, data=Auto)
1
```

```
## [1] 1
```

```
summary(lm.fit)
```

```
##
## Call:
## lm(formula = mpg ~ acceleration, data = Auto)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -17.989  -5.616  -1.199   4.801  23.239
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    4.8332     2.0485   2.359   0.0188 *
## acceleration   1.1976     0.1298   9.228   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 7.08 on 390 degrees of freedom
## Multiple R-squared:  0.1792, Adjusted R-squared:  0.1771
## F-statistic: 85.15 on 1 and 390 DF,  p-value: < 2.2e-16
```

Answer:

$\hat{\beta}_1 = 1.1976$ and our estimated standard error of $\hat{\beta}_1 = .1298$.

- **(b)**

Answer:

Our test statistic is $t = \frac{\hat{\beta}_1 - 0}{\widehat{\text{SE}}(\hat{\beta}_1)} = \frac{1.1976}{.1298} = 9.228$ which is confirmed in our summary output for the linear model, and our p-value = 2.2e−16. Therefore we can reject our null hypothesis that $H_0 : \hat{\beta}_1 = 0$.

- **(c)**

Answer:

Our residual standard error from the summart = 7.08 = $\hat{\sigma}$ and therefore $\hat{\sigma}^2 = 7.08^2 = 50.1264$.

- **(d)**

```
confint(lm.fit)
```

```
##                 2.5 %   97.5 %
## (Intercept)  0.8057651 8.860734
## acceleration 0.9424566 1.452792
```

Answer:

Our 95% confidence interval is (.9424566, 1.452792).

Question 2

- **(a)**

```
lm.fit = lm(mpg ~ cylinders + displacement + horsepower + weight +
              acceleration + year + origin, data=Auto)

summary(lm.fit)
```

```
##
## Call:
## lm(formula = mpg ~ cylinders + displacement + horsepower + weight +
##     acceleration + year + origin, 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
```

Answer:

This model has 7 predictors and they are cylinders, displacement, horsepower, weight, acceleration, year, and origin.

- **(b)**

Answer:

Using the summary above our coefficients are:

$$\begin{aligned}
\text{Cylinders:} \quad & \hat{\beta}_1 = -0.493376 \\
\text{Displacement:} \quad & \hat{\beta}_2 = 0.019896 \\
\text{Horsepower:} \quad & \hat{\beta}_3 = -0.016951 \\
\text{Weight:} \quad & \hat{\beta}_4 = -0.006474 \\
\text{Acceleration:} \quad & \hat{\beta}_5 = 0.080576 \\
\text{Year:} \quad & \hat{\beta}_6 = 0.750773 \\
\text{Origin:} \quad & \hat{\beta}_7 = 1.426141
\end{aligned}$$

- **(c)**

Answer:

Using the summary above our p-values are:

$$\begin{aligned}
\text{Cylinders, } \hat{\beta}_1 : p - value &= 0.12780 \\
\text{Displacement, } \hat{\beta}_2 : p - value &= 0.00844(**) \\
\text{Horsepower, } \hat{\beta}_3 : p - value &= 0.21963 \\
\text{Weight, } \hat{\beta}_4 : p - value &=< 2e-16(***) \\
\text{Acceleration, } \hat{\beta}_5 : p - value &= 0.41548 \\
\text{Year, } \hat{\beta}_6 : p - value &=< 2e-16(***) \\
\text{Origin, } \hat{\beta}_7 : p - value &= 4.67e-07(***)
\end{aligned}$$

The variables that are helpful in predicting mpg are displacement($\hat{\beta}_2$ coefficient), weight($\hat{\beta}_4$ coefficient), year($\hat{\beta}_6$ coefficient), and origin($\hat{\beta}_7$ coefficient).

- **(d)**

Answer:

Using the summary above, our F-statistic = 252.4,

degrees of freedom of 7 and 384,

and $p - value :< 2.2e-16 \approx 0$.

- **(e)**

```
lm.fit = lm(mpg ~ cylinders + horsepower + acceleration, data=Auto)

summary(lm.fit)
```

```
##
## Call:
## lm(formula = mpg ~ cylinders + horsepower + acceleration, data = Auto)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -12.3165  -3.1126  -0.3722   2.4537  17.1144
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  52.05717    2.44882  21.258  < 2e-16 ***
## cylinders    -1.72593    0.25298  -6.822 3.45e-11 ***
## horsepower   -0.11583    0.01336  -8.671  < 2e-16 ***
## acceleration -0.45469    0.11613  -3.916 0.000107 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4.501 on 388 degrees of freedom
## Multiple R-squared:  0.6699, Adjusted R-squared:  0.6674
## F-statistic: 262.5 on 3 and 388 DF,  p-value: < 2.2e-16
```

Answer:

Using the summary above our F-statistic = 262.5,

degrees of freedom of 3 and 388,

and $p - value :< 2.2\text{e} - 16 \approx 0$.

Our p-value is very small so we can reject $H_0 : \beta_1 = \beta_2 = \beta_3 = 0$. Among all of these predictors, there is at least one predictor that is helpful in predicting mpg.
