Q4

Zhen Zhang

4/24/2020

```
click = data.frame(sales=c(260.3,286.1,279.4,410.8,438.2,315.3,565.1,570.0,426.1,315.0, 403.6,220.5,343
```

(a) How much variation is left unexplained by the intercept model? (this will be called the null deviance)

```
deviance(lm(sales ~ 1, click))
```

```
## [1] 598253
```

(b) How much variation is explained by adding ad to the intercept model?

```
deviance(lm(sales ~ 1, click)) - deviance(lm(sales ~ ad, click))
```

```
## [1] 463451
```

(c) How much additional variation is explained by adding reps to a model that already has ad in it?

```
deviance(lm(sales ~ ad, click)) - deviance(lm(sales ~ ad + reps, click))
```

```
## [1] 59327.45
```

(d) How much additional variation is explained by adding eff to a model that already has ad and reps in it?

```r
deviance(lm(sales ~ ad + reps, click)) - deviance(lm(sales ~ ad + reps + eff, click))
```

```
## [1] 4430.622
```

(e) How much variation is unexplained by a model having all three predictors?

71043.94

(f) How much less variation is explained if we drop ad from a model with all three predictors in it?

```r
deviance(lm(sales ~ reps + eff, click)) - deviance(lm(sales ~ ad + reps + eff, click))
```

```
## [1] 44295.35
```

(g) Compute R2 for the three-predictor model "by hand" using only the numbers you have found above. Confirm your answer by having R compute it.

```r
fit = lm(sales ~ ad + reps + eff, click)
summary(fit)
```

```
##
## Call:
## lm(formula = sales ~ ad + reps + eff, data = click)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -87.407 -25.384  -6.546  26.937  76.693
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   31.150     34.175   0.911    0.368
## ad            12.968      2.737   4.738 3.34e-05 ***
## reps          41.246      7.280   5.666 1.95e-06 ***
## eff           11.524      7.691   1.498    0.143
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 44.42 on 36 degrees of freedom
## Multiple R-squared:  0.8812, Adjusted R-squared:  0.8714
## F-statistic: 89.05 on 3 and 36 DF,  p-value: < 2.2e-16
```

```r
(598253 - 71043.94) / 598253
```

```
## [1] 0.8812477
```

(h) Compute adjusted R2 by hand and confirm it.

```r
1 - ((1 - 0.8812477) * 39 / 36)
```

```
## [1] 0.8713517
```

(i) Compute the F statistic for the overall test of significance by hand.

```r
((598253 - 71043.94) / 3) / (71043.94 / 36)
```

```
## [1] 89.05065
```

(j) Compute the F statistic to test H0 : B1 = 0 by hand.

```r
44295.35 / (71043.94 / 36)
```

```
## [1] 22.44572
```