

## Quiz 6

A power company wants to use daily high temperature,  $x$ , to model daily peak power load,  $y$ , during the summer months when demand is greatest.

Although the company expects peak load to increase as the temperature increases, the rate of increase in  $E(y)$  might not remain constant as  $x$  increases. For example, a 1-unit increase in high temperature from 100 °F to 101 °F might result in a larger increase in power demand than would a 1-unit increase from 80 °F to 81 °F. Therefore, the company postulates that the model for  $E(y)$  will include a second-order (quadratic) term and, possibly, a third-order (cubic) term.

A random sample of 25 summer days is selected and both the peak load (measured in megawatts) and high temperature (in degrees) recorded for each day. The R output is attached.

**Exercise 6.1.** Fit the third-order model,  $E(y) = \beta_0 + \beta_1x + \beta_2x^2 + \beta_3x^3$ , to the data. Is there evidence that the cubic term,  $\beta_3x^3$ , contributes information for the prediction of peak power load? Test at  $\alpha = .05$ .

**Exercise 6.2.** Fit the third-order model,  $E(y) = \beta_0 + \beta_1x + \beta_2x^2$ , to the data. Test the hypothesis that the power load increases at an increasing rate with temperature. In other words, is the curve concave upward? Use  $\alpha = .05$ .

**Exercise 6.3.** Give the prediction equation for the second-order model, in Exercise 6.2. Are you satisfied with using this model to predict peak power loads?

```
third_order_model <- lm(Load ~ Temp + I(Temp^2) + I(Temp^3))
anova_alt(third_order_model)
```

```
## Analysis of Variance Table
##
##           Df      SS      MS      F      Pr
## Source   3 15012.2 5004.1 165.36 9.1368e-15
## Error   21   635.5   30.3
## Total   24 15647.7  652.0
```

```
summary(third_order_model)
```

```
##
## Call:
## lm(formula = Load ~ Temp + I(Temp^2) + I(Temp^3))
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -10.3229  -2.1941  -0.1422   3.3026   9.7775
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 331.25268035 477.11146572   0.694   0.495
## Temp        -6.39191245  16.79082602  -0.381   0.707
## I(Temp^2)    0.03775397   0.19451185   0.194   0.848
## I(Temp^3)    0.00008432   0.00074260   0.114   0.911
##
## Residual standard error: 5.501 on 21 degrees of freedom
## Multiple R-squared:  0.9594, Adjusted R-squared:  0.9536
## F-statistic: 165.4 on 3 and 21 DF, p-value: 9.137e-15
```

```
second_order_model <- lm(Load ~ Temp + I(Temp^2))
anova_alt(second_order_model)
```

```
## Analysis of Variance Table
```

```
##
```

```
##      Df      SS      MS      F      P
## Source  2 15011.8 7505.9 259.69 4.9908e-16
## Error  22   635.9   28.9
## Total  24 15647.7  652.0
```

```
summary(second_order_model)
```

```
summary(second_order_model)
```

```
##
```

```
## Call:
```

```
## lm(formula = Load ~ Temp + I(Temp^2))
```

```
##
```

```
## Residuals:
```

```
##      Min       1Q   Median       3Q      Max
## -10.4291  -2.1779  -0.0156   3.1759   9.6489
```

```
##
```

```
## Coefficients:
```

```
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 385.048093  55.172436   6.979 0.000000527 ***
## Temp        -8.292527   1.299045  -6.384 0.000002010 ***
## I(Temp^2)    0.059823   0.007549   7.925 0.000000069 ***
```

```
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
##
```

```
## Residual standard error: 5.376 on 22 degrees of freedom
```

```
## Multiple R-squared:  0.9594, Adjusted R-squared:  0.9557
```

```
## F-statistic: 259.7 on 2 and 22 DF, p-value: 4.991e-16
```