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 listed below.

Question 1. Fit the third-order model, $E(y) = \beta_0 + \beta_1 x + \beta_2 x^2 + \beta_3 x^3$, to the data. Is there evidence that the cubic term, $\beta_3 x^3$, contributes information for the prediction of peak power load? Test at $\alpha = .05$.

Question 2. Fit the second-order model, $E(y) = \beta_0 + \beta_1 x + \beta_2 x^2$, 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 $\alpha = .05$.

```r
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          P
## Source  3 15012.2 5004.1 165.36 9.1368e-15
## Error  21   635.5   30.3
## Total  24 15647.7  652.0
```

```r
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
```

```r
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
```

```r
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
```

Question 3. Give the prediction equation for the second-order model, in Question 2. Are you satisfied with using this model to predict peak power loads?

Instruction: Please complete the quick quiz on a piece of paper. Then take a picture and submit it to Blackboard $\rightarrow$ Work Submission.