

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, β_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      P
## 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

```