Number of Children - Poisson Models with Polynomial Terms

February 5, 2020

First of all, the children data is loaded:

```
> library(catdata)
> data(children)
> attach(children)
```

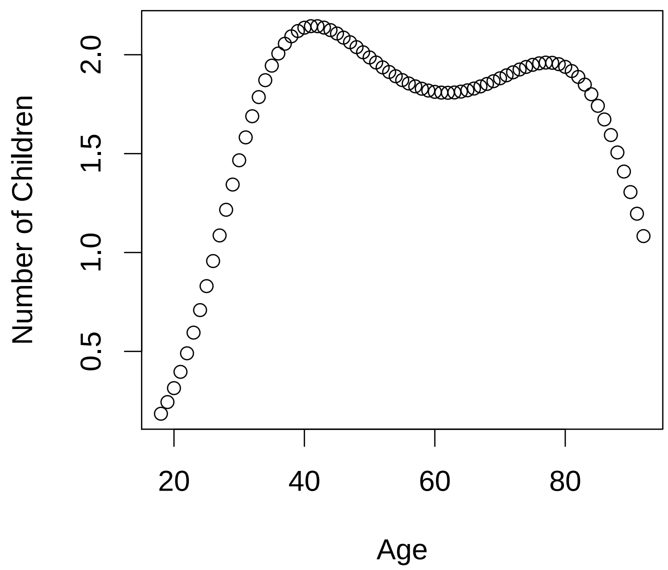
A log-linear Poission model with the number of children as dependent variable is fitted. Since one cannot expect that the metric predictors have linear effects, polynomial terms are included in the predictors.

```
> pois <- glm(child ~ age+I(age^2)+I(age^3)+I(age^4)+dur+I(dur^2)+nation+god+univ,
+              data = children,  family = poisson(link=log))
> summary(pois)

Call:
glm(formula = child ~ age + I(age^2) + I(age^3) + I(age^4) +
    dur + I(dur^2) + nation + god + univ, family = poisson(link = log),
    data = children)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-2.1514  -0.7559   0.0102   0.4832   3.6715

Coefficients:
              Estimate Std. Error z value Pr(>|z|)
(Intercept) -1.228e+01  1.484e+00  -8.277  < 2e-16 ***
age          9.359e-01  1.239e-01   7.553 4.26e-14 ***
I(age^2)    -2.490e-02  3.786e-03  -6.577 4.80e-11 ***
I(age^3)     2.842e-04  4.915e-05   5.781 7.42e-09 ***
I(age^4)    -1.180e-06  2.297e-07  -5.137 2.80e-07 ***
dur          1.118e-01  6.652e-02   1.680 0.092904 .
I(dur^2)    -8.328e-03  2.997e-03  -2.779 0.005454 **
nation1      5.686e-02  1.386e-01   0.410 0.681599
god2        -1.025e-01  5.903e-02  -1.736 0.082599 .
god3        -1.448e-01  6.780e-02  -2.136 0.032683 *
god4        -1.279e-01  7.088e-02  -1.805 0.071128 .
god5        -3.621e-02  6.695e-02  -0.541 0.588569
god6        -9.241e-02  7.505e-02  -1.231 0.218239
```

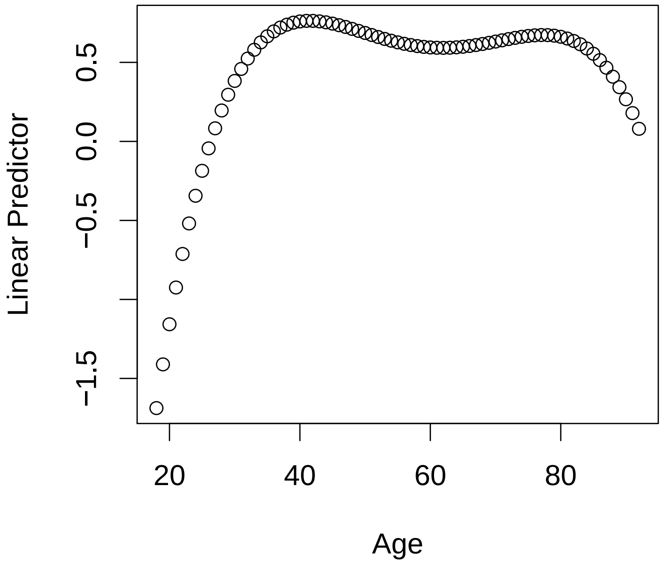
```
univ1         6.372e-01  1.729e-01   3.686 0.000228 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for poisson family taken to be 1)

    Null deviance: 2067.4  on 1760  degrees of freedom
Residual deviance: 1718.6  on 1747  degrees of freedom
AIC: 5196.8

Number of Fisher Scoring iterations: 5
```

Visualizing the effect of age and duration for education.

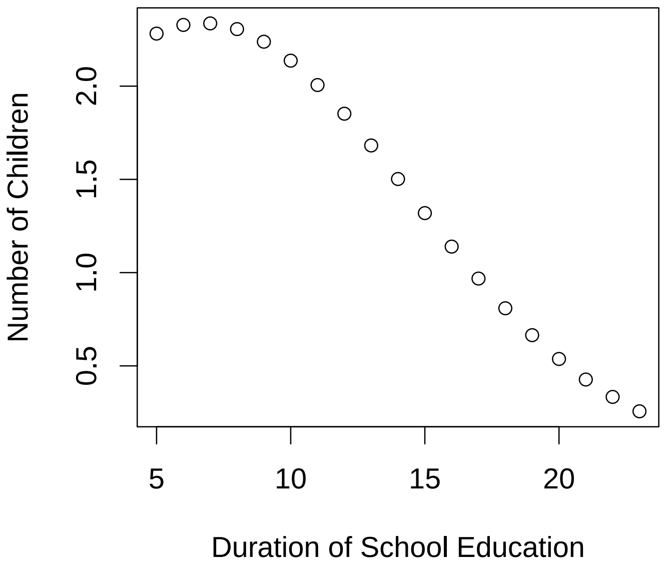
```
> x <- min(age):max(age)
> y <- exp(pois$coef[1]+pois$coef["age"]*x+pois$coef["I(age^2)"]*x^2+
+   pois$coef["I(age^3)"]*x^3+pois$coef["I(age^4)"]*x^4+pois$coef["dur"]*10+
+   pois$coef["I(dur^2)"]*100)
> par(cex=1.4)
> plot(x, y, ylab="Number of Children", xlab="Age")
```



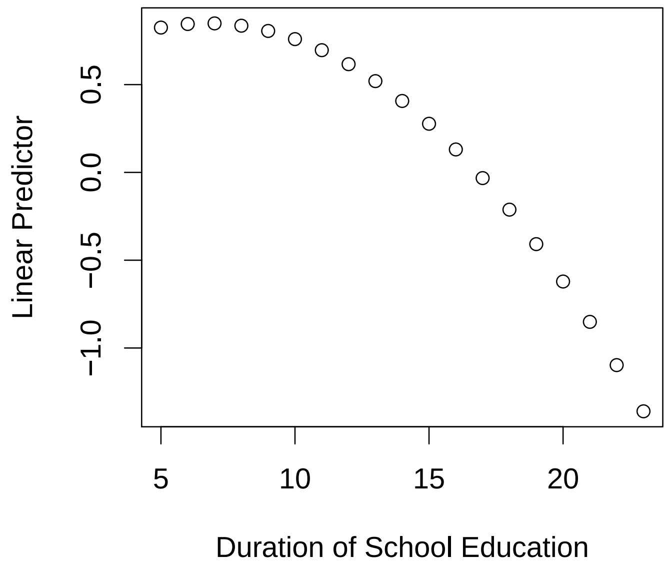

```
> y <- (pois$coef[1]+pois$coef["age"]*x+pois$coef["I(age^2)"]*x^2+
+   pois$coef["I(age^3)"]*x^3+pois$coef["I(age^4)"]*x^4+pois$coef["dur"]*10+
+   pois$coef["I(dur^2)"]*100)
> par(cex=1.4)
> plot(x, y, ylab="Linear Predictor", xlab="Age")
```




```
> x <- min(dur):max(dur)
> y <- exp(pois$coef[1]+pois$coef["age"]*40+pois$coef["I(age^2)"]*40^2+
+   pois$coef["I(age^3)"]*40^3+pois$coef["I(age^4)"]*40^4+pois$coef["dur"]*x+
+   pois$coef["I(dur^2)"]*x^2)
> par(cex=1.4)
> plot(x, y, ylab="Number of Children", xlab="Duration of School Education")
```




```
> y <- (pois$coef[1]+pois$coef["age"]*40+pois$coef["I(age^2)"]*40^2+
+   pois$coef["I(age^3)"]*40^3+pois$coef["I(age^4)"]*40^4+pois$coef["dur"]*x+
+   pois$coef["I(dur^2)"]*x^2)
> par(cex=1.4)
> plot(x, y, ylab="Linear Predictor", xlab="Duration of School Education")
```



Calculate the deviance of the Poisson model.

```
> anova(pois)

Analysis of Deviance Table

Model: poisson, link: log

Response: child

Terms added sequentially (first to last)


          Df Deviance Resid. Df Resid. Dev
NULL                       1760     2067.4
age        1   93.596      1759     1973.8
I(age^2)   1  108.618      1758     1865.2
I(age^3)   1   68.198      1757     1797.0
I(age^4)   1   26.290      1756     1770.7
dur        1   30.730      1755     1740.0
I(dur^2)   1    0.682      1754     1739.3
nation     1    0.459      1753     1738.8
god        5    6.729      1748     1732.1
univ       1   13.489      1747     1718.6
```