Exercises 5

These exercises use the switching measurement data studied in J. Karvanen, J. J. Vartiainen, A. Timofeev, J. Pekola, Experimental designs for binary data in switching measurements on superconducting Josephson junctions. Journal of the Royal Statistical Society: Series C (Applied Statistics) 56 (2), 167-181, 2007. Data set `switching` available at `http://www.tilastotiede.fi/data/switching1.Rdata` contains the data from the experiment and data set `switching2` available at `http://www.tilastotiede.fi/data/switching2.Rdata` contains the verification of the experiment. Documentation of `switching` is available at `http://www.blackwellpublishing.com/rss/Readmefiles/56p2Karvanen.htm` and `switching2` has variables x (the height of the current pulse), *trials* (number of trials) and *responses* (number of times when the presence of voltage pulse was recorded). The links are available also on the course page.

1. Explain the number of responses by the height of the current pulse and fit GLMs with logit, probit and complementary log-log link to the switching measurement data 2 `http://www.tilastotiede.fi/data/switching2.Rdata`. Plot the estimated response curves together with the observed responses. Compare the models by their deviance and residuals. Is there overdispersion?

2. Using the same three link functions, fit models where the number of responses is explained by a third order polynomial of x. Compare the six models by AIC and BIC.

3. Using the `switching2` data, test the null hypothesis that the regression parameters for the cloglog model are -60.628182 (intercept) and 0.240227 (coefficient for pulse height). Use the likelihood ratio test. (Useful R commands: `offset`, `pchisq`.)

4. For the switching measurement data, the probability of voltage response was explained by the height of the applied current pulse. A GLM with complementary log-log link was used as a model and the estimate $\hat{b} = -60.6282$ for the intercept and the estimate $\hat{a} = 0.2402$ for the regression coefficient of the current pulse were obtained from 117288 measurements. Physicists are interested in parameters that directly describe the location and the scale of the response curve in

addition to parameters a and b. Let us define the middle point θ and width of the curve λ, as follows

$$\theta = \frac{1}{a}(F^{-1}(0.5) - b)$$
$$\lambda = \frac{1}{a}(F^{-1}(0.9) - F^{-1}(0.1)),$$

where $F(z) = 1 - e^{-\exp(z)}$. Calculate estimates $(\hat{\theta}, \hat{\lambda})$ and derive their covariance matrix when the observed information matrix of $(\hat{a}, \hat{b})$ is

$$\begin{pmatrix} 2849969801 & 11237023.08 \\ 11237023.08 & 44319.61 \end{pmatrix}.$$