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A Bayesian approach to estimate Poisson excess relative risk models: Analysing the A-bomb survivors lifespan study with STAN.

The A-bomb survivors lifespan study (LSS) [http://www.rerf.jp/glossary_e/lss.htm] plays a pivotal role in radiation epidemiology: It has provided cancer risk estimates for radiation exposure that are the basis for many international radiation protection regulations. In the official analysis reports [http://www.rerf.jp/library/rr_e/rr1104.pdf], the risk estimates are calculated using Poisson excess relative risk (ERR) regression with fine-tuned models for baseline risk, dose-response, and effect modification. Uncertainty in the estimated radiation exposure is incorporated into the model with a fixed coefficient of variation. The regression is typically fit with idiosyncratic commercial software for ERR models using maximum likelihood methods.

Our ultimate goal is to apply Bayesian methods to model measurement uncertainty in the LSS data -- e.g., shared error and Berkson error (Carroll et al. 2006). We therefore started with fitting the official regression model to the publicly available data [http://www.rerf.or.jp/library/dl_e/lss14.html] using R and STAN. This talk summarizes the experience in estimating a multi-parameter model with 24 coefficients based on a moderately large data set (> 50.000 cells). The results are compared with attempts at directly optimizing the Poisson likelihood using gradient-based or derivative-free algorithms.

Carroll, Ruppert, Stefanski and Crainiceanu. 2006. Measurement Error in Nonlinear Models: A Modern Perspective, 2nd Edition. Chapman & Hall/CRC.