Case Study II

Math 315, Fall 2019

Due 8 November by 4:00 p.m.

Your task

The file `coal.csv` contains the number of coal-mining explosions in Great Britain where 10 or more miners were killed ("disasters") for the years 1851-1962. Researchers can see that the disaster rate decreased toward the end of the 19th century (1800s), but the actual change-point, τ, is unknown. Let Y_i be the number of disasters in year $i =$ actual year $- 1850$. Your task is to use JAGS to fit the following change-point model.

$$Y_i \sim \text{Poisson}(\mu_i)$$
$$\log(\mu_i) = \beta_0 + \beta_1 \times \delta(i - \tau),$$

where $\delta(t - \tau)$ is defined to be 1 if $t - \tau \geq 0$ and 0 otherwise. You can assume that τ, β_1, and β_2 are mutually independent. Focus your analysis and conclusions on the following quantities:

- θ: the expected number of disasters per year for $i < \tau$,
- λ: the expected number of disasters per year for $i \geq \tau$, and
- $R = \theta/\lambda$.

```
coal <- read.csv("https://aloy.rbind.io/data/coal.csv")
```

Report requirements

Summarize your analysis in a 3-6 page report (double spaced, 11pt, one-inch margins, including figures). Your report MUST have the follow sections and contents:

1. Introduction: Briefly describe the problem, the data, and your objectives
2. Model specification: Describe the Bayesian model you are fitting and other relevant details. This should certainly include a discussion of the likelihood, priors, and the joint posterior.
3. Computation: Give brief details about how you fit the model. Since you are fitting this model in JAGS, say so. Then, give the details so that a randomly selected classmate could run your analysis (e.g., burn-in length, number of MCMC draws, initial values, etc.). You don't need to include the code in the body of your report, just describe the set up.
4. Results: Analyze your posterior distribution and discuss your results.

Think of this case study as a "mini-project." This means that everything must be typed, proofread, labeled, captioned, and referenced, as appropriate. If you develop an interesting computational way to solve a problem, feel free to include pseudo (or actual) code as an appendix, but, in general, code is not required in the body of the report. Please email me your code for the case study with the subject line: "`Math 315 case study: <Last Name>, <Last Name>`," where you fill in the last names of your group as appropriate.

JAGS hints

- Define $\log(\mu_i)$ within the for loop where you set up the likelihood.
- Be sure to put priors on β_0, β_1, and τ. I recommend a uniform prior for τ.
- The `step()` function in JAGS is equivalent to the δ function defined above.
- You have the JAGS manual, don't hesitate to use it!