

STATISTICAL RETHINKING 2022

WEEK 6

The theme of this homework is tadpoles. You must keep them alive.

1. Conduct a prior predictive simulation for the Reedfrog model. By this I mean to simulate the prior distribution of tank survival probabilities α_j . Start by using this prior:

$$\begin{aligned}\alpha_j &\sim \text{Normal}(\bar{\alpha}, \sigma) \\ \bar{\alpha} &\sim \text{Normal}(0, 1) \\ \sigma &\sim \text{Exponential}(1)\end{aligned}$$

Be sure to transform the α_j values to the probability scale for plotting and summary. How does increasing the width of the prior on σ change the prior distribution of α_j ? You might try $\text{Exponential}(10)$ and $\text{Exponential}(0.1)$ for example.

2. Revisit the Reedfrog survival data, `data(reedfrogs)`. Start with the varying effects model from the book and lecture. Then modify it to estimate the causal effects of the treatment variables `pred` and `size`, including how `size` might modify the effect of predation. An easy approach is to estimate an effect for each combination of `pred` and `size`. Justify your model with a DAG of this experiment.

3. Now estimate the causal effect of `density` on survival. Consider whether `pred` modifies the effect of `density`. There are several good ways to include `density` in your Binomial GLM. You could treat it as a continuous regression variable (possibly standardized). Or you could convert it to an ordered category (with three levels). Compare the σ (tank standard deviation) posterior distribution to σ from your model in Problem 2. How are they different? Why?

4-OPTIONAL CHALLENGE. Using your estimates from the previous problems, compute the expected causal effect of removing predators from a population of tadpoles with `size` and `density` distributed according to this table:

density	size	
	small	large
10	25%	25%
35	25%	25%

In other words, 25% of the population is in groups of 10 small tadpoles, 25% in groups of 10 large tadpoles, 25% in groups of 35 small tadpoles, and 25% in groups of 25 large tadpoles. Think carefully about if and how you should incorporate the tank varying effects in this calculation.