

Exercises 2 and 3: Varying Coefficients

Goal and Background

Exercises 2 and 3 both including generating a model in JAGS and fitting it to the PLD data we have used in this course. Although Exercises 2 and 3 are both included in this assignment, that is simply for convenience so we can get through them faster—the main features of each assignment are retained within this combined assignment. Assignment 2 deals with fitting a varying intercept and fixed slope hierarchical model, and Assignment 3 deals with fitting a varying-coefficients model and modeling level-2 with a covariate. You are welcome to submit the assignments in one file (an HTML output from a Markdown file), but please add sections or other document structure to clearly separate the two assignments.

The data

You will be using the same data from Assignment 1—the data from the O'Connor et al. (2007) paper. See Assignment 1 if you need a refresher on the data. The data are included in the text file `PLD.txt`. Please use the \log_e -transformed PLD and temperature data. To be consistent with O'Connor et al (2007), please center the temperature predictor at 15C. Thus, the varying intercepts are interpreted as species-specific $\log_e(\text{PLD})$ at 15C.

Instructions

Please answer the enumerated items below as you complete the assignment. You are only required to turn in the answers to the enumerated items, but please respond with code where applicable. Although you may turn in additional material, it will not factor into your grade. Also, please refrain from printing out large chunks of R code. (Also note that the use of math mode should be used for coding statistical models in markdown language. In-line math mode is done by placing your expression between a set of dollar signs [$y^3 = x_i^3$], while placing an expression in between double dollar signs creates equation mode, where your expression is given it's own line.)

By 5pm on Wednesday, October 30th, please email me a digital version of the knitted output of an R Markdown file.

Exercise 2

1. Write the complete statistical model (i.e., not R code) for a varying-intercepts and fixed slope model. Include a brief mention of what the model terms mean (i.e., as you might report the model in a manuscript).
2. Fit the model using `lmer()`. Please report the model you fit and the σ_α^2 , σ^2 , μ_α , and β estimates. These will be used to reference the estimates produced in the JAGS model.
3. Fit the varying-intercept, fixed slope model in JAGS. I have not provided an R script as per Assignment 1, but feel free to work from the Assignment 1 script as much of the base scripting will be the same. (i.e., You can build from that code and examples from lecture). For this question, simply report the JAGS model you fit.
4. Compare the JAGS model coefficients to the `lmer` coefficients.

5. Using μ_α , plot a single regression for this model—you do not need to plot all α_j 's. How does this regression compare to the simple linear regression (same data, but not considering within-group structure) from Exercise 1?

Exercise 3

6. Write the complete statistical model (i.e., not R code) for a varying-intercepts and varying-slopes model. Include a brief mention of what the model terms mean (i.e., as you might report the model in a manuscript).

7. Fit the model using `lmer()`. Please report the model you fit and the σ_α^2 , σ_β^2 , σ^2 , μ_α , and μ_β estimates. These will be used to reference the estimates produced in the JAGS model.

8. Now that you have a model with varying slopes and intercepts, we want to determine if the species-specific intercepts and slopes differ among developmental feeding modes (lecithotrophic [nonfeeding] and planktotrophic [feeding]). This can be approached by adding the feeding mode as a dummy variable to the second level of the model. To accomplish this, we need to add a species-specific predictor (i.e., the species developmental feeding mode, either L for lecithotrophic or P for planktotrophic) for both the varying slopes and intercepts. For this question, please write out the second level of the statistical model to reflect this covariate. (Note: This builds off question 6.)

9. Fit this varying-coefficients model with the developmental mode covariate in JAGS, and report the JAGS model statement.

10. Generate 2 simple plots. The first plot will show two dots for the parameter estimates and lines for the 95% credible intervals to compare the mean intercepts between two developmental modes. The second plot will reflect similar information and presentation, but for the two slope estimates. Briefly mention what you might infer from these plots?