



Bayesian Modeling for Socio-Environmental Data

August 15-25, 2017

Instructors: Chris Che-Castaldo, Mary B. Collins, N. Thompson Hobbs

Course syllabus is subject to change.

Course Description: R is a crucial skill for success in this course. Considering reviewing Tom's R Primer, and head over to Quick R, <http://www.statmethods.net/index.html>, which gives a nice overview of basic R functionality. We ask that you are fluent with the following topics from Quick-R:

1. Data Types, Importing Data (from excel or a .csv file), Keyboard Input, and Missing Values under Data Input
2. All topics under Data Management
3. All topics under Graphs

Specifically, you should be very comfortable with manipulating matrices and lists and writing and using custom functions.

We strongly recommend purchasing Hobbs & Hooten 2015 <https://www.amazon.com/Bayesian-Models-Statistical-Primer-Ecologists/dp/0691159289>. The first three chapters provide foundational material that we will cover fairly quickly in the course, so if you have not had a course in mathematical statistics, reading those chapters before the course is crucial. The structure of the course closely follows the organization of the book. It will be a useful reference after the course.

We will be starting on the first day at 8am. Every other day we will begin at 9am. We will usually end at 5 or 5:30.

Remember that lunch will be served at SESYNC each day during the course.

Course materials will be distributed throughout the course via [GitHub](#). Clone our repo and plan on pulling down new material often.

Course Schedule

Day 1: Probability

- Participant and Course Introduction
- *What Sets Bayes Apart?*
- *Laws of Probability* & Probability Lab Exercises: I-V
- *Probability Concepts and Notation* & Probability Lab Exercise VI
- *Probability Distributions* & Probability Lab Exercise VII

Day 2: Likelihood & Bayes' Theorem

- *Likelihood* & Likelihood Problem Set
- *Bayes' Theorem Part A* & Bayes' Theorem Exercises I-IV
- *Bayes' Theorem Part B* & Bayes' Theorem Exercises V-VI
- *Bayes' Theorem Part C* & Bayes' Theorem Exercises VII-IX, XIV, XVI, XVII
- *Introduction to Hierarchical Models* & Hierarchical Modeling Board Work

Day 3: Priors & Markov chain Monte Carlo

- *Conjugate Priors Part A* & Beta-Binomial Exercise
- *Conjugate Priors Part B* & Poisson-Gamma Exercise
- *Normal-Normal and Normal-Inverse Gamma Usage* & Normal-Normal and Normal-Inverse Gamma Exercise
- *MCMC Overview* & MCMC Exercise III
- *MCMC Next Steps* & MCMC Exercises IV-V
- *MCMC Accept Reject* & MCMC Metropolis-Hastings Coding Exercise
- *Happy Hour at SESYNC*

Day 4: JAGS & Modeling Practice

- JAGS Primer Work
- *Inference From a Single Model*
- *Vague Priors in Non-Linear Models* & Islands Problem Set
- Non-Linear Priors Problem Set

Day 5: Bayesian Regression, Analysis of Covariance, & Multi-Level Modeling

- *Bayesian Regression* & Practice: Writing Models and Psuedo Coding
- *Multi-Level Modeling* & Begin Multi-Level Modeling Lab

Day 6: Multi-Level Modeling Continued, Model Checking, & Model Selection

- Continue Multi-Level Modeling Lab
- *Model Selection*
- *Model Checking*
- *Utility and Use of the Half-Couchy Prior*

Day 7: Flavors of Modeling

- *Mixture Models, Zero Inflation, & Occupancy* & Swiss Birds Lab

Day 8: Dynamic Models & Applying Your Knowledge

- *Dynamic Models* & Lynx Exercises
- Participant Project Work

Day 9: Spatial Modeling

- *Continuous Spatial Process Modeling* & Source Diversity Lab
- *Synthesis via Meta Analysis* & Pediatric Deaths Lab

Day 10: Using Your Bayes' Skills

- Participant Project Presentations and Feedback