Bayesian Modeling for Socio-Environmental Data

August 15-25, 2017

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Course syllabus is subject to change.

Course Preparation: 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.

Course Logistics: 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 [notes: TOM LEAD (no lab)]
- *What Sets Bayes Apart?* [notes: TOM LEAD justification why we need laws of prob]
- *Laws of Probability* & Probability Lab Exercises: I-V [notes: MARY LEAD conditioning/independence, tot prob, chain rule]
- *Probability Concepts and Notation* & Probability Lab Exercise VI [notes: CHRIS LEAD support, pmf/pdf, cdf, quantile function, cheat sheets]
- *Probability Distributions* & Probability Lab Exercise VII [notes: TOM LEAD moment matching]

Day 2: Likelihood & Bayes' Theorem

- *Likelihood* & Likelihood Problem Set [notes: CHRIS LEAD profile, total likelihood, max likelihood, ratios]
- *Bayes' Theorem Part A* & Bayes' Theorem Exercises I-IV [notes: TOM LEAD plotting data, prior on θ]
- *Bayes' Theorem Part B* & Bayes' Theorem Exercises V-VI [notes: TOM LEAD Likelihood and joint]
- *Bayes' Theorem Part C* & Bayes' Theorem Exercises VII-IX, XIV, XVI, XVII [notes: TOM LEAD]
- *Introduction to Hierarchical Models* & Hierarchical Modeling Board Work [notes: TOM LEAD]

Day 3: Priors & Markov chain Monte Carlo

- *Conjugate Priors Part A* & Beta-Binomial Exercise [notes: MARY/TOM LEAD Bayes lab problem 15?]
- *Conjugate Priors Part B* & Poisson-Gamma Exercise [notes: MARY/TOM LEAD]
- *Normal-Normal and Normal-Inverse Gamma Usage* & Normal-Normal and Normal-Inverse Gamma Exercise [notes: TOM LEAD?]
- *MCMC Overview* & MCMC Exercise III [notes: TOM LEAD]
- *MCMC Next Steps* & MCMC Exercises IV-V [notes: TOM LEAD]
- *MCMC Accept Reject* & MCMC Metropolis-Hastings Coding Exercise [notes: TOM LEAD]
- Happy Hour at SESYNC

Day 4: JAGS & Modeling Practice

- JAGS Primer Work
- *Inference From a Single Model* [notes: TOM LEAD]
- *Vague Priors in Non-Linear Models* & Islands Problem Set [notes: TOM LEAD]
- Non-Linear Priors Problem Set [notes: TOM LEAD]

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

- *Bayesian Regression* & Practice: Writing Models and Psuedo Coding [notes: CHRIS/TOM LEAD]
- *Multi-Level Modeling* & Begin Multi-Level Modeling Lab [notes: TOM LEAD]

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

- Continue Multi-Level Modeling Lab [notes: CHRIS/TOM LEAD]
- *Model Selection* [notes: TOM LEAD]
- *Model Checking* [notes: TOM LEAD]
- *Utility and Use of the Half-Couchy Prior* [notes: TOM LEAD]

Day 7: Flavors of Modeling

- *Mixture Models, Zero Inflation, & Occupancy* & Swiss Birds Lab [notes: TOM LEAD]

Day 8: Dynamic Models & Applying Your Knowledge

- *Dynamic Models* & Lynx Exercises [notes: TOM LEAD]
- Participant Project Work

Day 9: Spatial Modeling

- *Continuous Spatial Process Modeling* & Source Diversity Lab [notes: TOM/MARY LEAD]
- *Synthesis via Meta Analysis* & Pediatric Deaths Lab [notes: TOM LEAD]

Day 10: Using Your Bayes' Skills

- Participant Project Presentations and Feedback