Introduction to Course

Bayesian Modeling for Socio-Environmental Data

N. Thompson Hobbs

August 1, 2016

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Bayesian Modeling for Socio-Environmental Data

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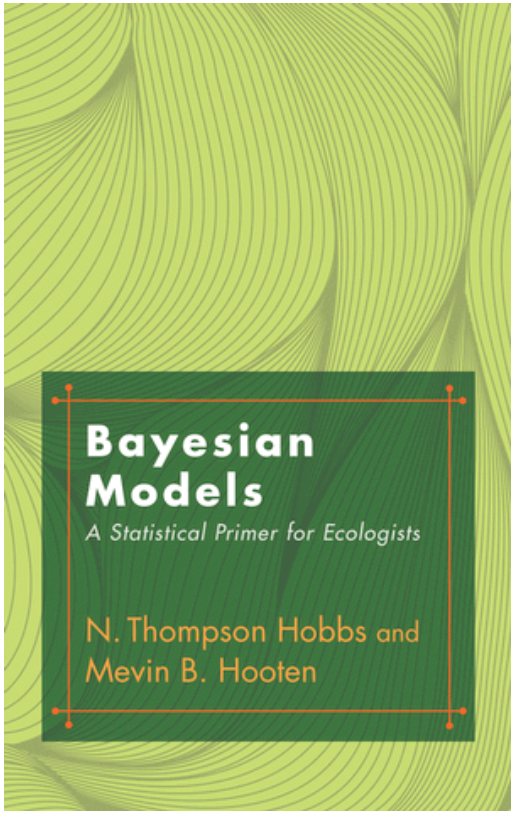
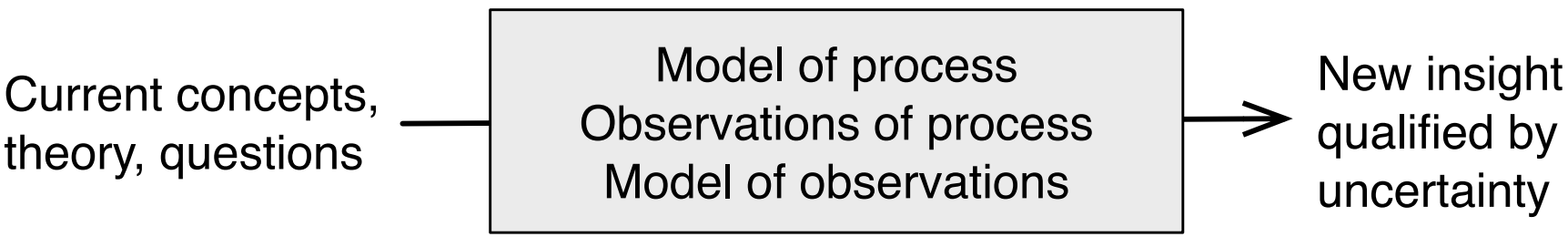
- Introductions
- GitHub for course materials
- Daily schedule
- Lecture style
- Pulling notes just in time
- Exercises

Readings



Errata: `http://warnercnr.colostate.edu/~hooten/papers/pdf/Hobbs_Hooten_Bayesian_Models_2015_errata.pdf`

What is this course about?



What is this course about?

Building models of processes

$$[z_i|\boldsymbol{\theta}_p]$$

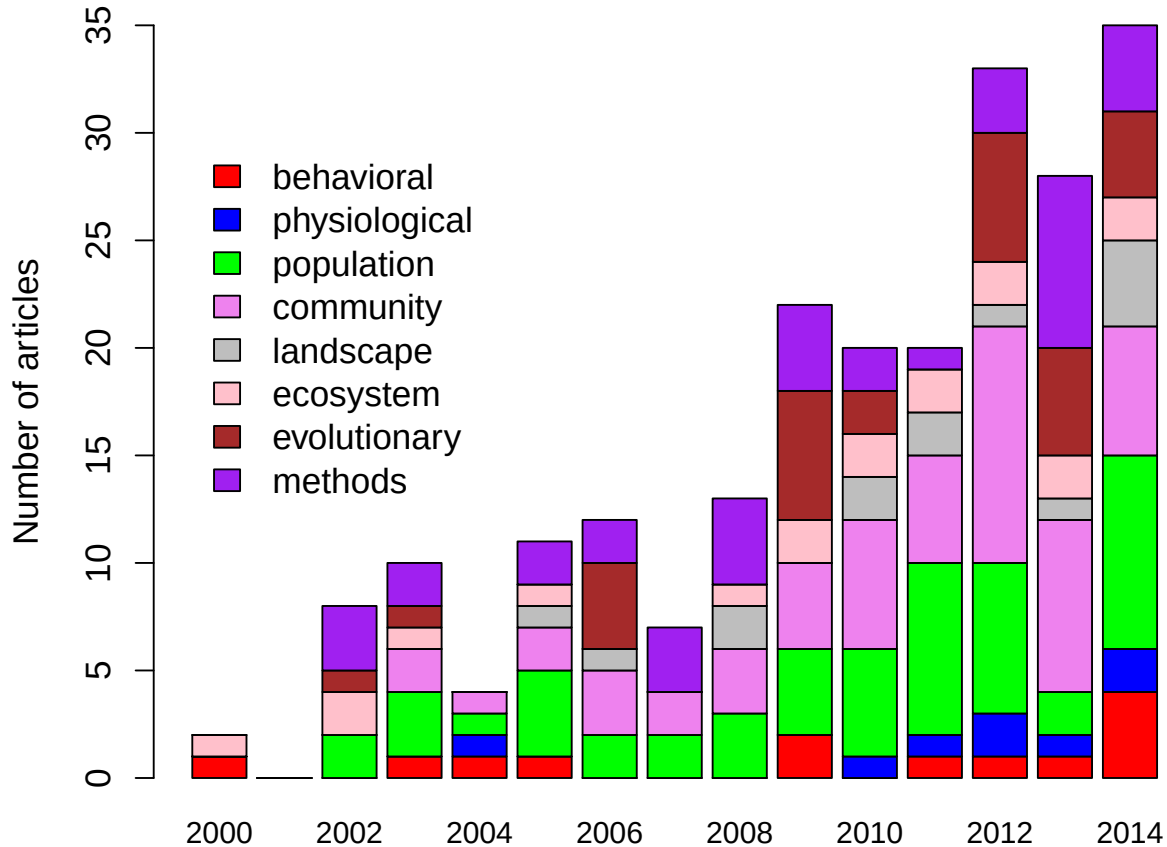
and linking those models to data

$$[y_i|z_i, \boldsymbol{\theta}_d]$$

using Bayesian methods.

Why this course?

Papers using Bayesian analysis in *Ecology*



Why this course?

3 A	5 B	1 B	4 B	2 A	1 A	4 A	3 B	2 B	5 A	Block 1
2 A	5 B	4 B	2 B	4 A	3 A	1 A	1 B	3 B	5 A	Block 2
1 A	3 B	4 B	5 B	3 A	4 A	2 A	2 B	1 B	5 A	Block 3

Factorial Arrangement of Treatments in a Randomized Complete Block Design

5 A	2 A	1 A	4 A	3 A	1 B	3 B	5 B	4 B	2 B	Block 1
5 B	3 B	1 B	2 B	4 B	4 A	3 A	2 A	1 A	5 A	Block 2
4 A	3 A	5 A	1 A	2 A	2 B	1 B	3 B	5 B	4 B	Block 3

Factorial Arrangement of Treatments in a Split-Plot Design

Why this course?

Problems poorly suited to traditional approaches

- Multiple sources of data
- Multiple sources of uncertainty
- Inference across scales
- Unobservable quantities
- Derived quantities
- Forecasting

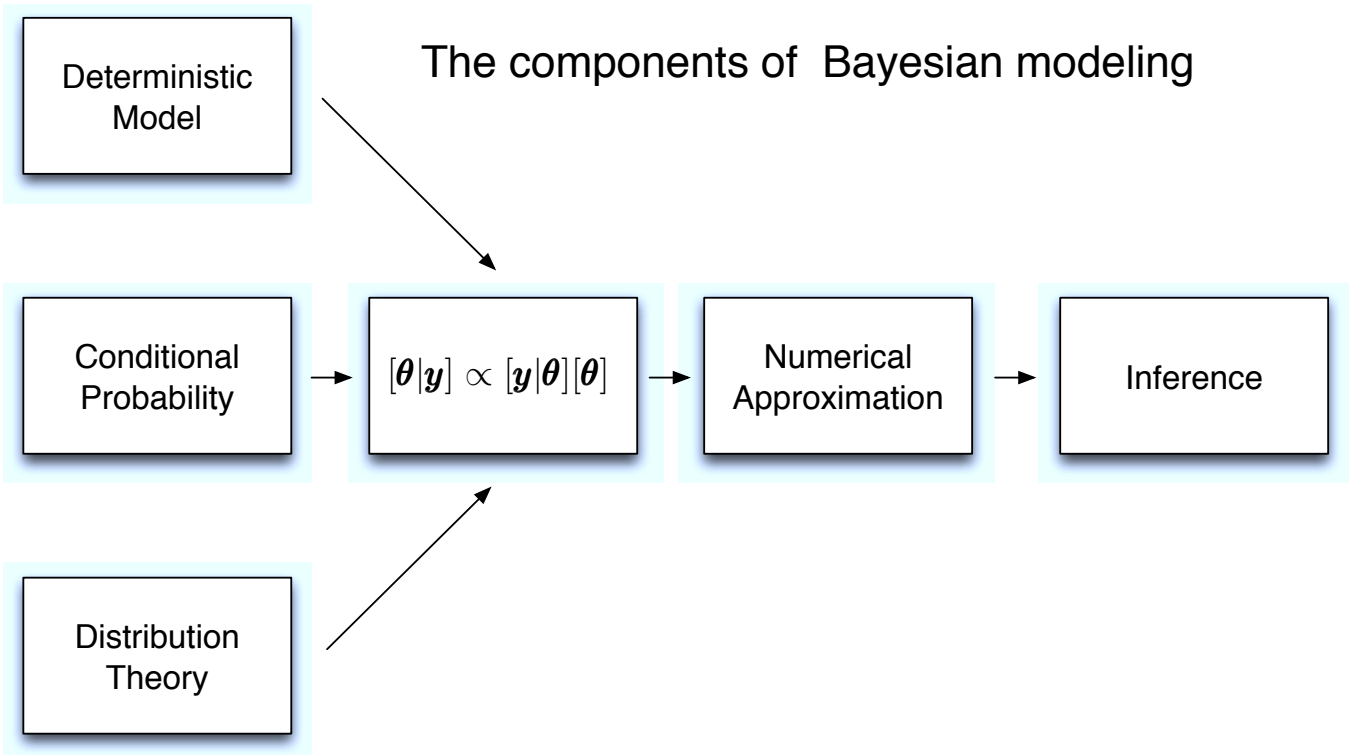
Why this course?

SESYNC is dedicated to fostering synthetic, actionable science related to the structure, functioning, and sustainability of socio-environmental systems.

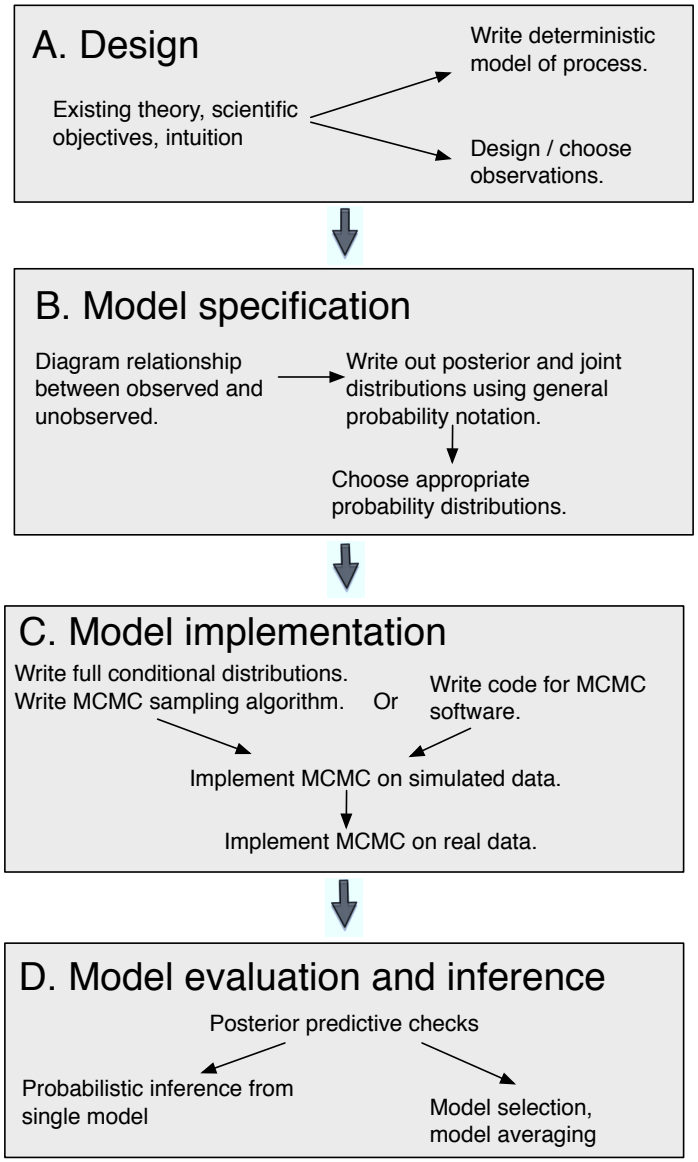
Goals

- Provide *principles* based understanding
- Enhance intellectual satisfaction
- Foster collaboration
- Build a foundation for self-teaching

Learning outcomes



Learning outcomes



Learning outcomes

1. Explain basic principles of Bayesian inference.
2. Diagram and write out the posterior and joint distributions for Bayesian models.
3. Explain basics of Markov chain Monte Carlo (MCMC).
4. Use software for implementing MCMC method.s
5. Develop and implement hierarchical models.
6. Evaluate model fit.
7. Appreciate possibilities for model selection.
8. Understand papers and proposals using Bayesian methods.

Topics

Principles

- Laws of probability
- Distribution theory
- Moment matching
- Bayes' theorem
- Conugacy

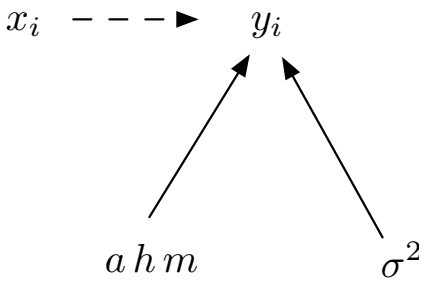
Implementation and inference

- MCMC
- JAGS
- Inference on a single model

Hierarchical models

- Introduction
- Multi-level regression
- Mixture and occupancy
- State-space
- Inference on multiple models
- Spatial models

Cross cutting theme



$$\mu_i = \frac{m x_i^a}{h^a + x_i^a}$$

$$[a, h, m, \sigma^2 | \mathbf{y}] \propto \prod_{i=1}^{n} [y_i | \mu_i, \sigma^2][a][h][m][\sigma^2]$$

```
model{

      for(i in 1:length(y)){
            mu[i] <- (m*x[i]^a)/(h^a+x[i]^a)
            y[i] ~ dgamma(mu[i]^2/sigma^2,mu[i]/sigma^2)
      }
a ~ dnorm(0,.0001)
m ~ dgamma(.01,.01)
h ~ dgamma(.01,.01)
sigma ~ dunif(0,5)
}
```