

Bayesian inference for environmental models

ENV/BIO665, Spring 2024

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Application of environmental models and applications to data using Bayesian analysis. Provides the basic distribution theory needed for model building and algorithm development. Computation is done with the language R. Applications include physiology, population growth, species interactions, disturbance, and ecosystem dynamics. Discussions focus on classical and current primary literature.

Needed for class

- bring a laptop
- install RStudio

Webpage: sakai: ENV/BIO665 BAYESIAN INFERENCE ENV MODELS

Objectives

Recognition and usage of observational, experimental data

Comprehension:

- basic distribution theory for connecting data and models
- foundational overlap and distinctions with traditional/Bayes/machine learning

Implementation: scientific question to data to model to computation

- acquiring, visualizing, summarizing data
- model building and algorithm construction in R
- diagnostics
- variable selection

Communicate/critique model analyses

Assignments: Questions from each unit are generally due at the next meeting. Your answers will be discussed within groups, with individual responses turned in by the end of that date.

Grading

- 30% Participation: contribute in class and to working groups
- 45% Group and individual assignments
- 25% final presentation and report

Structure

- Discussion of problem sets and readings from the literature
- Vignettes in R
 - concepts and R code for course
 - problem sets: discussed in working groups, written up individually
- Field trip: Data collection at Duke Forest

Working groups and assignments

- groups of 3 to 4 students work on assignments together
- designated coordinator, rotate assignments

Semester project: Projects address a problem of interest, often focused on graduate research. There is a final report and presentation.

In the schedule that follows, the assignments are problems given in the vignettes. The vignettes will be updated as needed for the class.

Date	Unit	Concepts/tools	Assignments due
jan	11	1. The Bayesics	Bayes' theorem, hierarchical models, graphs
	16	2. Discussion, Introduction to R	Issues with P values; R foundations
	18	3. Forest inventory	Duke Forest prep , elements of Bayes
	20	Duke Forest Data collection	Saturday trip, 9 am to noon
	23	3. Forest inventory	Duke Forest
	25	4. Exploratory data analysis	Structured inventories, including BBS
	30	4. Exploratory data analysis	Estimates vs predictions
feb	1	5. Parameters vs predictions	Semester project , observations & experiments
	6	6. Random effects are hierarchical	Field trip data, working groups
	8	7. Probability foundations	Distribution theory; semester project ideas
	13	7. Probability foundations	Distribution theory; semester project ideas
	15	8. Probability applications	Prior to posterior, regression; projects
	20	9. MCMC concepts	Inbreeding depression
	22	10. MCMC applications	MCMC chains to estimates
	27	11. State-space models	Time series data
	29	11. State-space models	Semester project
mar	5	Do not meet	Make up 20 Jan field trip
	7		
	12	Spring break	
	14		
	19	12. Multiple time series	Summary presentation to class
	21	13. Multivariate responses	MVN, multinomial, composition data
	26	13. Multivariate responses	MVN, multinomial, composition data
	28	14. MV time series	Semester project issues
apr	2	15. Spatial models	Species distributions
	4	15. Spatial models	Climate change, migration
	9	16. Traits	Plants and ground beetles
	11	Overview	
	16	Final presentations	Semester projects
	18	Final presentations	Semester projects