Bayesian inference for environmental models
ENV/BIO665, Spring 2026
4100 Grainger Hall, 8:30 Tuesday/Thursday

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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: CANVAS: ENVIRON/BIO665.01.Sp26 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

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.

Draft schedule

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