EEBIO 187 / 297 Bayesian Modeling for Ecology

Fall 2025

Welcome to the world of Bayesian model-building!

In the field of ecology – and one could say, the life sciences in general – model-building and model-fitting has become a fundamental part of scientific inference. To the extent that ecologists take statistics, most are taught to follow a cookbook to match the right 'test' with a dataset and then let some pre-programmed command [e.g. `glm()`, `lmer()`] tell you the answer (usually a p-value). In this class, we will be throwing that cookbook out and starting from scratch, learning the fundamentals of quantitative inference through the lens of custom-built Bayesian models. This will require thinking differently about statistics, about inference, and about models, but by giving you the tools to build your own statistical models, it will unlock the ability to analyze data with nearly unlimited flexibility, not just the way someone programmed a command.

Prerequisite

STATS 20, or EE BIO C172 (C202), or permission of instructor along with relevant statistical and programming experience

Course Goals

1. Learn the fundamental principles of Bayesian statistical philosophy
2. Gain proficiency in coding statistical models in the JAGS model language
3. Build competency in building Bayesian models piece-by-piece for each statistical analysis
4. Understand how to make inference from Bayesian models and check that models are good

Your Learning Support Team

	Instructor	**Teaching Assistant**
Section:	Lecture	Lab
Name:	Prof. Morgan Tingley (he/him)	Eugene Hopkins (he/they)
Contact:	mtingley@ucla.edu	mlhopkins@g.ucla.edu
Office hours:	Wednesdays 10 am - 11 am Botany 310L (ring doorbell)	Mondays 11am - 12 pm, Fridays 1 - 2 pm 4335 Life Sciences Building

We are happy to make ourselves available outside of office hours. Please email to ask for an appointment

Lecture: *Tuesdays/Thursdays 3:30 – 4:45 Physics and Astronomy 1749*

Week	**Date**	**Themes**	**Reading** (to do by the date)
0	Sep 25	Definitions and Philosophies of Inference	HH Preface – Ch. 1
1	Sep 30	How to approach data	HH Ch. 2 – 3.4.1 HH Ch. 3.4.2 – 3.4.3
	Oct 2	Stochastic models	
2	Oct 7	Bayes Theorem	HH Ch. 4 – 5.3 HH Ch. 7.1 – 7.3.2
	Oct 9	MCMC	
3	Oct 14	Bayesian GLMS 1	HH Ch. 10, F 13 F 14–16
	Oct 16	Bayesian GLMS 2	
4	Oct 21	Selecting and Checking Priors	HH Ch. 5.4 – 5.4.4 HH Ch. 7.3.4 – 8.1
	Oct 23	Goodness of Fit	
5	Oct 28	***Midterm***	
	Oct 30	Intro to Hierarchical Models	HH Ch. 6 – 6.2; F 18
6	Nov 4	Bayesian GLMMs	HH Ch. 6.2.1 F 17; HH Ch. 6.2.2 – 6.2.4
	Nov 6	Mixture Models 1	
7	Nov 11	Mixture Models 2	HH Ch. 6.3 HH Ch. 9 (F 8 as reference)
	Nov 13	Model Selection	
8	Nov 18	Bayesian Model Inference 1	HH Ch. 8 HH Ch. 11.1 – 11.3
	Nov 20	Bayesian Model Inference 2	
9	Nov 25	Frontiers: emerging ecological models	HH Ch. 13 – 14 (skim for fun)
	Nov 27	*NO CLASS: Thanksgiving*	
10	Dec 2	***Final Project Presentations***	
	Dec 4	***Final Project Presentations** (cont.)***	
Exam	Dec 9	***Final Projects Reports Due***	

Lab: *Tuesdays 10:00 am – 12:00 pm Botany 108; bring your own laptop*

Week	**Date**	**Topic**
1	Sep 30	Coding fundamentals
2	Oct 7	Probability distributions
3	Oct 14	Intro to JAGS
4	Oct 21	GLMS two ways: frequentist and Bayesian
5	Oct 28	Choosing priors and checking posteriors
6	Nov 4	Random and mixed-effects models
7	Nov 11	Fun with zero-inflation: latent and non-latent variable models
8	Nov 18	Model selection and cross-validation
9	Nov 25	*Final Project work time*
10	Dec 2	*Final Project work time*

Textbooks

(*HH*) Hobbs, N. Tom, and Mevin. B. Hooten. 2015. *Bayesian Models: A Statistical Primer for Ecologists*. Princeton University Press. (*required)*

(*F*) Fieberg, John. 2024. *Statistics for Ecologists: A Frequentist and Bayesian Treatment of Modern Regression Models*. University of Minnesota Libraries Publishing. (*online*)

Grading breakdown (1000 points total)

Problem sets (8)	60%
Midterm exam	15%
Final project presentation	5%
Final project report	20%
	100%

Grading notes

Problem Sets will be assigned weekly (on Thursday, beginning week 1) and will be due the following Thursday, by 11:30 am on BruinLearn. All problem sets must be turned in via BruinLearn, not emailed. Late problem sets will lose 25% per 24-hours. Problem sets are based on R and JAGS coding and aim to integrate knowledge gained through lecture, lab, and reading.

Midterm Exam will be in-class, written-only, closed-book. The focus will be on the fundamentals of Bayesian statistics and ecological as applied to our field.

The Final Project is an opportunity for you to apply the skills and techniques you've learned in this class to real data in a way that hopefully is useful to you. We hope that you will use your own data, or at least data that you can borrow from a PI or lab member. The project should ideally be both useful to you and a learning opportunity. Since ecological and environmental data are inherently tricky and often require specific types of analyses – topics we will be discussing throughout the quarter – we encourage you each to discuss your final project ideas and data *early in the quarter* so that we can best help you.

Extensions may be granted in advance given extenuating circumstances. If you would like to request an extension in advance, please gain confirmation from Prof. Tingley *at least 24 hours before the due date*. The TA is not authorized to grant extensions, and extensions will not be granted within 24 hours of due dates. If you are granted an extension, your grade will not be penalized if the assignment is turned in on the agreed-upon date (even though BruinLearn might tell you it's 'late').

Class Culture

Be kind and encouraging to your classmates. I will pause lecture periodically to do exercises and check comprehension. You will also often work together in lab or on problem sets. Statistics is often a very difficult topic for people to grasp, and many students may have considerable anxiety even talking about statistical topics. While we aim to reduce this anxiety and build comfort and expertise this quarter, it's important to realize that not everyone is beginning at the place (e.g., enrolled students include undergrads as well as 5th year PhD candidates!). To ensure everyone feels secure asking and answering questions we ask that you listen respectfully and be supportive. Don't be afraid to offer a different perspective or even challenge what another student has said but do so with kindness and respect.

Be willing to ask for help. There will no doubt be times when you find yourself confused by the material. This should not be a reason for embarrassment. The authors of books and scientific papers, and certainly your professor, are fallible human beings and don't always explain things well despite our best intentions. So rather than assuming your confusion is your fault, assume there has simply been a failure of communication and ask for clarification. You are welcome to ask questions in class, come to office hours, or request more individualized appointments.

Connect and communicate. This is a small class and you will be working together all quarter. Things will go best if we can communicate. You may wish to set up a group WhatsApp during the first lab, solely use BruinLearn, or set up another form of communication with each other so you can form study groups and connect with the class.

Resources for Learning

Class website on BruinLearn: The course has a dedicated website with announcements, a general discussion board, and weekly course materials. You may use the general class discussion board at any time to ask or answer any question. Your TA and professor will monitor this board to help clarify anything we can. If we don't answer your question via the board we'll try to address it in class. There is no credit given for use of this forum but I highly recommend it as one way to get answers to questions that come up outside of class.

Preparatory materials: All necessary materials will be available on BruinLearn either on the main course page or in one of the weekly folders. Lectures will be provided in person and PDFs of the lectures will be uploaded to BruinLearn.

We're Here to Support You

Providing feedback to me and to your TAs: I encourage your feedback at any time throughout the quarter about things that are helping you learn, or things that aren't helping. Please communicate with me or with your TA if there are ways that we can improve the course to better support your learning.

Personal Problems: I understand that sometimes life makes it difficult to focus on schoolwork. If you are having a personal problem that affects your participation in this course, please talk to us to create a plan. Please do not wait until the end of the quarter to share any challenges that have negatively impacted your engagement and academic performance. The sooner we meet, the more options we will have available to discuss to support your overall academic success

Academic Accommodations Based on a Disability: Students needing academic accommodations based on a disability should contact me as well as the Center for Accessible Education (CAE) at (310)825-1501 or in person at Murphy Hall A255. When possible, students should contact the CAE within the first two weeks of the term as reasonable notice is needed to coordinate accommodations. For more information visit www.cae.ucla.edu.

Academic Honesty

Since the University is an academic community, its fundamental purpose is the pursuit of knowledge. Essential to the success of this educational mission is a commitment to the principles of academic integrity. Every member of the University community is responsible for upholding the highest standards of honesty at all times. Students, as members of the community, are also responsible for adhering to the principles and spirit of the following Code of Academic Integrity.

Activities that have the effect or intention of interfering with education, pursuit of knowledge, or fair evaluation of a student's performance are prohibited. Examples of such activities include but are not limited to the following definitions:

A. **Cheating**: using or attempting to use unauthorized assistance, material, or study aids in examinations or other academic work or preventing, or attempting to prevent, another from using authorized assistance, material, or study aids. *Example*: using a cheat sheet in a quiz or exam, altering a graded exam and resubmitting it for a better grade, etc.
B. **Plagiarism**: using the ideas, data, or language of another without specific or proper acknowledgment. *Example*: copying another person's paper, article, or computer work and submitting it for an assignment, cloning someone else's ideas without attribution, failing to use quotation marks where appropriate, etc. (note: these examples are not all 'equal' in severity)
C. **Fabrication**: submitting contrived or altered information in any academic exercise. *Example*: making up data for an experiment, fudging data, citing nonexistent articles, contriving sources, etc.
D. **Multiple submission**: submitting, without prior permission, any work submitted to fulfill another academic requirement.
E. **Facilitating academic dishonesty**: knowingly helping or attempting to help another violate any provision of the Code. *Example*: working together on a take-home exam, etc.
F. **Unfair advantage**: attempting to gain unauthorized advantage over fellow students in an academic exercise. *Example*: gaining or providing unauthorized access to examination materials, obstructing or interfering with another student's efforts in an academic exercise, lying about a need for an extension for an exam or paper, continuing to write even when time is up during an exam, destroying or keeping library materials for one's own use, etc.

If a student is unsure whether their action(s) constitute a violation of the Code of Academic Integrity, then it is that student's responsibility to consult with the instructor to clarify any ambiguities.

AI and LLMs in this class

The rapid development and integration of Artificial Intelligence (AI) and specifically Large-language Models (LLMs) continue to pose challenges to education. While AI chat programs like GPT certainly can be used to support education and learning, most experts and emerging scientific studies agree that more often these tools are used to circumvent learning. In my personal experience, LLMs like GPT are mediocre at coding in R and generally fail to provide workable solutions when coding in specialized languages like JAGS. While GPT and its ilk can convincingly tell you that its solution or code is correct, please remember that it should be your educational goal to be able to know whether you have the correct answer.