STA 360: Bayesian methods and modern statistics

Fall 2024

Syllabus

Course description

This course introduces Bayesian modeling and inference, motivated by real world examples. Course topics include Bayes' theorem, exchangeability, conjugate priors, Markov chain Monte Carlo (MCMC), Gibbs sampling, Metropolis-Hastings, hierarchical modeling, Bayesian regression and generalized linear models. We compare and contrast Bayesian methods to the frequentist paradigm. By the end of this course students should feel comfortable (1) writing Bayesian models and, when appropriate, (2) sampling from the posterior using MCMC to make inference.

Logistics

Teaching team & office hours

	Contact	Office hours	Location
Dr. Alexander Fisher	aaf29@duke.edu	Mo/We: 10:30-11:30am	Old Chem 223B
Matt O'Donnell	matthew.l.odonnell@duke.edu	Mo: 5:00-7:00pm	Old Chem 203B
Shuo Wang	shuo.wang717@duke.edu	Tu: 3:00-5:00pm	Old Chem 203B
Bo Liu	bo.liu1997@duke.edu	We: 12:45-2:45pm	Old Chem 203B
Minh-Anh To	minhanh.to@duke.edu	Fr: 3:00-5:00pm	Zoom (link on Canvas)

Meetings

Lecture	Mo/We 3:05 - 4:20pm	Reuben-Cooke Building 130
Lab 01	Th 1:25pm - 2:40pm	LSRC A155
Lab 02	Th 3:05pm - 4:20pm	Old Chemistry 003

Course website: sta360-fa24.github.io

Course material

- A First Course in Bayesian Statistical Methods. As a Duke student, an electronic version of the book is freely available to you on Springer link. Check the errata at the link above.
- Chapter summaries. I compile major take-away points from each section. Review these to help prepare for exams.
- We will use the statistical software package R on homework asignments in this course. R is freely available at http://www.r-project.org/. RStudio, the popular IDE for R, is freely available at https://posit.co/downloads/.

Schedule of topics

Part I: The Bayesian modeling toolkit

1. Review of probability
2. Conjugate statistical models
3. Posterior summaries and Monte Carlo sampling
4. Markov chain Monte Carlo (Metropolis-Hastings)

Part II: Statistical model building and analysis

1. Semi-conjugate models and Gibbs sampling
2. Linear regression
3. Generalized linear models
4. Hierarchical models

Evaluation

Assignment	Description
Homework (40%)	Individual take-home assignments, submitted to Gradescope.
Midterms (30%)	Two in-class exams.
Final exam (25%)	Cumulative final during final's week.
Quizzes (5%)	In-class pop quizzes.

A >= 93, A- < 93, B+ < 90, B < 87, B- < 83, C+ < 80, C < 77, C- < 73, D+ < 70, D < 67, D- < 63, F < 60

> **i** A note on quizzes
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> On random class days, there will be a brief quiz on the previous lectures. If you score > 60% cumulatively on your final quiz grade, you will receive full participation credit. Your lowest **two** quizzes will also be dropped.

> **i** A note on exams
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> If you miss either midterm 1 or midterm 2, **and have an excused absence**, your missing midterm grade will be replaced by your final exam grade. You must take at least 1 midterm and the final exam to pass the course.

Policies

Academic integrity

By enrolling in this course, you commit to upholding Duke's community standard reproduced as follows:

> I will not lie, cheat, or steal in my academic endeavors;
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> I will conduct myself honorably in all my endeavors; and
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> I will act if the Standard is compromised.

Any violations of academic integrity will automatically result in a 0 for the assignment and will be reported to the Office of Student Conduct for further action. For the Exams and Quizzes, students are required to work alone. For the Homework assignments, students may work with a study group but each student must write up and submit their own answers.

Late work

Late homework may be submitted within 48 hours of the assignment deadline. Late homework submitted within 24 hours (even 1 minute late) will receive a 5% late penalty. Late work submitted between 24 to 48 hours of the deadline will receive a 10% late penalty. Work submitted after 48 hours will not be accepted. Exams cannot be turned in late and can only be excused under exceptional circumstances. The Duke policy for illness requires a short-term illness report or a letter from the Dean; except in emergencies, all other absenteeism must be approved in advance (e.g., an athlete who must miss class may be excused by prior arrangement for specific days). For emergencies, email notification is needed at the first reasonable time.

Errors in grading

Errors in grading must be brought to the attention of the TA or instructor during office hours within 1 week of receiving the grade.