STATS/DATASCI 551/651: Bayesian Modeling

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Overview

Description. This course introduces Bayesian modeling and computation for statistical inference, prediction, and decision making. Course materials and announcements will be posted on Canvas.

Prerequisites. The prerequisites are previous coursework in linear algebra, multivariate calculus, and basic probability and statistics. Previous experience in numerical analysis and optimization would be helpful but is not required. Familiarity with R, Python, or a related programming language will be necessary.

Textbooks. Class readings will mainly come from the following books.

- Gelman et al. Bayesian Data Analysis. Chapman and Hall, 2005. PDF
- Hoff. A first course in Bayesian statistical methods. Springer, 2009. PDF
- Bishop. Pattern Recognition and Machine Learning. New York: Springer, 2006. PDF
- Murphy. Probabilistic Machine Learning: Advanced Topics. MIT Press, 2023. PDF

Piazza and participation bonus. All communications with the teaching team should be conducted on Piazza; please do not email. If you wish to ask a question privately to the teaching team, please post a private note on Piazza; see instructions here; you can expect an answer within 48 hours during weekdays (except holidays). The GSIs and the instructor will be monitoring Piazza, endorsing correct student answers, and answering questions that remain after a discussion.

As a bonus, **up to 3 percentage points will be added to your final course grade based on Piazza participation.** You will receive $3x$ bonus percentage points if the number of your total Piazza contributions is $(x \cdot 100)\%$ of the maximum number of contributions among all students. The number of Piazza contributions will be determined by Piazza class statistics.

Requirements and Grades

1. **Homework (5%).** There will be roughly biweekly homework assignments. Homework is graded on effort.
2. **In-class quizzes (15%).** There will be roughly biweekly in-class quizzes. Each quiz is a closed-book, individual pen-and-paper quiz. The quiz questions will be randomly selected from recent homeworks. No notes, books, internet, software, or AI tools may be used.

The lowest quiz score will be dropped. This policy is intended to accommodate the add/drop period, registration matters, absences, and personal circumstances.

Regrade Policy. You may submit a regrade request if you believe that the course staff made an error in grading. Any regrade requests should be submitted through Gradescope *within **seven** days* of receiving your grade. Please try to be as specific as possible with your regrade request.

3. **Midterm exam (35%).** There will be a midterm exam.

4. **Final exam (45%).** There will be a final exam.

5. **Final letter grade.** The final grade will be set so that the distribution of final grades approximately matches that of previous offerings of the course.

Schedule

The schedule is subject to change.

1. Introduction
2. Probability: a review of basic concepts and Bayes' theorem
3. One-parameter models
4. Monte Carlo approximation
5. The normal model, the multivariate normal model, and multi-parameter models
6. Bayesian computation and introduction to Stan
7. Group comparisons and hierarchical modeling
8. Regression models
9. Finite mixture models
10. Guest lectures

Support Resources

Course recordings. Course lectures may be audio/video recorded and made available to other students in this course. As part of your participation in this course, you may be recorded. If you do not wish to be recorded, please contact the instructor during the first week of class (or as soon as you enroll in the course, whichever is latest) to discuss alternative arrangements.

Academic integrity. The University of Michigan community functions best when its members treat one another with honesty, fairness, respect, and trust. The college promotes the assumption of personal responsibility and integrity and prohibits all forms of academic dishonesty and misconduct. All cases of academic misconduct will be referred to the LSA Office of the Assistant Dean for Undergraduate Education. Being found responsible for academic misconduct will usually result in a grade sanction, in addition to any sanction from the college. For more information, including examples of behaviors that are considered academic misconduct and potential sanctions, please see https://lsa.umich.edu/lsa/academics/academic-integrity.html for more information.

You are welcome to discuss homework with your classmates, but the work that you turn in must be yours and yours alone, and you must disclose the names of those you spoke with in your homework, including both classmates and others outside the class. This disclosure applies whether a student has helped someone else or has received help. However, it is not necessary to disclose any discussion you have with the course instructor or the course GSIs.

Restricted use of generative AI. Generative AI tools, including U-M GPT, may be used only when an assignment explicitly permits them. When permitted, you must disclose the tool and how it was used, verify its output, and remain responsible for the work.

Accommodations for students with disabilities. The University of Michigan recognizes disability as an integral part of diversity and is committed to creating an inclusive and equitable educational environment for students with disabilities. Students who are experiencing a disability-related barrier should contact Services for Students with Disabilities (ssd.umich.edu, 734-763-3000, or ssdoffice@umich.edu). For students who are connected with SSD, accommodation requests can be made in Accommodate. If you have any questions or concerns please contact your SSD Coordinator or visit SSD's Current Student webpage. SSD considers aspects of the course design, course learning objectives, and the individual academic and course barriers experienced by the student. Further conversation with SSD, instructors, and the student may be warranted to ensure an accessible course experience.

Mental Health and Well-Being. University students may experience stressors that can impact both their academic experience and their personal well-being. These may include academic pressures and challenges associated with relationships, mental health, alcohol or other drugs, identities, finances, etc. If you are experiencing concerns, seeking help is a courageous thing to do for yourself and those who care about you. If the source of your stressors is academic, please contact me so that we can find solutions together. For personal concerns, U-M offers a variety of resources, many of which are listed on the Resources for Student Well-being webpage. You can also search for additional well-being resources here.

Acknowledgments.

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