STAT 516 – Stochastic Modeling of Scientific Data I

Autumn Quarter 2023

Instructor:	Prof. Alexander Giessing giessing@uw.edu	**Office Hours:**	Tue 4:00 – 5:00 PM (B-308 PDL)
TAs:	Jerry Wei zwei5@uw.edu	**Office Hours:**	Wed 4:00 – 5:00 PM (STSC) Thu 4:00 – 5:00 PM (STSC)
Lectures:	Tue Thu 2:30 – 3:50 PM	**Classroom:**	JHN 175
Course Page:	https://canvas.uw.edu/courses/1662610		

Course Description: This course covers discrete-time Markov chain theory with applications to inference, Monte Carlo methods, missing data, hidden Markov models, and Gaussian Markov random fields. The lectures will focus on developing the mathematical theory, the homework will be a mix of theory and work on real data sets. Four lectures are designated for extensive coding exercises and will be led by the TA.

Prerequisites: STAT 342, MATH/ STAT 396, or STAT 391.

Lecture Notes: Lecture notes will be posted ahead of each lecture. I advise to take notes during the lecture.

References: There is no required textbook, we will use a number of different texts:

- Brémaud, P. (2008) *Markov Chains: Gibbs Fields, Monte Carlo Simulation, and Queues.* Corrected Edition. Springer.
- Grimmett, G. R. and Stirzaker, D. R. (2001). *Probability and Random Processes.* 3rd Edition. Oxford University Press.
- Guttorp, P. (1995). *Stochastic Modeling of Scientific Data.* 1st Edition. Chapman & Hall.

Homework: There will be weekly problem sets. Problem sets will be posted on Canvas. Please submit your solution in a single pdf or jpg. Unexcused late homework submissions will receive a score of zero. You may work in groups of two or three students on the homework problems, please indicate your study group members on your homework submission. However, verbatim copying solutions is strictly forbidden; each student must produce their own solutions.

Midterm and Final Exam: There will be a midterm and a final exam. Both exams have an in-class and take-home component. This means that you will answer a few questions in class (closed-book) and then have up to three days to submit answers to a coding exercise via Canvas (open book).

Schedule and Grade Policy:

Homework (50%) ..... 11:59 PM at due dates
Midterm (25%) ..... Thu, Nov 2, 2023
Final (25%) ..... Tue, Dec 12, 2023

Academic Integrity: Students shall abide by the University of Washington Academic Responsibility policies, which are outlined at https://depts.washington.edu/grading/pdf/AcademicResponsibility.pdf. Violations and suspected violations will be reported to the appropriate Dean's Representative and through the webpage for Community Standards and Student Conduct. The instructor reserves the right to assign a failing grade for the course for serious violations of student conduct.

Academic Accommodations: Your experience in this class is important to me. It is the policy and practice of the University of Washington to create inclusive and accessible learning environments consistent with federal and state law. If you have already established accommodations with Disability Resources for Students (DRS), please activate your accommodations via myDRS so we can discuss how they will be implemented in this course. If you have not yet established services through DRS, but have a temporary health condition or permanent disability that requires accommodations (conditions include but not limited to; mental health, attention-related, learning, vision, hearing, physical or health impacts), contact DRS directly to set up an Access Plan. DRS facilitates the interactive process that establishes reasonable accommodations. Contact DRS at disability.uw.edu.

Religious Accommodations: Washington state law requires that UW develop a policy for the accommodation of student absences or significant hardship due to reasons of faith or conscience or for organized religious activities. The UW's policy, including more information about requesting an accommodation, is available at Religious Accommodations Policy. Accommodations must be requested within the first two weeks of this course using the Religious Accommodations Request form.

Diversity and Inclusion: Diverse backgrounds, embodiments, and experiences are essential to the critical thinking endeavor at the heart of university education. Therefore, I expect you to follow the UW Student Conduct Code in your interactions with your colleagues and me in this course by respecting the many social and cultural differences among us, which may include, but are not limited to: age, cultural background, disability, ethnicity, family status, gender identity and presentation, citizenship and immigration status, national origin, race, religious and political beliefs, sex, sexual orientation, socioeconomic status, and veteran status.

Tentative Course Outline:

1. Review of Probability and Statistics
2. (week 1) Parameter Estimation
3. Hypothesis Testing
4. (week 2) Markov chains: definition, transition probabilities, first-step analysis
5. Stopping times, Strong Markov
6. (week 3) **Coding Lab 1 (Oct 17, 2023)**
7. Classification of states, transience, recurrence
8. (week 4) Stationary distribution, Limiting behavior
9. Statistical Inference, Monte Carlo
10. (week 5) MCMC
11. **Midterm (Nov 2, 2023)**
12. (week 6) **Coding Lab 2 (Nov 7, 2023)**
13. Missing Data
14. (week 7) Missing Data
15. Graphical Models
16. (week 8) **Coding Lab 3 (Oct 21, 2023)**
17. **Thanksgiving (Nov 23, 2023)**
18. (week 9) HMM
19. HMM
20. (week 10) Gaussian Markov Fields
21. **Coding Lab 4 (Dec 7, 2023)**