Course Syllabus

STAT5710 Applied Stochastic Processes

Fall 2026

Stochastic processes describe phenomena in which dependence arises from evolution across time (or space). Formally, they are probability models defined by indexed collections of random variables, with dependence usually characterized through conditional distributions. This course is a graduate-level introduction to stochastic processes covering several standard probability models — Markov processes, point processes, and Gaussian processes — and their applications in statistics, including Markov Chain Monte Carlo (MCMC) and selected modeling applications drawn from various domains.

Instructor: Trevor Ruiz (he/him) [email]

Class meetings: TR 9:00am–10:20am in 52-0E33

Office hours: TR 2:30pm–4:00pm in 25-236

Final exam: Tuesday, December 15, 10:00am-12:30pm

Catalog description: Properties, simulation, and application of stochastic processes. Discrete-time and continuous-time Markov chains, hidden Markov models, Poisson processes, Gaussian processes, continuous-state Markov processes. Markov chain Monte Carlo (MCMC) simulation methods and applications. Estimation methods for stochastic processes. 3 lectures. *Prerequisite: Graduate standing or Statistics major; and MATH 206, MATH 1151, MATH 244, or MATH 2341; and STAT 305 or STAT 2610. Recommended: STAT 426 or STAT 4620. Formerly STAT 545.*

Textbook: Robert P. Dobrow, Introduction to Stochastic Processes with R. Wiley, 2016. An online version is available through the [Kennedy Library]. You can also purchase or rent a print or electronic copy through the bookstore or the [publisher's website].

Learning outcomes:

- [L1] Apply Markov chains to model discrete-time phenomena and data.
- [L2] Apply Poisson processes, Gaussian processes, and continuous-time Markov chains and processes to model continuous-time phenomena and data.
- [L3] Choose an appropriate probability model to analyze a random phenomenon.
- [L4] Conduct simulation analyses of probability models by writing original computer code, and write reports that summarize results of simulation analyses.
- [L5] Implement Markov chain Monte Carlo (MCMC) methods in a modern computing environment.
- [L6] Apply and interpret Markov chain model fitting to data, including hidden Markov models.

Assessments

Your attainment of learning outcomes will be measured by homework assignments, two midterm exams, a course project, and a cumulative final exam. These are described below, with the relative contributions to final grades indicated parenthetically.

- **Homeworks (20%).** Homework assignments will comprise short sets of textbook problems. These tend to focus on mathematical and/or computational problem-solving applications of course content and serve to reinforce key ideas through practice. One problem selected at random will be scored from each assignment.
- **Midterm exams (30%).** Two written midterm exams will be given in class, each worth 15% of the final grade. These will be open-book, open-note exams; while not explicitly cumulative, the second midterm may indirectly require material covered prior to the first midterm.
- **Project (20%).** You will complete one course project with 1-2 partners exploring an application, illustration, implementation, or extension of a topic discussed in class. Projects should involve original code and some element of simulation or data analysis. I will provide suggested projects; you can pick one or propose your own by week 12. You will give a brief in-class presentation, not to exceed 10 minutes, during the last week of instruction, and submit a written summary of no more than two pages for an audience of peers by the start of the final exam period.
- **Final exam (30%).** A cumulative written final exam will be given at the time scheduled by the registrar: 10:00am–12:30pm on Tuesday, December 15, in our usual classroom. The final exam will be open-book and open-note.

Your scores will be recorded in Canvas for your reference along with an estimate of your running course total on a 0-100 scale. Tentatively, letter grades will span the following ranges: A (90, 100]; B (75, 90]; C (60, 75]; D (50, 60]; F [0, 50]. Please note these are *approximate* ranges and subject to change without notice (though I will notify the class of any major changes and will report final thresholds at the end of the term). Please note that failure to adhere to course policies may result in a lower letter grade than would otherwise be assigned.

Tips for success

I want you to succeed in this course. Below are some simple but effective habits:

- find a buddy or form a study group
- do the reading (skim before class, read closely after class)
- use office hours to discuss general questions about material and concepts, not just homework help (but that too)
- prepare summary notes and try a few extra problems from the book before exams
- take notes in class, but listen too—exact transcripts aren't necessary (since I post notes) and writing every detail can distract from following the overall narrative

If you find yourself falling behind at any point during the term, or feel you are struggling with the course, please come and talk with me. The sooner you reach out, the more options I'll have to help you.

Tentative schedule

Subject to change at instructor discretion.

Week	Topics	Reading	Assignments (due)
1 (8/24)	Introduction to stochastic processes; preliminaries	1.2; 1.4-1.5; 2.1-2.2	
2 (8/31)	**DTMC:** transition probabilities; limiting and stationary behavior	2.3; 3.1-3.2	HW1 (Th)
3 (9/7)	**DTMC:** communication classes; recurrence, transience, periodicity	3.3-3.5	HW2 (Th)
4 (9/14)	**DTMC:** limit theorems	3.6, 3.8, 3.10	HW3 (Th)
5 (9/21)	**DTMC:** likelihood and Bayesian estimation; hidden Markov models	Guttorp 2.7	HW4 (Th)
6 (9/28)	**MCMC:** Metropolis-Hastings algorithm	5.1	Midterm 1 (Tue)
7 (10/5)	**MCMC:** proposal design, applications, diagnostics	5.2	HW5 (Th)
8 (10/12)	**MCMC:** Gibbs sampling, Metropolis-within-Gibbs; applications	5.3	HW6 (Th)
9 (10/19)	**Counting processes:** homogeneous Poisson processes and their properties	6.1-6.5	HW7 (Th)
10 (10/26)	**Counting processes:** nonhomogeneous and spatial processes; estimation; applications	6.6-6.7	HW8 (Th)
11 (11/2)	**Counting processes:** point processes and applications	Supp. notes	Midterm 2 (Th)
12 (11/9)	**CTMC:** introduction; transition rates	7.1-7.2	HW9 (Th)
13 (11/16)	**CTMC:** generators; limiting behavior	7.3-7.4	HW10 (Th)
—	*Thanksgiving break*	—	—
14 (11/30)	**GP:** Brownian motion and random walks	8.1-8.2	HW11 (Th)
15 (12/7)	**GP:** Gaussian processes	8.3-8.4	Project presentations (Th)
Finals (12/14)	Cumulative final exam Tuesday 12/15 10:00am-12:30pm		Final exam (Tue) 10:00am-12:30pm Project report (Tue) 10:00am

Policies

Time commitment

STAT 5710 is a three-unit course, which corresponds to a *minimum* time commitment of 9 hours per week, including class meetings, reading, assignments, and study time. I try not to assign work in substantial excess of this minimum, but you should expect to invest about 9 to 12 hours per week on average, with occasional overage due to assignments, exams, or material requiring more careful reading. While I aim to distribute workload as evenly as possible throughout the term and offset expected overages by adjusting assignment schedules, you should allow an extra hour or two in your schedule to accommodate variability if possible. Since class meetings account for about 2 hours and 40 minutes per week, I recommend that you budget approximately 6 to 7 hours per week outside of class meetings to study and complete assignments; this recommendation includes a buffer for week-to-week variation. Please let me know if you are regularly exceeding these amounts or if you need help managing your time efficiently in the course.

Attendance and absences

Regular attendance is essential for success in the course and required per University policy. Absences should be excusable, but you do not need to notify me unless you anticipate an extended absence or will miss an in-class assessment; I trust you to adhere to Cal Poly norms and policies regarding class attendance. Please note, however, that frequent unexplained absences may negatively impact your course grade.

Classroom environment

I support Cal Poly's commitment to building an inclusive learning environment where all students can succeed. To that end, I strive to create a classroom in which every student is treated with respect and dignity, regardless of background, beliefs, opinions, identity, or the many visible and nonvisible differences within our community. I want you to feel comfortable in class, especially when sharing your perspective, asking questions, and interacting with me and with your peers. All members of this class are therefore expected to contribute to a respectful, supportive, and inclusive climate. I expect you to treat others with respect, even (and especially) when you disagree with or do not understand their perspective. I hold myself to this standard, and I expect the same of every other student in the class. If you experience any form of disrespect or discrimination, small or large, please speak with me.

Collaboration

Collaboration with classmates is encouraged. If you work with a group on homework problems, you are expected to be an active contributor and prepare your own solutions in your own words and writing, and by submitting your work you are attesting that you have met this expectation. You should not distribute or accept copies of written solutions under any circumstances.

Use of AI

I encourage the use of AI to support, but not replace, critical thinking. If I do not want you to use AI for a particular task or assignment, I will say so explicitly. Otherwise, you may use AI at your discretion for supportive tasks, such as clarifying concepts, drafting exploratory code, and generating practice problems. For example:

- Concept review: "Remind me how irreducible is defined and what it means intuitively."
- Problem-solving strategies: "Give me a few ways to check whether a Markov chain is irreducible, with examples."
- Coding help: "Provide simple R code to simulate a bounded 2D random walk."
- Extra practice: "Create a few practice problems like this one, but vary the numbers and context."

As a rule of thumb, AI use for secondary tasks is usually acceptable, but AI use for the direct resolution of primary tasks (e.g., producing full solutions to assigned problems or writing work you submit as your own) is not acceptable and may constitute plagiarism. To avoid crossing this line, don't paste full prompts into AI tools; many models will simply solve them (possibly incorrectly) whether you ask for a solution or not, and this is hard to unsee. If you're stuck, make up a structually similar problem or ask for general solution strategies (like the second example prompt above). Remember that you'll need to demonstrate understanding without AI on exams, so it will benefit you to struggle with problems a little on your own. For further guidance on responsible use, see the CSU AI Commons page on [ethical AI use for students].

Communication and email

I encourage you to ask questions in class and during office hours, since that is the only certain means of obtaining a response within a guaranteed time frame.

I respond to most email within 24 weekday hours, but I cannot guarantee this response time and I occasionally miss messages altogether (though I try not to). I rarely answer emails at night or on weekends, so while you are welcome to write me outside of business hours, please don't expect a reply until the following business day. I also sometimes get behind on answering emails, so please wait at least a few days if it's not pressing before sending a follow-up or reminder.

Please do not ask technical questions about assignments by email.

Late and missing work

I understand that unexpected circumstances may arise and require you to temporarily rearrange your priorities and commitments on occasion during the term. You may, at any time during the term and without notice or penalty, use the following personal exceptions:

- turn in one homework assignments up to one week late
- miss one homework assignment altogether

Once your personal exceptions are exhausted, homework assignments turned in up to one week late will be awarded 50% credit unless an extension is granted in advance, and missing homework assignments will be treated as zeros. If you miss no homework assignments, your lowest score will be dropped.

No other late work will be accepted unless an exception to this policy is granted. I will consider exceptions for personal and medical emergencies or other similarly unforeseeable circumstances.

Requests for reassessment of graded work

I make my best effort to assess your work accurately and apply assessment criteria consistently across the class. While I sometimes do so imperfectly, I am also aware that granting adjustments to scores or grades can disadvantage more reticent students and favor those more comfortable approaching me about credit awarded on course assessments. So, in consideration of maintaining fairness, I ask that you limit requests for reassessment to clear mistakes, discrepancies, or oversights. And in the interest of maintaining accuracy, I also ask that you *please do* let me know if you think such an error may have occurred; if so, I will then ascertain whether other students in the class are owed credit and adjust evenly across the whole class to the best of my ability.

Please raise any possible issues with assessment in a timely manner (*i.e.,* within one week of receiving graded work) and not at the end of the term. While I may consider late requests to review previously graded work at my discretion, I make no guarantee that I will do so.

Changes to scores or final grades

Per University policy, faculty have final responsibility for grading criteria and grading judgment and have the right to alter student assessment or other parts of the syllabus during the term. It is not appropriate to attempt to negotiate scores or final grades for any reason. Once the term has concluded, final grades will only be changed in the case of clerical errors, without exception. If you feel your grade is unfairly assigned at the end of the course, you have the right to appeal your grade according to the Cal Poly academic petition procedure.

Accommodations

It is University policy to provide, on a flexible and individualized basis, reasonable accommodations to students who have disabilities that may affect their ability to participate in course activities or to meet course requirements. Accommodation requests should be made through the Disability Resource Center (DRC).

Conduct and Academic Integrity

You are expected to be aware of and adhere to University policy regarding academic integrity and conduct. Detailed information on these policies, and potential repercussions of policy violations, can be found via the Office of Student Rights & Responsibilities (OSRR).