THE UNIVERSITY OF ARIZONA

DATA 468 / MATH 468 / MATH 568

Applied Stochastic Processes - Spring 2023

TTh 2-3:15 in Bio Sci W 237

Last revised February 24, 2023

Important notice: Many parts of the syllabus are subject to change. For the latest version of this document, follow this link.

Description of Course

Basic theory of discrete-time Markov chains. Poisson process. Markov jump processes. Additional topics chosen based on instructor and student interest; potential topics include (but are not limited to) gaussian processes, renewal processes, martingales, Monte Carlo.

Course Prerequisites or Co-requisites

MATH-464 Theory of Probability or instructor permission.

Textbook

The required textbook is Essentials of Stochastic Processes, Third Edition by Rick Durrett. Reading assignments and homework problems will be given directly from the text. This will be supplemented by Introduction to Stochastic Processes by Paul Hoel, Sidney Port, and Charles Stone. Another excellent reference is Introduction to Stochastic Processes by Greg Lawler.

Instructor and Contact Information

Kevin K. Lin, PhD
Email: klin@math.arizona.edu
Phone: 520-626-6628
Office: Math-606

Office Hours. Office hours will be hybrid. For times, see instructor home page. I am also available to meet individually, online or in person, by appointment. I would appreciate in-person attendees to wear a mask (and I will do the same). Zoom link(s) for office hours will be shared separately.

Course Webpage: http://math.arizona.edu/~klin/468

Course D2L site: https://d2l.arizona.edu/d2l/home/1258017

Course Gradescope: https://www.gradescope.com/courses/484208

Most course information, e.g., the course calendar, syllabus, and any course notes, will be available on both the public web page and the D2L site.

Course Communications

Course-wide announcements will be made in class and distributed electronically by email and D2L. It is the student's responsibility to keep informed of any announcements, syllabus adjustments or policy changes. The

best way to reach me is by email. I will do my best to respond within 1 business day.

Course Format and Teaching Methods

This class is scheduled to be taught in the in-person modality. Selected lectures may be recorded and/or streamed at the discretion of the instructor.

Class Meetings

The class will meet in person at the time and place stated above.

Classroom attendance:
- If you feel sick, or if you need to isolate or quarantine based on University protocols, stay home. Except for seeking medical care, avoid contact with others and do not travel.
- Notify your instructor(s) if you will be missing a course meeting or an assignment deadline.
- Non-attendance for any reason does **not** guarantee an automatic extension of due date or rescheduling of examinations/assessments.
    - Please communicate and coordinate any request directly with your instructor.
    - If you must miss the equivalent of more than one week of class, please contact the Dean of Students Office DOS-deanofstudents@email.arizona.edu to share documentation about the challenges you are facing.
- Voluntary, free, and convenient COVID-19 testing is available for students on Main Campus.
- If you test positive for COVID-19 and you are participating in on-campus activities, you must report your results to Campus Health. To learn more about the process for reporting a positive test, visit the Case Notification Protocol.
- The COVID-19 vaccine and boosters are available for all students at Campus Health.
- Visit the UArizona COVID-19 page for the most up-to-date information.
    Compliance with COVID-19 mitigation guidelines: As we enter the spring semester, the health and wellbeing of everyone in this class is the highest priority. Accordingly, we are all required to follow the university guidelines on COVID-19 mitigation. Please visit www.covid19.arizona.edu for the latest guidance.

Staying current: It is expected that you will keep up with the course material by

- attending lectures

- reading the textbook according to the course calendar

- completing all assignments.

Additionally, I may post short videos and/or notes covering additional examples and background material. These will be announced in class, by email, and on D2L. You are responsible for learning this material on your own time by the assigned date.

Class Recordings: At the discretion of the instructor, some lectures *may* be recorded. These recordings will be shared with students in the class upon request. If you do not wish your name to be used in class, please inform the instructor ASAP.

For lecture recordings, which are used at the discretion of the instructor, students must access content in D2L only. Students may not modify content or re-use content for any purpose other than personal educational reasons. All recordings are subject to government and university regulations. Therefore, students accessing unauthorized recordings or using them in a manner inconsistent with UArizona values and educational policies (Code of Academic Integrity and the Student Code of Conduct) are also subject to civil action.

Course Materials

Additional course material, e.g., worksheets and class notes, will be posted in D2L and/or the course web page. Any recordings made for the course will be available in D2L.

Required Materials

Equipment and software requirements: For this class you will need daily access to a device with reliable internet signal that can:

● Access D2L

● Join Zoom meetings (for office hours and department tutoring)

● Watch videos posted on D2L

● Access Gradescope

● Scan and upload written work

● View pdf documents

Note: Enrolled students can borrow technology from the UA Library on a first come, first served basis. See https://new.library.arizona.edu/tech/borrow for details.

Course Goals and Objectives

This course is an introduction to the theory of stochastic processes. Topics to be covered include

- Discrete-time finite and countable state space Markov chains
    - Poisson process
- Continuous-time Markov jump processes
- Renewal processes

Time permitting and depending on instructor and/or student interest, I may cover additional topics, which may include martingales and/or Gaussian processes.

Learning Outcomes for DATA/MATH-468

Upon completion of the course, the student will

- be able to perform concrete calculations, e.g., transition probabilities, exit times, and stationary distributions involving common stochastic process models like Markov chains, Markov jump processes, the Poisson process, and renewal processes;
- be able to interpret common stochastic process models and use them to model, e.g., queues.

Learning Outcomes for MATH-568

In addition to the above, students in MATH-568 are expected to

- be able to conduct computer simulations of basic stochastic process models;
- be able to prove some basic results in the theory of stochastic processes.

Classroom Behavior Policy

As we enter the Fall semester, the health and wellbeing of everyone in this class is the highest priority. Accordingly, we are all required to follow the university guidelines on COVID-19 mitigation. Please visit https://www.covid19.arizona.edu for the latest guidance.

To foster a positive learning environment, students and instructors have a shared responsibility. We want a safe, welcoming, and inclusive environment where all of us feel comfortable with each other and where we can challenge ourselves to succeed. To that end, our focus is on the tasks at hand and not on extraneous activities (e.g., texting, chatting, reading a newspaper, making phone calls, web surfing, etc.).

Students are asked to refrain from disruptive conversations with people sitting around them during lecture.

Students observed engaging in disruptive activity will be asked to cease this behavior. Those who continue to disrupt the class will be asked to leave lecture or discussion and may be reported to the Dean of Students.

Netiquette

Netiquette is an abbreviation for "internet etiquette" – more simply put, guidelines for communicating online to ensure meaningful and polite exchanges. The common standards listed below work well for online classrooms, online office hours, discussion boards, and beyond in professional online communication:

● Behavior. Maintain the same standard of behavior and ethics that you would follow in a face-to-face context.

● Tone. Treat others with respect. Be mindful of your tone and how that is conveyed in your writing style. DO NOT USE ALL CAPS. It is considered shouting and not appropriate in a classroom. Avoid sarcasm and irony as it is easily misinterpreted in an online environment.

● Clarity and Content. Be succinct. Write, reread, and then post. Carefully consider what you have written. Does it make sense? Is it free from errors? Does it add to the conversation? Is it unnecessarily confrontational or offensive?

● Contribute. Online learning is not passive. It is expected that you will share your knowledge and insight. Be an active contributor to the learning community.

● Be forgiving. If someone makes a mistake or does something inappropriate, address it privately and politely. You can always let the instructor know and ask them to address it as well.

Makeup Policy for Students Who Register Late

Students who register after the first class meeting are expected to make up some or all of the missed work. Specific assignments and deadlines are to be arranged with the instructor on a case by case basis.

Assignments and Examinations

Regular homework assignments are to be turned in online, via Gradescope or D2L.

Collaboration policy. I encourage you to work together on homework assignments. However, each student must turn in their own written solution, which may not be simply copied from another person's work (or from any other outside source). If you work with someone else on a problem or assignment, give them credit in your write-up.

Copying. Sharing and/or copying solutions from an electronic solutions manual or similar source is prohibited, and will be considered a violation of the University of Arizona Code of Academic Integrity; note that this includes consulting and/or posting a homework question to an online forum.

Clarity matters. Homework should be typed or written in legible, use complete sentences, and show calculations and reasoning in a clear, logical order. **Unless otherwise stated, you should always explain how you obtained your answer clearly and concisely to receive full credit.** If you choose to scan your assignment, please use a scanning app instead of turning in raw pictures. There are several free apps you can use, e.g., Adobe Scan. If I'm unable to read your solution due to poor image quality, it will be considered incorrect.

Late homework. Homework is due at the announced day and time. Unless you have prior permission to turn in an assignment late, I will accept late homework for partial credit (20% will be deducted per day the assignment is late).

Midterm exam. There will be one in-class mid-term exam. It will be closed book & closed notes. No electronic devices are allowed.

If you are an undergraduate student, your **letter grade** in the course will be based on the following:

- Homework: 40%
- Midterm: 30%
- Final: 30%

- If you are a graduate student, your grade will be assigned according to

- Homework: 30%
- Midterm: 25%
- Project: 15%
- Final: 30%

If it improves your grade, I will replace your midterm score (in percentage) by your final exam percentage.

Final Examination

The final examination will be comprehensive. It is closed book, closed notes, and no electronic devices are allowed. It will take place at the scheduled time and place (see above). The University's [Exam regulations](#) will be strictly followed.

Grading Scale and Policies

Your final course grade will be determined by a percentage of the 700 total possible points in the course. Grades will be no lower than the following:

A: 100-90%   B: 89-80%   C: 79-70%   D: 69-60%   E: 59-0%

No extra credit or bonus points are offered in this course.

Requests for incomplete (I) or withdrawal (W) must be made in accordance with University policies, which are available at http://catalog.arizona.edu/policy/grades-and-grading-system#incomplete and http://catalog.arizona.edu/policy/grades-and-grading-system#Withdrawal respectively.

You may drop the class without a W through **September 4, 2022** using UAccess. The class will appear on your UAccess record, but will not appear on your transcript. You may withdraw with a W through **October 30, 2022** using UAccess. The University allows withdrawals through **November 20, 2022** but only with the Dean's approval. Late withdraws are dealt with on a case by case basis, and requests for late withdraw without a valid reason may or may not be honored.

Dispute of Grade Policy: In general, any questions regarding the grading of any assignment, quiz, or exam need to be cleared up within one week after the graded item has been returned.

Confidentiality of Student Records

See the University's [FERPA information page](#).

Tentative Schedule

This schedule is *tentative* . For actual schedule, see [course home page](#) or [D2L site](#).

Week	Topics	Text / HW
1: 1/12	Introduction	1.1, A.1–A.3
2: 1/17, 1/19	Transition probabilities; classification of states	1.2, 1.3; HW1
3: 1/24, 1/26	Classification of states; stationary distributions; detailed balance	1.4, 1.5; HW2
4: 1/31, 2/2	Detailed balance; limiting behavior	1.5, 1.6; HW3

5: 2/7, 2/9	Limit behavior; returns to a fixed state; convergence theorem	1.6, 1.7, 1.8; HW4
6: 2/14, 2/16	Convergence theorem; exit distributions; exit times	1.8, 1.9, 1.10; HW5
7: 2/21, 2/23	Infinite state spaces	1.11; HW6
8: 2/28, 3/2	*Midterm? (to be confirmed)*	
9: 3/14, 3/16	Poisson process	2.1, 2.2; HW7
10: 3/21, 3/23	Compound Poisson process; transformations	2.3, 2.4; HW8
11: 3/28, 3/30	Renewal process; queues	3.1, 3.2; HW9
12: 4/4, 4/6	Age & residual life; continuous time Markov chains	3.3, 4.1; HW10
13: 4/11, 4/13	Transition probability; branching processes; limiting behavior	4.2, 4.3; HW11
14: 4/18, 4/20	Limiting behavior; detailed balance; exit times	4.3, 4.4, 4.5; HW12
15: 4/25, 4/27	Markov queues	4.5; HW13
16: 5/2	Review	
5/6	Final exam at 330p	

Subject to Change Statement

Information contained in the course syllabus, other than the grade and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructor.

University-wide Policies link

The Links to the following UA policies are at https://academicaffairs.arizona.edu/syllabus-policies:

● Threatening Behavior Policy

● Accessibility and Accommodations Policy

● Code of Academic Integrity

● Nondiscrimination and Anti-Harassment Policy

Absence and Class Participation Policy

Participating in the course and attending lectures and other course events are vital to the learning process. As such, attendance is required at all lectures and discussion section meetings. If you anticipate being absent, are unexpectedly absent, or are unable to participate in class activities, please contact me as soon as possible. Students who miss the first two class meetings, and do not contact me within 24 hours of the second class meeting, may be administratively dropped. To request a disability-related accommodation to this attendance policy, please contact the Disability Resource Center at (520) 621-3268 or drc-info@email.arizona.edu. If you are experiencing unexpected barriers to your success in your courses, the Dean of Students Office is a central support resource for all students and may be helpful. The Dean of Students Office is located in the Robert L. Nugent Building, room 100, or call 520-621-7057.

The UA's policy concerning Class Attendance, Participation, and Administrative Drops is available at: https://catalog.arizona.edu/policy/class-attendance-and-participation

The UA policy regarding absences for any sincerely held religious belief, observance or practice will be accommodated where reasonable; see http://policy.arizona.edu/human-resources/religious-accommodation-policy.

Absences pre-approved by the UA Dean of Students (or Dean Designee) will be honored. See https://deanofstudents.arizona.edu/absences

It is the student's responsibility to notify the instructor in advance of an absence related to religious observation or an activity for which a Dean's excuse has been granted, and to arrange for how any missed work will be handled. It is also the student's responsibility to keep informed of any announcements, syllabus adjustments or policy changes made during scheduled classes.

Additional Resources for Students

UA Academic policies and procedures are available at http://catalog.arizona.edu/policies

Student Assistance and Advocacy information is available at http://deanofstudents.arizona.edu/student-assistance/students/student-assistance

Academic advising: If you have questions about your academic progress this semester, please reach out to your academic advisor (https://advising.arizona.edu/advisors/major). Contact the Advising Resource Center (https://advising.arizona.edu/) for all general advising questions and referral assistance. Call 520-626-8667 or email to advising@.arizona.edu

Life challenges: If you are experiencing unexpected barriers to your success in your courses, please note the Dean of Students Office is a central support resource for all students and may be helpful. The Dean of Students Office can be reached at 520-621-2057 or DOS-deanofstudents@email.arizona.edu.

Physical and mental-health challenges: If you are facing physical or mental health challenges this semester, please note that Campus Health provides quality medical and mental health care. For medical appointments, call (520) 621-9202. For After Hours care, call (520) 570-7898. For the Counseling & Psych Services (CAPS) 24/7 hotline, call (520) 621-3334.

Where to go, who to call if you're in crisis:

Located in Tucson? Call the Community-Wide Crisis Line 24 hours a day, 7 days a week at 520-622-6000.

Are you a University of Arizona student? If it is not an emergency and you are a UA student, call or walk-in to Counseling and Psych Services at 520-621-3334 Monday - Friday. Walk-in triage is available between 9 am and 4 pm Monday - Friday.

Are you a concerned friend? Concerned friends can find out more about helping a friend who might be experiencing problems through our Friend 2 Friend website.

Resources for sexual assault, relationship violence, and stalking.

24-Hour Hotlines:

The National Suicide Prevention Lifeline is a 24-hour, toll-free, confidential suicide prevention hotline available to anyone in suicidal crisis or emotional distress. By dialing 1-800-273-TALK (8255), the call is routed to the nearest crisis center in our national network of more than 150 crisis centers. The Lifeline's national network of local crisis centers provides crisis counseling and mental health referrals day and night.

Crisis Text Line: Text HOME to 741741 from anywhere in the United States, anytime, about any type of crisis. A live, trained Crisis Counselor receives the text and responds, all from a secure online platform. Find out more about how it works at crisistextline.org.

Suicide Prevention for LGBTQ Youth through the Trevor Project:

- **The Trevor Lifeline** is a 24/7 suicide hotline: 866-4-U-TREVOR (1-866-488-7386)

- TrevorChat: Online instant messaging available 7 days a week, 3 pm - 10 pm ET (12 pm -- 7 pm PT)

- **TrevorText:** Confidential and secure resource that provides live help for LGBTQ youth with a trained specialist, over text messages. Text TREVOR to 1-202-304-1200 (available 7 days a week, 3 pm - 10 pm ET, 12 pm -- 7 pm PT)

Veterans' Suicide Prevention Lifeline: 1-800-273-TALK (1-800-273-8255)

SAMHSA Treatment Referral Hotline (Substance Abuse): 1-800-662-HELP (1-800-662-4357)

National Sexual Assault Hotline: 1-800-656-HOPE (1-800-656-4673)

Loveisrespect (National Dating Abuse Helpline): Call 1-866-331-9474 (TTY: 1-866-331-8453). Text LOVEIS to 22522 - you'll receive a response from a peer advocate prompting you for your question. Go ahead and text your comment or question and we will reply.