Syllabus
Stat 4330: Introduction to Stochastic Processes
Fall 2023

Instructor: Dr. Krishna Padmanabhan, Email: kpadm@wharton.upenn.edu.

Time and Location: T, Th 10:15-11:45; JMHH F90.

Class Dates: Aug 29 - Dec 7. No class on Oct. 12 Th., Fall break; Nov. 23 Th., Thanksgiving

Textbook: Introduction to Stochastic Processes with R, by Robert P. Dobrow

(Primary, Copies at Penn Bookstore)

Essentials of Stochastic Processes, Rick Durrett (Optional)

Pre-requisites: The class assumes knowledge of Stat 4300 as well as multivariate calculus at the level of Math 1410. Some knowledge of linear/matrix algebra at the level of Math 2400 is also required. If you do not have a background equivalent to Stat 4300, it is unlikely that you will succeed in this course.

Topics: This class is focused on developing a firm foundational knowledge of stochastic processes with a particular emphasis on Markov chains and Poisson processes. During the semester you will learn how to model real-world systems using probability in a wide variety of areas. Additionally, you will also learn to use simulation to gain intuition for and analyze complicated stochastic processes. Measure theory will not be introduced.

Homework: There will be four significant homework assignments (incl. coding). You are free to work with others to exchange ideas, but you should write up the solutions & code on your own. I strongly recommend working on the homework throughout the period since it is assigned. The homework will be submitted via Gradescope. Your answers should be carefully written and well organized. Homework is also an extremely important part of preparing you for the mid-term and Final exams. HW will usually be due on Monday.

Grading: In addition to the homework assignments, there will be a midterm exam and a final. They will count toward your final grade as follows. Please **DO NOT** ask for make-up or additional opportunities to improve your grade, without documented evidence of hardship and the written support of your academic advisor.

Assignments (weighted by total points)	50%
Midterm	25%
Final	25%.

Exams: The midterm exam will be on *Thursday*, *October* 19. The final exam is on *Thursday*, *December* 7, both in class from 10:15 to 11:55 am. The exams will be closed book, closed notes and without the use of a calculator.

Instructor Office Hours: Thursday 5:15-6:45PM, by appointment. Location: TBD

Grader / TA team:

Ben Beyer: Grading

Yash Somaiya: Grading

Patrick Zhang: TA Office Hours [Monday and Wednesday: 3:30-5PM; Location: TBD]

Course website: All announcements and course related materials will be distributed via the Canvas website and grades can be checked during the quarter using Canvas. You can also use Piazza on Canvas to ask questions regarding the course material, assignments and any scheduling issues.

Software: We will use R to complement the course material and more intuitively learn about stochastic processes. Since this is not a formal prerequisite, we will spend 0.5 class sessions on R and provide

resources to get up to speed. Plan to bring your laptop to the first class. Please install these required software packages by the start of Class on 8/29.

• The R software: Download at https://www.r-project.org/

• RStudio, an integrated development environment (IDE) for R: Download the "Desktop" version at https://posit.co/download/rstudio-desktop/

Grading schema: The following tentative grading scheme is proposed but is subject to change based on overall class performance (curving). I will round to nearest .5, i.e., 91.6 is an A, but 81.4 is a B-

>=97 = A+
92-<97 = A
90-<92 = A-
86-<90 = B+
82-<86 = B
80-<82 = B-
75-<80 = C+
70-<75 = C
60-<70= D
Anything lower = F

Regrade requests: for each homework or exam, regrade requests should be submitted in writing (hardcopy or email) to the instructor within one week of grade release. The entire assignment in question will be regraded upon receipt of request, meaning that the resulting grade may increase, decrease, or remain unchanged compared to the initial grade.

Classroom Expectations

- Class Attendance: You are expected to attend each class unless something extenuating arises.
- Laptops are helpful for following along in-class demonstrations of R code. But only have them open them when we are actively coding.
- Electronic devices should be silenced and are not to be used for activities that distract fellow students or the instructor.
- COVID: COVID is now viewed like any other acute illness and there are no special quarantine, masking, or testing requirements. You can find Penn COVID policies on https://wellness.upenn.edu

Academic Integrity: All students are bound by University of Pennsylvania's Code of Academic Integrity. (https://catalog.upenn.edu/pennbook/code of-academic-integrity/) Any academic dishonesty will result in failing grade for the course and referral to the Office of Student Conduct. Students in doubt about whether an action constitutes academic dishonesty should discuss with the instructor in advance.

Students with Disabilities:

All students are welcome in this course. Students should make requests for any accommodations they need through Student Disability Services (SDS). In SDS's own words: "University of Pennsylvania provides reasonable accommodations to students with disabilities who have self-identified and been approved by the Office of Student Disabilities Services (SDS). If you have not yet contacted SDS and would like to request accommodations or have questions, you can make an appointment by calling SDS at 215-573-9235. The office is located in the Weingarten Learning Resources Center at Stouffer Commons 3702 Spruce Street, Suite 300. All services are confidential." (https://wlrc.vpul.upenn.edu/sds/)

"Students with disabilities who seek accommodation at Penn are responsible for self identifying with SDS. Identification may take place upon admission or at any time during the student's course of study.

Students who are approved for accommodations must authorize SDS to inform professors about their approved accommodations. They must also make online requests to SDS for individual exam accommodations each semester. Students are encouraged to introduce themselves to professors to initiate a dialogue about their particular needs."

Useful Resources:

- In addition to our in-class reviews, everyone can audit free courses on DataCamp, Coursera etc., which provide introductory R courses. It's a convenient way to gain some familiarity with R, a useful tool for our course and beyond. I will provide an overview video (1-2 hrs.) and practice problems. We will also have a 45 min. R in-class practice session.
- Our textbook also provides a tutorial of R basics (appendix) and has a useful collection of R scripts available. Download these from https://people.carleton.edu/~rdobrow/stochbook/RScripts.html
- LaTeX is a great way to format your homeworks and scientific work in general. You can use a native editor such as Emacs, MikTex etc. or an online WYSIWYG tool such as TeXstudio or LyX (WYSIWYM). *Note*: Turning in your work in LaTeX is not required.
- If you enjoy doing Calculus II by hand [Finding integrals, differentials, infinite sums etc.], my congratulations to you. But a good way to check your work is via use of a symbolic computation software such as Mathematica or Maple. There is a learning curve, but worthwhile if this is not your terminal course in Statistics. Wolfram also provides a free online tool at: https://www.wolframalpha.com/
- Matrix Algebra: Review the Appendix material in our textbook. We will assume that these are familiar to you. In case you want to develop a deeper intuition of linear and matrix algebra, I suggest the Youtube playlist by 3Blue1Brown (YT search "3B1B Essence of Linear Algebra"). Best investment of your time for learning about this subject.

Tentative Course Schedule:

Week	**Content Planned (Textbook Section)**
Week 1	Intro, Pre-Req. review; Conditional Probability& Expectation (1.1-1.5)
Week 2	Markov Chains Introduction (2.1-2.2). **R Review**$*$ (10:15-11AM Thu.)
Week 3	**Class Survey**; Markov Chains Continued (2.3-2.5)
Week 4	Long Term Markov Chains (3.1-3.2)
Week 5	HW1 due; Long Term Markov Chains Contd (3.3-3.4)
Week 6	LTMC (3.5) and **Fall Break**
Week 7	Long Term Markov Chains Contd (3.5-3.7); **Mid Term**
Week 8	Long Term Markov Chains Contd (3.8)
Week 9	HW2 is due; Poisson Processes (6.1-6.2)
Week 10	Poisson Processes Contd. (6.4-6.5)
Week 11	Continuous Time Markov Chains (7.1-7.2)
Week 12	HW3 due; CTMC (7.3) **Thanksgiving Break.**
Week 13	CTMC (7.4)
Week 14	Branching Processes (4.1-4.3)$^+$ or MCMC (5.1,5.3)$^+$
Week 15	HW4 is due; Review Session and **Final Exam**

$*$ R review portion of class on Sep. 7 is optional for students who are comfortable with R;
$+$ Time-Permitting

Student-Faculty Lunch Program: During the semester, I am open to hosting you for lunch to share ideas and perspectives outside the classroom. Once we are past the initial phase of the course, I will remind you of this and solicit interest likely around the week of Fall break.

My sentiments on use of AI in general mirror Prof. Katsevich's to a large extent [link below]. But the utility of LLMs in a course such as 4330 is less than ideal. I worry about hallucinations with such an involved topic and I am not expert enough to advise you on how best to use these. If I was a student in 4330, I would likely use LLMs to supplement my conceptual understanding of Stochastic Processes, much like a personalized tutor.

https://katsevich-teaching.github.io/stat-4710-fall-2023/resources/ai

Name Coach and Preferred Pronouns

Feel free to use NameCoach on Canvas in case you have a difficult to pronounce name. Also enter any preferred pronouns in NameCoach if you wish.

Textbook Price Match @ Penn Bookstore

Via email from Bookstore Manager: "*We price match against Amazon, if the book is both shipped and sold by Amazon.*" Consider supporting the campus bookstore in case this alleviates any price related concerns. They also price match against BN etc.