THE OHIO STATE UNIVERSITY

COLLEGE OF ARTS AND SCIENCES

SYLLABUS: STAT 6540
APPLIED STOCHASTIC PROCESSES
SPRING 2023

Course overview

Instructor

Instructor: Mario Peruggia
Email address: peruggia@stat.osu.edu
Phone number: 614-292-0963
Office hours: Virtual Hours via CarmenZoom: Tuesday 1:30-2:30 pm and Friday 3:00-4:00 pm.
The instructor will also be available to answer any questions by appointment.
Office Location: 205A Cockins Hall

Grader

Md Rejuan Haque
Email address: haque.62@osu.edu

Course description

This course introduces some of the commonly encountered stochastic processes, including Markov chains and population processes. Both discrete-time and continuous-time stochastic processes will be covered. Basic theory as well as applications will be discussed.
Prerequisites: Stat 6301, or permission of the instructor.

Course learning outcomes

By the end of this course, students should successfully be able to:

- Understand some common types of stochastic processes.

- Master techniques for answering questions pertaining to a set of selected common stochastic processes.
- Work proficiently with discrete-time Markov chains; understand transition probability matrices, convergence, and stationary and limiting distributions.
- Gain familiarity with a number of continuous-time stochastic processes, including Poisson processes, branching processes, and birth and death processes.

A more detailed, tentative course plan is provided at the end of this document.

Course materials

Required

The required textbook for this course is:
Mark A. Pinsky and Samuel Karlin (2011), "An Introduction to Stochastic Modeling," fourth edition, Elsevier.
The eBook is freely available for download from the OSU library website:
https://library.ohio-state.edu/record=b10286042~S7

Optional materials

Some topics covered in the course will be based on material presented in additional books and articles. Appropriate references will be provided as needed.

Course technology

The course is scheduled to be offered in person. Office hours will be held via Zoom sessions. To be able to attend office hours and to complete some course requirements (including the homework), certain technical skills for online courses will be relevant. These skills should already be familiar to most students.

For help with your password, university e-mail, Carmen, or any other technology issues, questions, or requests, contact the OSU IT Service Desk. Standard support hours are available at https://ocio.osu.edu/help/hours, and support for urgent issues is available 24x7.

- **Self-Service and Chat support:** http://ocio.osu.edu/selfservice
- **Phone:** 614-688-HELP (4357)
- **Email:** 8help@osu.edu
- **TDD:** 614-688-8743

Baseline technical skills necessary for online courses

- Basic computer and web-browsing skills
- Navigating Carmen

Technology skills necessary for this specific course

- CarmenZoom
- Ability to upload assignments to Carmen (Word or PDF format)

Necessary equipment

- Computer: current Mac (OS X) or PC (Windows 10+) with high-speed internet connection
- Webcam: built-in or external webcam, fully installed
- Microphone: built-in laptop or tablet mic or external microphone

Necessary software

- Some components of this class may require you to use the statistical software package called R (The R Project for Statistical Computing; http://www.r-project.org/). This software package is available as Free Software.
    - You can download R for Windows, Mac, and Linux, from the CRAN archive at https://cran.r-project.org.
    - An in-depth introduction to R is available at http://cran.r-project.org/doc/manuals/R-intro.pdf
    - Hands-on tutorials are available in the Swirl system, which you can learn about at http://swirlstats.com/. In particular, "R Programming: The basics of programming in R" is an appropriate first tutorial for students who have never used R.
- An easier to use interface to R is available in the software package RStudio. This package is available for Windows, Mac, and Linux and can be downloaded for free from http://rstudio.org. **Note that RStudio requires R to be installed.**

- **Microsoft Office 365 ProPlus**. All Ohio State students are now eligible for free Microsoft Office 365 ProPlus through Microsoft's Student Advantage program. Each student can install Office on five PCs or Macs, five tablets (Windows, iPad® and Android™) and five phones.
    - Students are able to access Word, Excel, PowerPoint, Outlook and other programs, depending on platform. Users will also receive 1 TB of OneDrive for Business storage.
    - Office 365 is installed within your BuckeyeMail account. Full instructions for downloading and installation can be found https://ocio.osu.edu/kb04733.

Course delivery

The course is scheduled to be offered in person. We will meet WF 9:35-10:55 in Scott Lab N056.

Zoom links for the course office hours will be listed on Carmen.

Grading and faculty response

Grades

Assignment or category	Percentage
Homework	30%
Midterm Exam	30%
Final Exam	40%
Total	100

Assignment information

Grades will be recorded on the class website.

Homework: There will be regular homework assignments (11 are scheduled as of now). Homework must be uploaded to Carmen by the posted deadline on the day it is due. Homework is **not** accepted by email. Late homework is not accepted, but the lowest homework score will be dropped. You are encouraged to work together on the homework, but do not copy any part of a homework. Each student must produce his/her own homework to be handed in.

Feel free to ask me for help after you have attempted the questions. The grader for the course does not have the time to provide detailed explanations on each question. To make up for this, I will try to prepare homework solutions detailed enough to allow you to understand how the question could be approached. Homework solutions will be available on the class web site.

Exams: There will be two midterms and one final exam. All exams will be administered **in the classroom**. The final exam will take place at the time and date established by the University. Information about the exams will be posted well in advance through the course website.

Midterm	Fri Mar 3	9:35–10:55
Final	Wed Apr 26	10.00– 11.45

All exams are **closed book/closed notes.** There are no make-up exams. A basic calculator is allowed – tablets, laptops, and cellphones are not allowed. Statistical tables will be provided as needed.

Homework preparation rules: Homework may be uploaded to Carmen in PDF or Word format. PDF scans of handwritten pages are acceptable. Put your name and the homework assignment number at the top of the first page. Number all pages consecutively. Submit the problems in order.

The midterm will focus on the material covered prior to the exam since the beginning of the course.

The final will cover all the material for the course.

Late assignments

Assignments will be due at the time posted on Carmen. With few exceptions, late assignments will not be accepted.

Grading scale

Final grades will be assigned based on performance in the course. The grades will not be lower than those in the "straight scale" of 90% for an A, 80% for a B, 70% for a C and so on. Appropriate adjustments to these cutoffs will be made to account for the difficulty of the exam questions.

Faculty feedback and response time

I am providing the following list to give you an idea of my intended availability throughout the course. (Remember that you can call **614-688-HELP** at any time if you have a technical problem.)

Grading and feedback

For large weekly assignments, you can generally expect feedback within **7-10 days**.

E-mail

I will reply to e-mails within **24 hours on school days**.

Attendance, participation, and discussions

The class is designed around the lectures. Attendance is strongly encouraged as is class participation. If you have questions, ask in class, or see me during office hours.

If you are unable to attend due to COVID-19 or for other reasons, let me know. If you test positive for the virus or believe that you have symptoms, it is best that you take care of health concerns before worrying about this class. Let me know of the situation promptly and we will make special arrangements.

Other course policies

Health and safety

The Ohio State University Wexner Medical Center's Cornavirus Outbreak site (https://wexnermedical.osu.edu/features/coronavirus) includes the latest information about COVID-19 as well as guidance for students, faculty and staff. Guidelines and requirements for campus safety from the University's Reactivation Task Force are published on the Safe and Healthy website (https://safeandhealthy.osu.edu).

Potential disruptions to instruction

- As much as possible, students will have access to material online if they are unable to attend class because of positive diagnosis, symptoms, or quarantine required following contact tracing.
- If the instructor is unable to be present in person because of positive diagnosis, symptoms, or quarantine following contact tracing a new instructor will be assigned to the course. Details will be given on the course website.

Student academic services

Student academic services offered on the OSU main campus
http://advising.osu.edu/welcome.shtml.

Student support services

Student support services offered on the OSU main campus:
https://artsandsciences.osu.edu/current-students/undergraduate-students/student-resources.

Academic integrity policy

Policies for this online course

- **Exams**: You must complete the exams yourself, without any external help or communication.

- **Written homework assignments**: You are encouraged to work with fellow students on the homework, but do not copy any part of a homework. Each student must produce his/her own homework to be handed in.

Ohio State's academic integrity policy

It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct https://trustees.osu.edu/bylaws-and-rules/code.

Copyright disclaimer

The materials used in connection with this course may be subject to copyright protection and are only for the use of students officially enrolled in the course for the educational purposes associated with the course. Copyright law must be considered before copying, retaining, or disseminating materials outside of the course.

Statement on title IX

Title IX makes it clear that violence and harassment based on sex and gender are Civil Rights offenses subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories (e.g., race). If you or someone you know has been sexually harassed or assaulted, you may find the appropriate resources at http://titleix.osu.edu or by contacting the Ohio State Title IX Coordinator at titleix@osu.edu

Accessibility accommodations for students with disabilities

The university strives to make all learning experiences as accessible as possible. In light of the current pandemic, students seeking to request COVID-related accommodations may do so through the university's request process, managed by Student Life Disability Services. If you anticipate or experience academic barriers based on your disability (including mental health, chronic, or temporary medical conditions), please let me know immediately so that we can privately discuss options. To establish reasonable accommodations, I may request that you register with Student Life Disability Services. After registration, make arrangements with me as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion. SLDS contact information: slds@osu.edu; 614-292-3307; http://slds.osu.edu; 098 Baker Hall, 113 W. 12th Avenue.

Accessibility of course technology

This online course requires use of Carmen (Ohio State's learning management system) and other online communication and multimedia tools. If you need additional services to use these technologies, please request accommodations with your instructor.

- Carmen (Canvas) accessibility
- Streaming audio and video
- Synchronous course tools

Your mental health

As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. The Ohio State University offers services to assist you with addressing these and other concerns you may be experiencing. If you or someone you know are suffering from any of the aforementioned conditions, you can learn more about the broad range of confidential mental health services available on campus via the Office of Student Life's Counseling and Consultation Service (CCS) by visiting ccs.osu.edu or calling 614- 292-5766. CCS is located on the 4th Floor of the Younkin Success Center and 10th Floor of Lincoln Tower. You can reach an on call counselor when CCS is closed at 614-292-5766 and 24 hour emergency help is also available through the 24/7 National Suicide Prevention Hotline at 1-800-273- TALK or at suicidepreventionlifeline.org

Disclaimer

This syllabus should be taken as a fairly reliable guide for the course content. However, you cannot claim any rights from it and in particular we reserve the right to change due dates or the methods of grading and/or assessment if necessary. Any changes will be communicated to you through official course announcements.

Course schedule (tentative)

Week	Dates	Topics, Readings, Assignments, Deadlines
1	Jan 11, 13	Probability review (Ch 1); Conditioning (Ch 2)
2	Jan 18, 20	Conditioning (Ch 2); Introduction to stochastic processes (Ch. 1); Markov Chains: Definition and transition probabilities (Ch 3, Sec 1-2)
3	Jan 25, 27	Markov chains: Examples (Ch. 3, Sec. 3), First-step analysis (Ch 3, Sec. 4)
4	Jan Feb 1, 3	Markov chains: Additional examples (Ch 3, Sec 5), Long run behavior (regular TPM) (Ch4, Sec 1)
5	Feb 8, 10	Markov chains: Interpretation of the limiting distribution (Ch 4, Sec 1), Examples (Ch 4, Sec 2)
6	Feb 15, 17	Markov chains: The classification of states (Ch 4, Sec 3), Limit theorems (Ch 4, Sec 4)
7	Feb 22, 24	Markov chains: Limit theorems (Ch 4, Sec 4), The reducible case (Ch 4, Sec 5); The Poisson process (Ch 5, Sec 1)
8	Feb Mar 1, 3	The law of rare events (Ch 5, Sec 2) Midterm Exam – Fri, Mar 3, 9:35-10:55 am
9	Mar 8, 10	Distributions associated with the Poisson process (Ch5, Sec 3-4); Marked and compound Poisson processes (Ch 5, Sec 6)
10	Mar 22, 24	Branching Processes (Ch3, Sec 8-9)
11	Mar 29, 31	Birth process (Ch 6, Sec 1); Death process (Ch 6, Sec 2)
12	Apr 5, 7	Birth and death process (Ch 6, Sec 3-5)
13	Apr 12, 14	A two-state continuous time Markov chain example; Connection between sojourn time representation and infinitesimal representation for continuous time Markov chains (Ch 6; Sec 6)
14	Apr 19, 21	Queueing models (Ch 7); Brownian motion (Ch 8)

Week	Dates	Topics, Readings, Assignments, Deadlines
15	Apr 26	Final Exam – Wed, Apr 26, 10.00-11.45