STAT 4370/5370 SYLLABUS
STOCHASTIC PROCESSES
Department of Mathematics and Statistics

Fall 2023

Dalhousie University acknowledges that we are in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq People and pays respect to the Indigenous knowledges held by the Mi'kmaq People, and to the wisdom of their Elders past and present. The Mi'kmaq People signed Peace and Friendship Treaties with the Crown, and section 35 of the Constitution Act, 1982 recognizes and affirms Aboriginal and Treaty rights. We are all Treaty people.

Dalhousie University also acknowledges the histories, contributions, and legacies of African Nova Scotians, who have been here for over 400 years.

Course Instructor

Théo Michelot

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Office: Chase Building – 201

Office hours: Monday and Wednesday, 11:00-12:00

Course Description

This course explores the theory and application of stochastic processes. Topics to be discussed include discrete and continuous time Markov processes, Poisson processes, and hidden Markov models.

- Course prerequisites: STAT 3360 (Probability)
- Course exclusions: None

Course structure

Lectures will be delivered in person, and will not be recorded.

- Monday 08:35 – 09:55
- Wednesday 08:35 – 09:55

Room: Life Science Centre – Common Area – C234

Course materials

Course materials are loosely based on the following book:

📖 Ross (2019), *Introduction to Probability Models*, 12th Edition, AP Press.

Students are not required to purchase the book, and course notes will be provided by the instructor. Course materials, including notes, slides, and assignments will be shared on Brightspace.

Assessment

Your final grade will combine assignments (75%) and a final exam (25%).

Assignments

There will be 6 assignments through the term. Your lowest assignment mark will be dropped, and the remaining 5 assignments will each count for 15% towards of your final grade (adding up to 75%). All assignments are due at 23:59 on the due date. Assignments can be typeset or handwritten.

	Start Date	Due Date
Assignment 1	September 21, 2023	September 27, 2023
Assignment 2	October 5, 2023	October 11, 2023
Assignment 3	October 16, 2023	October 22, 2023
Assignment 4	October 26, 2023	November 1, 2023
Assignment 5	November 6, 2023	November 12, 2023
Assignment 6	November 27, 2023	December 3, 2023

Final exam

The final exam will have a weight of 25%.

It will be held during the final exam period, and the date will be communicated later.

Conversion of numerical grades to final letter grades follows the Dalhousie Grade Scale

A+ (90-100)	B+ (77-79)	C+ (65-69)	D (50-54)
A (85-89)	B (73-76)	C (60-64)	F (0-49)
A− (80-84)	B− (70-72)	C− (55-59)	

Course Policies on Missed or Late Academic Requirements

Late assignment submissions will result in a penalty of 10% per day, with a limit of five days. If the submission is more than five days late, the assignment mark will be zero.

Course Policies Related to Academic Integrity

Students are not allowed to work together on assignments.

You can use generative AI (e.g., ChatGPT) for assignments, for help generating ideas and computer code. You should not directly copy any text generated by AI, as this poses a difficult problem regarding indirect plagiarism and the inability to identify original sources. If you use AI, your submission must include a statement describing the specific tool that you used, and what you used it for (e.g., help with code, brainstorming). You are responsible for checking the accuracy of the information.

Learning Objectives

- Apply common results from probability theory to stochastic processes.

- Understand the key properties and applied utility of Markov processes.

- Define simulation algorithms for common stochastic processes.

- Construct probability models to represent many real-life situations.

Course Content

This is a tentative overview of the topics covers in the course, subject to change.

1. Review of probability theory

   - Common results and definitions

   - Conditional probability

2. Discrete-time Markov processes

   - Definition

   - Chapman-Kolmogorov equations

   - Long-term behaviour

   - Applications (Markov chain Monte Carlo, Page Rank, N-gram models)

   - Statistical inference

3. Poisson processes

   - Definition

   - Distributions of arrival and interarrival times

   - Statistical inference

   - Extensions

4. Continuous-time Markov processes

   - Definition

   - Transition rates and transition probabilities

   - Long-term behaviour

   - Examples (birth-death process, queueing theory)

- Brownian motion

5. Hidden Markov models

   - Mixture models

   - Hidden Markov models as dependent mixture models

   - Likelihood evaluation

   - State decoding

   - Examples

University Policies and Statements

Recognition of Mi'kmaq Territory

Dalhousie University would like to acknowledge that the University is on Traditional Mi'kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel, and support. Visit or e-mail the Indigenous Student Centre at 1321 Edward St or `elders@dal.ca`. Additional information regarding the Indigenous Student Centre can be found at: `https://www.dal.ca/campus_life/communities/indigenous.html`.

Internationalization

At Dalhousie, 'thinking and acting globally' enhances the quality and impact of education, supporting learning that is "interdisciplinary, cross-cultural, global in reach, and orientated toward solving problems that extend across national borders". Additional internationalization information can be found at: `https://www.dal.ca/about-dal/internationalization.html`.

Academic Integrity

At Dalhousie University, we are guided in all our work by the values of academic integrity: honesty, trust, fairness, responsibility, and respect. As a student, you are required to demonstrate these values in all the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity. Additional academic integrity information can be found at: `https://www.dal.ca/dept/university_secretariat/academic-integrity.html`.

Accessibility

The Student Accessibility Centre is Dalhousie's centre of expertise for matters related to student accessibility and accommodation. If there are aspects of the design, instruction, and/or experiences within this course (online or in-person) that result in barriers to your inclusion, please contact the Student Accessibility Centre (`https://www.dal.ca/campus_life/academic-support/accessibility.html`) for all courses offered by Dalhousie with the exception of Truro. For courses offered by the Faculty of Agriculture, please contact the Student Success Centre in Truro (`https://www.dal.ca/about-dal/agricultural-campus/student-success-centre.html`).

Conduct in the Classroom – Culture of Respect

Substantial and constructive dialogue on challenging issues is an important part of academic inquiry and exchange. It requires willingness to listen and tolerance of opposing points of view. Consideration of individual differences and alternative viewpoints is required of all class members, towards each other, towards instructors, and towards guest speakers. While expressions of differing perspectives are welcome and encouraged, the words and language used should remain within acceptable bounds of civility and respect.

Diversity and Inclusion – Culture of Respect

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness (Strategic Priority 5.2). Additional diversity and inclusion information can be found at: `http://www.dal.ca/cultureofrespect.html`.

Student Code of Conduct

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner - perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution. The full Code of Student Conduct can be found at: `https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html`.

Fair Dealing Policy

The Dalhousie University Fair Dealing Policy provides guidance for the limited use of copyright protected material without the risk of infringement and without having to seek the permission of copyright owners. It is intended to provide a balance between the rights of creators and the rights of users at Dalhousie. Additional information regarding the Fair Dealing Policy can be found at: `https://www.dal.ca/dept/university_secretariat/policies/academic/fair-dealing-policy-.html`.

Originality Checking Software

The course instructor may use Dalhousie's approved originality checking software and Google to check the originality of any work submitted for credit, in accordance with the Student Submission of Assignments and Use of Originality Checking Software Policy. Students are free, without penalty of grade, to choose an alternative method of attesting to the authenticity of their work and must inform the instructor no later than the last day to add/drop classes of their intent to choose an alternate method. Additional information regarding Originality Checking Software can be found at: `https://www.dal.ca/dept/university_secretariat/policies/academic/student-submission-of-assignments-and-use-of-originality-checking-software-policy-.html`

Student Use of Course Materials

Course materials are designed for use as part of this course at Dalhousie University and are the property of the instructor unless otherwise stated. Third party copyrighted materials (such as books, journal articles, music, videos, etc.) have either been licensed for use in this course or fall under an exception or limitation in Canadian Copyright law. Copying this course material for distribution (e.g. uploading to a commercial third-party website) may lead to a violation of Copyright law.