Stat/Math 3460 Syllabus
Intermediate Statistical Theory
Department of Mathematics and Statistics

Winter 2025

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

Email: `theo.michelot@dal.ca`

Office: Chase Building – 201

Office hours: Tuesdays 11am-12pm, and Thursdays 9:30-10:30am

Course Description

This course provides an intermediate level coverage of statistical theory to provide a framework for valid inferences from sample data. The methods developed are based on the likelihood function and are discussed from the frequentist, likelihood, and Bayesian approaches. The problems of point estimation, interval estimation and hypothesis testing and the related topics of sampling distributions, sufficiency, and Fisher Information are discussed.

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

Course structure

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

- Tuesday 2:35pm – 3:55pm
- Thursday 2:35pm – 3:55pm

Room: Life Science Centre – Psychology – P5260

Course materials

There is no textbook for this course. Course materials, including notes, slides, and assignments will be shared on Brightspace.

Assessment

Your final grade will combine assignments, a midterm exam, and a final exam, with the following weights.

	Weight	Date
8 assignments	$8 \times 5\% = 40\%$	Weekly
Midterm exam	20%	February 27th, 2:35pm – 3:55pm
Final exam	40%	TBD by registar's office

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 three days. If the submission is more than three days late, the assignment mark will be zero. If there is a good reason why you will not be able to submit an assignment on time (or at all), you should contact me about it as early as possible.

Course Policies Related to Academic Integrity

You can discuss assignments with each other at a high level (brainstorming), but you must write your solutions independently. Never show someone your final solution, or copy someone else's work.

You can use generative AI (e.g., ChatGPT) for assignments, for help generating ideas. Like other external help and resources, note that excessive reliance on generative AI to come up with solutions will impede your learning rather than support it. 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., brainstorming). You are responsible for checking the accuracy of the information.

Learning Objectives

At the end of this course, you will be able to:

- Find estimators of parameters for simple distributions, including method of moments estimator and maximum likelihood estimator.

- Quantify the amount of information about a parameter that is present in a data set, using the notion of Fisher information.

- Compute the posterior distribution of a parameter in a Bayesian setting, given the prior distribution and likelihood function.

- Find several Bayesian estimators for a parameter, corresponding to different loss functions.

- Critically compare prior distributions in terms of how informative they are.

- Compute and interpret confidence intervals, likelihood intervals, and credible intervals for uncertainty quantification.

- Find hypothesis tests with good properties (uniformly most powerful test) for simple statistical models.

- Derive and interpret the power function of a hypothesis test.

- Transform a hypothesis test into a confidence interval and vice-versa.

Course Content

1. Basics of statistical inference

    - estimators and sampling distributions

    - unbiased estimators

    - asymptotic properties of estimators

    - mean squared error

    - sufficiency

    - method of moments

2. Maximum likelihood estimation

    - the likelihood function

    - finding the maximum likelihood estimator (MLE)

    - properties of the MLE

    - Fisher information

    - asymptotic normality of the MLE

3. Bayesian estimation

    - the Bayesian paradigm

    - conjugate prior distributions

    - Bayesian estimators

    - choosing a prior

    - asymptotic properties of posterior distributions

4. Interval estimation

- confidence intervals

- the pivotal quantity method

- large-sample confidence intervals

- likelihood intervals

- Bayesian credible intervals

5. Hypothesis testing

   - power function

   - uniformly most powerful tests

   - p-values

   - likelihood ratio tests

   - link between confidence intervals and hypothesis tests

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.