statistical inference 1

course website for ubc stat 460/560 fall 2025 (Winter Term 1)

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Syllabus

Acknowledgement

UBC's Point Grey Campus is located on the traditional, ancestral, and unceded territory of the xʷməθkʷəy̓əm (Musqueam). The land it is situated on what has always been a place of learning for the Musqueam, who for millennia have passed on their culture, history, and traditions from one generation to the next on this site. We are fortunate to study, work, live, and play in this place. My sense of place here includes being aware of the fact that there are many ways of knowing and of acquiring knowledge. In this course, we get to explore some that have particularly precise and formal structures.

More information: https://indigenous.ubc.ca/

Teaching team

Instructor: Ben Bloem-Reddy

- Email: ben dot bloem-reddy at ubc dot ca
- Office hours: See Canvas

TA: David Xu

- Email: See Canvas
- Office hours: See Canvas

Teaching approach

I approach this class knowing that every student enters with different preparation, and with different goals. I will do my best to support your learning, regardless of from where you've come or where you're going. This course can be challenging, and I am striving to make it a collaborative endeavour in which we work together to learn with and from each other. There will be plenty of opportunities for help and advice from peers and from the teaching team. Please reach out if there is something we could do better. Suggestions, ideas, etc., are always welcome.

Commitment to equity and inclusion

I am committed to supporting an inclusive learning environment, and I am continually learning how best to do so. If you have concerns that I or someone else may not be upholding this commitment, I invite you to either talk with me if you feel comfortable, or share your thoughts on an anonymous feedback survey. If in class discussions there are derogatory, harassing or hateful statements made I will intervene to help prevent further harm and uphold a respectful class environment. My pronouns are he/him/his, and I invite you to use the option on Canvas to provide your pronouns (find out how in the Canvas Student Guide).

Course overview

Description: Statistical inference (as a topic) traditionally includes two branches: estimation (or learning) of quantities of interest from data, and inference (typically focusing on hypothesis testing but more broadly construed as uncertainty quantification). It makes a formal bridge between the mathematics of probability theory and the practicalities of learning from data, often to make decisions. In this course, we will focus on how to use mathematics to formulate and state precisely what properties we can expect statistical techniques to have, and under what conditions. We will move quickly and cover a wide range of topics, getting exposure to general statistical methods (e.g., bootstrap estimation, parametric inference, model selection, simulation) and general theoretical techniques (e.g., asymptotic analyses of estimators). We will cover theory with a focus on practical implications, and may use computation as a tool for learning. At the end of the course, students should have a good knowledge of classical and modern methods for statistical estimation, including estimating uncertainty, and a strong foundation for mathematical analysis of statistical methods.

Learning in this course is a collaborative effort led by you, with support from the teaching team. Learning will be evaluated based on a combination of individual and

group work emphasizing regular practice, resourcefulness, and engaging with the concepts in ways that are meaningful to you. (Details are in Assessments.)

Formal pre-requisites: MATH 320 (undergraduate real analysis), STAT 305 (undergraduate Intro to Statistical Inference), and one of MATH 152/221/223 (undergraduate linear/matrix algebra).

Class meetings: Regular attendance and participation are an important part of your learning in the course. Class meets in person two times per week for 80 minutes (dates and times on Canvas). Please come to class having engaged with the assigned reading, completed any assigned pre-class work, and prepared to work on the in-class activities (more below). You can find the planned schedule of topics and reading on Canvas.

Communications

I will use Canvas to make announcements.

Please use email for course-related communications (or talk to me before/after class).

Course objectives

If you are willing and able to meet the requirements, by the end of this course you will be able to:

- understand technical statistical language and ideas in research papers, *when explicitly stated and otherwise* (the latter situation is especially common outside of statistics journals);
- define and manipulate the estimation and uncertainty quantification aspects of a statistics or machine learning problem;
- define and analyze statistically meaningful theoretical properties of core statistical methods;
- understand the *process* of constructing a mathematical analysis of a statistical procedure;
- communicate your thinking about statistical analysis verbally and mathematically;
- learn related and advanced topics through self-study.

Learning activities

Class meetings will be our primary mode of interaction. Much of your learning will occur outside of class meetings through (see below for details on each):

- Reading and small pre-class assignments
- Activity solutions
- Assignments
- Self-reflection/-assessment via learning logs

Class meetings

It is imperative that you read the assigned sections of the textbook(s) prior to class and complete any assigned pre-class work. I will cover only certain topics in detail; much of the class time will be devoted to individual and group learning activities that depend on you reading before class.

Reading

Textbooks

Primary textbooks:

- L. Wasserman, *All of Statistics*, available as a PDF through the UBC library. Primary text for first half of the course.
- A. van der Vaart, *Asymptotitic Statistics*, available as a PDF through the UBC library. Primary text for the second half of the course.

Complements and references:

- L. Wasserman, *All of Nonparametric Statistics*, available as a PDF through the UBC library.
- B. Efron and T. Hastie, *Computer age statistical inference*, available as a PDF through the UBC library.
- M. Schervish, *Theory of Statistics*, available as a PDF through the UBC library.
- M. Wainwright, *High-dimensional statistics: a non-asymptotic viewpoint*, available as a PDF through the UBC library.

- J. Jacod and P. Protter, *Probability Essentials*, available as a PDF through the UBC library.

- M. A. Proschan and P. A. Shaw, *Essenials of Probability Theory for Statisticians*, available as a PDF through the UBC library.

Assessments

Your final grade will be calculated as follows:

Category	Contribution	Notes
Activity solutions	Grad students: 5%	See description below
Pre-class assignments	Grad students: 10%; Undergrads: 15%	See description below
Assignments	25%	(roughly) every week; see description below
Midterm exam	30%	Scheduled for October 29; more details to follow
Final exam	30%	Exam period is December 9-20; more details to follow (UBC typically confirms dates in mid-October)

Your average between the midterm and final exams must be at least 50% in order to pass the course.

My primary concern is that you learn mathematical statistical estimation/inference to the level of the course objectives. If you work hard and demonstrate what you are learning (via assignments, learning logs, in-class participation, office hours attendance, etc.), you will do fine.

Policy on concessions

If circumstances arise that prevent you from attending class or completing an assignment, please let me know *as soon as possible*. UBC's policy on academic concessions is here. If you have grounds for academic concession, we will work together to find something that works.

The default policy for assignments: you have three "late days" to be used at your discretion during the term. When you have run out of late days, any further late days will result in the grade of the late work to be multiplied by 0.8 each day that it is late. **If you are using a late day, you must let me know before the assignment is due.**

Pre-class assignments

As an incentive to keep up with the reading and come to class prepared, most Monday classes will have a small amount of assigned pre-class work to be completed on Canvas. The work is not intended to be overly difficult or time-consuming.

Participation

Each class meeting we will involve a number of activities, typically structured as "think-pair-share": I describe a problem, everyone thinks/works independently for a few minutes, we discuss our thoughts/work in pairs or small groups, and then someone volunteers to share with the entire class. The point is not necessarily to get the exercise correct; it is to practice thinking through a problem and communicating your thinking. Engaging in each step of the activity is important for your learning.

Activity solutions

Throughout the term, graduate students will typeset solutions to the in-class activities. Depending on class size, these may be assigned in pairs. A schedule will be posted on Canvas. Solutions should be typeset using the solutions template on the Assignments page. The solutions are due no more than one week after the class meeting. Depending on the class size, there may be some unassigned class meetings; undergraduate students may write solutions for these and receive extra credit. (This won't happen until late in term, and priority will be given to students who could use the extra credit the most; I will coordinate this when the time arrives.)

Assignments

There will be assignments, roughly weekly. Solutions must be LaTeXed (template on the Assignments page), submitted as a **PDF** via Canvas **before class on the due date**.

These will be a mix of exercises from the textbook and more challenging problems. Most of the grading will be binary (you make a good effort at the problem or not), and one or two problems will be graded in detail. You will (hopefully) learn something new —not covered in lecture—in the course of doing the assignment.

I encourage you to discuss assignment problems with your classmates. Learning in this class is a team sport! Solutions must be written up independently. Additionally,

please state who and/or what materials you consulted while working on the assignment; feedback is optional and welcome.

Exams

There will be a midterm exam on October 16, and a final exam sometime during the December exam period (to be scheduled by UBC). More information on format and topics covered will be given closer to the exam dates.

In-person class

Covid Safety in the Classroom

Masks: Masks are no longer required for indoor public spaces on campus, including classrooms. For our in-person meetings in this class, it is important that all of us feel as comfortable as possible engaging in class activities while sharing an indoor space. Non-medical masks that cover our noses and mouths are a primary tool to make it harder for Covid-19 to find a new host. If you choose to, please wear a mask during our class meetings. If you have not yet had a chance to get vaccinated against Covid-19, vaccines are available to you, free and on campus (http://www.vch.ca/covid-19/covid-19-vaccine). Please pay attention to trends in community transmission; mask-wearing may be recommended if infection rates rise.

Your personal health

If you're sick, it's important that you stay home, no matter what you think you may be sick with (e.g., cold, flu, other). You can do a self-assessment for Covid symptoms here: (https://bc.thrive.health/covid19/en) Do not come to class if you have Covid symptoms, have recently tested positive for Covid, or are required to quarantine. This precaution will help reduce risk and keep everyone safer. You can check this website to find out if you should self-isolate or self-monitor: (http://www.bccdc.ca/health-info/diseases-conditions/covid-19/self-isolation#Who).

If you do miss class because of illness:

- Let me know as soon as possible.
- Make a connection early in the term to another student or a group of students in the class. You can help each other by sharing notes.
- Do your best to keep up with the reading, exercises, and assignments. The "late day" policy for assignments is intended to help with such situations, and can be adapted as needed.

Instructor health

I will do my best to stay well, but if I am ill then I may not come to class. If that happens, then either class will be held on Zoom or there may be a temporary replacement instructor. Our classroom will still be available for you to sit and attend an online session, in this (hopefully rare) instance.

UBC's values and policies

UBC provides resources to support student learning and to maintain healthy lifestyles but recognizes that sometimes crises arise and so there are additional resources to access including those for survivors of sexual violence. UBC values respect for the person and ideas of all members of the academic community. Harassment and discrimination are not tolerated nor is suppression of academic freedom. UBC provides appropriate accommodation for students with disabilities and for religious and cultural observances. UBC values academic honesty and students are expected to acknowledge the ideas generated by others and to uphold the highest academic standards in all of their actions. Details of the policies and how to access support are available here: https://senate.ubc.ca/policies-resources-support-student-success.

Academic integrity

From the UBC website on academic integrity:

> *Doing your own work, acknowledging the contributions of others, and seeking help when you need it are all part of what academic integrity means at UBC, as is avoiding tools and services that subvert these practices.*
>
> *Academic integrity is a commitment to upholding the values of respect, integrity, and accountability in academic work. It is foundational to teaching and learning and is a fundamental and shared value of all members of the UBC community. UBC adopts an educative approach to academic integrity that supports students and instructors around awareness and that values academic misconduct processes that are fair and effective.*
>
> *Academic integrity is a set of values and skills that must be learned and refined over time. Instructors are responsible for setting clear expectations around academic integrity in their courses, modelling honest behaviour as teachers and scholars, and creating a space for students to develop their understanding of academic integrity. Students are responsible for meeting these expectations in their academic work, developing an understanding of concepts, and seeking support when they have questions. UBC is responsible for creating and sustaining the culture of academic integrity that makes all of this possible.*
>
> *Everyone plays a part in supporting and enhancing academic integrity at UBC.*

In this course, you are expected to do your own work on out-of-class assignments (see assignments). Any people or resources consulted while working on your assignments must be acknowledged on the work you submit. Using generative AI tools such as (but not limited to) ChatGPT is allowed only for searching for information in the same way as you use a search engine. The following uses are strictly prohibited and would be considered academic misconduct.

- Obtaining solutions to assigned problems.
- Generating computer code or figures for your assignments.

This list is not exhaustive. **If you are unsure, ask the instructor.**
