STA355H1F: Theory of Statistical Practice
Fall 2024
Course Syllabus

Instructor Contact Information & Course Details

Instructor:	Ismaïla Ba (email: ismaila.ba@utoronto.ca)
Office Hours:	Instructor and TAs will hold office hours in a combination of online and in-person formats. The office hour schedule and mode of delivery will be posted on Quercus once finalized. It is recommended that you visit office hours whenever you have a question about the material.
Quercus discussion board:	We will use the Quercus discussion board as an online discussion forum, which can be accessed through the Quercus course page. All questions about course material should be posted here or asked during instructor or TAs office hours. The instructor and TAs will monitor the board and will help answer questions but students are encouraged to answer posts and help their fellow classmates.
Class Schedule:	Mondays, 12:00 p.m. – 3:00 p.m. in NF 003.
Prerequisite:	STA255H1 (73%)/ STA248H1 (73%)/ STA238H1 (73%)/ STA261H1 (60%)/ ECO227Y1 (60%)/ STAB57H3 (60%)/ STA260H5 (60%)/ ECO227Y5 (60%); MAT235Y1/ MAT237Y1/ MAT257Y1/ (MATB41H3, MATB42H3)/ (MAT232H5, MAT236H5)/ (MAT233H5, MAT236H5); MAT223H1/ MAT224H1/ MAT240H1/ MATA22H3/ MATA23H3/ MAT223H5/ MAT240H5/ MATB24H3/ MAT224H5
Goal:	The main goal of this course is to provide students with the necessary tools of mathematical statistics necessary to be a good applied statistician. The focus of the course will be on the theory behind statistical methodology (from exploratory data analysis to formal statistical inference) and there will be a substantial data analytic component.
Course Description:	STA355H1 provides a unifying structure for the methods taught in other courses, and will enable students to read methodological research articles or articles with a large methodological component. Topics covered include statistical models and distributions; fundamentals of inference: estimation, hypothesis testing, and significance levels; likelihood functions and likelihood-based inference; prior distributions and Bayesian inference. Statistical software (R) will be used throughout and will be required for the completion of various assessments during the term.

Topics

The following topics will be covered in the course:

- **Short probability review.** Random variables, probability distributions and expected values, convergence in distribution and in probability, related theorems (e.g., Central Limit Theorem (CLT), Weak Law of Large Numbers (WLLN)), Delta Method.
- **Statistical models.** Parametric and non-parametric models, order statistics, introduction to goodness-of-fit via probability plots, sampling variation and uncertainty in estimation.
- **Point and interval estimation.** Substitution principle, standard errors, jackknife standard error estimates, likelihood estimation, confidence intervals, pivots, introduction to Bayesian inference, credible intervals, bias/variance trade-offs, robustness, methods for "big data".

- **Hypothesis Testing.** Elements of hypothesis testing, Neyman-Pearson Lemma and its consequences, p-values, goodness-of-fit testing, multiple testing, rank tests (if time permits).

Course Materials

Course Content: We have a Quercus course page for this course. All lecture slides, assignments and any other materials will be posted on this Quercus course page. In addition, any important announcements will also be posted in Quercus. Please make sure to check it regularly.

Textbook: The recommended textbook is Statistical Models by A. C. Davison (Cambridge University Press); it is available online through the UofT Library System and a link is provided on the Quercus site. We will not make extensive use of this book although it will serve as a valuable reference in subsequent courses. The textbook will be supplemented with a number of handouts and some journal articles; some of these are already on Quercus and more will be added as the course progresses. Some other good references are:

- D. Nolan and T. Speed: Stat Labs: Mathematical Statistics Through Applications. (Springer)
- G. James, D. Witten, T. Hastie and R. Tibshirani: An Introduction to Statistical Learning with Applications in R. (Springer)
- G. Casella and R. L. Berger: Statistical Inference. (Cengage Learning)

The first two books are freely available as electronic copies through the University of Toronto Library system, while the third book can be downloaded online.

Statistical Software: To recognize the role of computing in mathematical statistics as well as to emphasize the connections between applied and mathematical statistics, we will use R extensively in this course both for data analysis as well as for carrying out simple Monte Carlo (simulation) experiments. No previous experience is necessary and samples of R code will be provided. R is a free software and can be downloaded (for Windows, Mac, and Linux operating systems) from `https://www.r-project.org`. Of interest to many of you will be RStudio, which provides a very nice environment for using R; information on RStudio (including downloads) can be found at `https://posit.co/download/rstudio-desktop/`. RStudio can be used in a cloud environment through the Jupyter-Hub for the University of Toronto. This will allow you to login with your official UofT credentials and use RStudio without the need for a local installation. It can be run on any device that has access to an internet connection.

Course Work, Examinations & Grading

Assignments: There will be four assignments for this course in total. The assignments will involve both mathematical exercises as well as some computing (using R). Two assignments will be due before the midterm and two after the midterm. You must submit the written work individually. Copying (in whole or in part) the work of another student will not be tolerated and will result in disciplinary action (see Academic Integrity section). Assignment due dates will be specified as soon as questions are released (via Crowdmark). **No late submission will be accepted.**

Midterm Test: There will be one IN CLASS midterm test scheduled during lecture time. This test will account for 35% of the final grade. The tentative date is November 4, 2024.

Note: If you miss the midterm exam due to illness or other circumstances beyond your control, the weight from the midterm will be carried over to the final exam.

Final exam: This will be held during the December exam period and will cover all topics.

Grading Scheme:

Item	Percent	
4 Assignments	20%	(each worth 5%)
Midterm Test	35%	
Final Exam	45%	
Total	100%	

Regrade requests

Regrade requests will be accepted for all assessments. To be considered, you must clearly identify the question you have concerns about, provide a detailed justification for your concern and make specific references to your answer, the feedback you received and to the relevant course material. All regrade requests must be submitted by email no later than one week after the grade for that assessment is released. No regrade requests will be accepted after this deadline. The instructor reserves the right to re-evaluate the entire assessment (i.e., grades may go up, down, or remain unchanged). Please allow a few weeks for the instructor to process regrade requests.

Intellectual property

Course materials provided on Quercus, including lecture slides, assessments, videos, and solutions, are the intellectual property of your instructor and are intended solely for the use of students currently enrolled in this course. **Sharing these materials with any person or organization outside of the course constitutes unauthorized use and violates copyright**.

Class Communication

All communication will be made through Quercus announcements or during lectures. Please ensure that you check Quercus regularly to stay updated on important information.
Questions about the course material should be posted on Quercus. Inquiries that are more personal or sensitive in nature should not be posted on Quercus Discussions; instead, contact your instructor during office hours or email sta355@course.utoronto.ca.
Please ensure that you communicate **politely** and **respectfully** with all members of the teaching team and your fellow classmates. When posting or responding on Quercus Discussions, please only type what you would be comfortable saying in person. The Quercus discussion board is a teaching and learning tool and should be used accordingly. Any posts that detract from the learning goals of the board will be removed to maintain a safe and productive space.

Use of artificial intelligence

This course policy is designed to promote your learning and intellectual development, helping you achieve the course's learning outcomes.
The use of generative artificial intelligence tools and apps is **strictly prohibited** in all course assessments (i.e., assignments, midterm and final exam) unless explicitly stated otherwise by the course instructor on assessment instructions. This includes ChatGPT, Copilot, Google Gemini, and other AI writing and coding assistants. Students may not copy or paraphrase from any generative artificial intelligence applications, including ChatGPT and other AI writing and coding assistants, for the purpose of completing assessments in this course. The use of generative AI in this course is considered the use of an unauthorized aid, which is a form of cheating.

Academic Integrity

The University treats cases of plagiarism and cheating very seriously. It is the students' responsibility for knowing the content of the University of Toronto's Code of Behaviour on Academic Matters. All suspected cases of academic dishonesty will be investigated following procedures outlined in the above document. If you have questions or concerns about what constitutes appropriate academic behaviour or appropriate research and citation methods, you are expected to seek out additional information on academic integrity from your instructor or from other institutional resources (see http://academicintegrity.utoronto.ca/). Here are a few guidelines regarding academic integrity:

- Being dishonest when reporting an illness or personal emergency to get an extension or accommodation is an academic offence.
- You may consult class notes/lecture slides during take-home assessments, however sharing or discussing questions or answers with other students is an academic offence.
- Students must complete all assessments individually. Working together is not allowed unless otherwise specified.
- Paying anyone else to complete your assessments for you is academic misconduct.
- Completing assessments for another student is academic misconduct.
- Sharing your answers/work/code with others is academic misconduct.
- All work that you submit must be your own! You must not copy mathematical derivations, computer output and input, or written answers, etc. from anyone or anywhere else. Unacknowledged copying or unauthorised collaboration will lead to severe disciplinary action, beginning with an automatic grade of zero for all involved and escalating from there. Please read the UofT Policy on Cheating and Plagiarism, and don't plagiarise.

Accomodations

The University of Toronto offers academic accommodations for students with disabilities. If you require accommodations, or have any accessibility concerns about the course, the classroom, or course materials, please contact Accessibility Services as soon as possible: accessibility.services@utoronto.ca or http://accessibility.utoronto.ca.