STA255H1 S LEC0101 20241:Statistical Theory

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Term:	Winter/Spring 2024
Time:	Tu 11am-1pm, Th 12-1pm Tutorial Th 11am-12pm
Lecture Locations:	NF 3 (Tu) BT 101 (Th)
Instructor:	Meredith Franklin, **meredith.franklin@utoronto.ca** **(mailto:meredith.franklin@utoronto.ca)**
Office:	700 University #9087
Office Hours:	Th 1-2pm after class and by appointment
Contact:	**sta255@utoronto.ca** **(mailto:sta255@utoronto.ca)**
TAs	Sebastian Calcetero (TUT104, VC101) Pak Hop Chan (TUT102, EM302) Dayi (David) Li (TUT105, NF113) Yuan Tian (TUT101, VC212) Yan Zhang (TUT103, NF119)

Course Description

This course deals with the mathematical and computational aspects of topics discussed in STA220. Students will become acquainted with the fundamental concepts of statistics, in both theory and

application, by using mathematics and statistical software to explore statistical techniques. In particular this course will cover: probability, discrete and continuous random variables, multivariate probability distributions, sampling distributions, methods of estimation, hypothesis testing, and linear regression.

Learning Objectives

In this course you will:

- Understand the mathematical ideas, principles, and considerations that are common to all statistical methods,
- Develop a basic statistical toolbox for the analysis of real data using statistical software,
- Develop statistical literacy, including the ability to recognize the importance of mathematics and statistical computing in data analysis and decision-making.

Prerequisites: STA220H1/STA221H1/ECO220Y1 (note: ECO220Y1 may be taken as a co-requisite), MAT133Y1(70%)/(MAT135H1,MAT136H1)/MAT137Y1/MAT157Y1
Exclusions: ECO227Y1/STA257H1/STA261H1/STA247H1/STA248H1

Course Notes

Lecture notes presented in class will be posted on Quercus

Discussion

We will use Piazza for discussion and Q&A **https://piazza.com/utoronto.ca/winter2024/sta255h** ⤷ **(https://piazza.com/utoronto.ca/winter2024/sta255h)** .

Technological Proficiency and Hardware/Software Required

Computation using R (downloaded from **http://cran.r-project.org** ⤷ **(http://cran.r-project.org)**) will be used throughout the semester. The RStudio interface will be used (**https://posit.co/** ⤷ **(https://posit.co/)**).

Textbook

- **<u>A Modern Introduction to Probability and Statistics, Understanding Why and How</u>**, 2005 F.M. *Dekking, C. Kraaikamp, H.P. Lopuhaa, L.E. Meeester*, Springer **<u>https://link.springer.com/book/10.1007/1-84628-168-7</u>** ⬚ **<u>(https://link.springer.com/book/10.1007/1-84628-168-7)</u>**

Supplementary Reference

- **<u>R for Data Science</u>,** 2023 *Hadley Wickham and Garrett Grolemund.* **<u>https://r4ds.hadley.nz/</u>** ⬚ **<u>(https://r4ds.hadley.nz/)</u>**

Tutorials

There will be weekly one-hour tutorial sessions throughout the term. The purpose of the tutorials is to work through problems applying the material learned in class with support from your TA and your peers to deepen your understanding of the course concepts. Although there are no grades for attendance/participation in your tutorials, you are strongly encouraged to attend your tutorials regularly and to ask your TA questions during tutorial. The tutorials are designed to help you with the quizzes and exams.

Assessments

Online Quizzes: Weekly quizzes (10) will be posted on Quercus on Thursdays and available until the due date of 11:59pm Sundays. They will cover that week's material. The quizzes are open-book but must be completed independently (no collaboration permitted – and absolutely no sharing and/or posting of questions and/or answers is permitted). Once you start the quiz, you will have exactly 60 minutes to complete and submit your answers. There are no extensions on the availability periods under any circumstances.

Midterm: There will be a 90 minute midterm (2 hours allotted) on February 15th (during class time) covering the material up to and including February 13th.

Final: There will be a 3-hour exam (mostly written answers) scheduled but the Faculty of Arts and Science during the April exam period. You must bring your student identification to the final exam. Information on coverage, along with some sample questions will be posted on Quercus in advance.

Grading Breakdown

Assignment	% of Grade
Online Quizzes (10)	20%
Midterm	30%
Final Exam	50%

* If your final exam grade is better than your midterm then the weighting will be 70% final, 10% midterm.

Course Schedule: A Weekly Breakdown

	Topics	Book Chapters	Activities
Week 1 January 9 January 11	Introduction, outcomes, events, probability	1-2	
Week 2 January 16	Counting, conditional probability	3	
January 18	Bayes Rule, Independence, Discrete random variables	3	Tutorial, Quiz*
Week 3 January 23	Discrete random variables and their distributions (con't)	4	
January 25	Continuous random variables and their distributions	5	Tutorial, Quiz*

Week 4

January 30	Expectation, variance	7	
February 1	Transformations of random variables	8	Tutorial, Quiz*

Week 5

February 6	Joint distributions	9	
February 8			Tutorial, Quiz*

Week 6

February 13	Review	1-9 (excluding ch 6)	
February 15	Midterm 11am-1pm: Room ES 1050 Last Names A-S; Room PB B250 Last Names T-Z.		Midterm

Week 7

February 20/22	Reading Week

Week 8

February 27	Covariance and correlation, computations with random variables	10-11	
March 1			Tutorial, Quiz*

Week 9

March 6	Asymptotics (LLN, CLT)	13-14	
March 8	Exploratory data analysis, basic models	15-17	Tutorial, Quiz*

Week 10

March 13	Estimators (bias, efficiency, MSE)	18-20	
March 15	Maximum Likelihood	21	Tutorial, Quiz*

Week 11

March 20	Least Squares	22	

| March 22 | Confidence Intervals | 23-24 | Tutorial, Quiz* |

Week 12

| March 27 | Hypothesis testing | 25 | |
| March 29 | Sampling distributions, the t-test | 26-28 | Tutorial, Quiz* |

Week 13

April 3

| | Wrap-up and review | | Tutorial, Quiz* |

April 5

* Quizzes are due the Sunday of that week at 11:59pm

Accommodations for Missed Assessments

- If the midterm is missed for a valid medical reason, you must email your instructor directly or through Quercus immediately, then submit the University of Toronto Verification of Student Illness or Injury form (**http://www.illnessverification.utoronto.ca (http://www.illnessverification.utoronto.ca)**) to your instructor within one week of the midterm. The form will only be accepted as valid if the form is filled out according to the instructions on the form. **The form must indicate that the degree of incapacitation on academic functioning is moderate, serious, or severe in order to be considered a valid medical reason for missing the midterm (and for quizzes, it must cover their entire availability period). If the form indicates that the degree of incapacitation on academic functioning is negligible or mild or does not cover the midterm date or quiz availability period, then this will NOT be considered a valid medical reason.**

- Other reasons for missing a midterm or quiz will require prior approval by your instructor. If approval is not granted in advance for non-medical reasons, then you will receive a grade of 0% for the missed midterm or quiz.

- Note: If you submit a quiz or write the midterm, it will be assumed that you deemed yourself fit enough to do so and your grade will stand as calculated. No accommodation will be made based on claims of medical, physical, or emotional distress after the fact.

- **Accommodation for missed quizzes** - There are no make-ups for quizzes. If accommodation is granted by the instructor for a missed quiz, the weighting for that quiz will be shifted to your final exam; otherwise 0% will be recorded for your missed quiz.

- **Accommodation for a missed midterm** – There will be a make-up midterm available only to students who missed the midterm for a valid medical reason. It will follow the same grading breakdown as above.

Statements on Academic Conduct and Support Systems

Academic Conduct

All suspected cases of academic dishonesty will be investigated following procedures outlined in the *Code of Behaviour on Academic Matters*. If you have questions or concerns about what constitutes appropriate academic behaviour or appropriate research and citation methods, please reach out to me. Note that you are expected to seek out additional information on academic integrity from me or from other institutional resources (for example, the **University of Toronto website on Academic Integrity (http://academicintegrity.utoronto.ca/)**).

Accommodations

The University provides academic accommodations for students with disabilities in accordance with the terms of the Ontario Human Rights Code. This occurs through a collaborative process that acknowledges a collective obligation to develop an accessible learning environment that both meets the needs of students and preserves the essential academic requirements of the University's courses and programs.

Students with diverse learning styles and needs are welcome in this course. If you have a disability that may require accommodations, please feel free to approach me and/or the Accessibility Services* office. **Accessibility Services on the St. George campus (https://studentlife.utoronto.ca/department/accessibility-services/)**

Religious Observances

The University provides reasonable accommodation of the needs of students who observe religious holy days other than those already accommodated by ordinary scheduling and statutory holidays. Students have a responsibility to alert members of the teaching staff in a timely fashion to upcoming religious observances and anticipated absences and instructors will make every reasonable effort to avoid scheduling tests, examinations or other compulsory activities at these times. Please reach out to me as early as possible to communicate any anticipated absences related to religious observances, and to discuss any possible related implications for course work.

Family Care Responsibilities

The University of Toronto strives to provide a family-friendly environment. You may wish to inform me if you are a student with family responsibilities. If you are a student parent or have family responsibilities, you also may wish to visit the Family Care Office website at **familycare.utoronto.ca (https://familycare.utoronto.ca/)** .

Intellectual Property Statement

Course material that has been created by your instructor (i.e. lecture slides, term test questions/solutions and any other course material and resources made available to you on Quercus) is the intellectual

property of your instructors and is made available to you for your personal use in this course. Sharing, posting, selling or using this material outside of your personal use in this course is not permitted under any circumstances and is considered an infringement of intellectual property rights.

Land Acknowledgement

A land acknowledgement is a way of honoring the Indigenous people who have lived and worked here for thousands of years, and whose land was colonized. It is also an invitation to reflect on the history of this land and we encourage you to consider the history of the land wherever you are now. **https://native-land.ca/** ⬀ **(https://native-land.ca/)**

Course Summary:

Date	Details	Due
Sun Jan 21, 2024	🚀 **Quiz 1** **(https://q.utoronto.ca/courses/337617/assignments/1205990)**	due by 11:59pm
Sun Jan 28, 2024	🚀 **Quiz 2** **(https://q.utoronto.ca/courses/337617/assignments/1205991)**	due by 11:59pm
Sun Feb 4, 2024	🚀 **Quiz 3** **(https://q.utoronto.ca/courses/337617/assignments/1205989)**	due by 11:59pm
Sun Feb 11, 2024	🚀 **Quiz 4** **(https://q.utoronto.ca/courses/337617/assignments/1205984)**	due by 11:59pm
Sun Mar 3, 2024	🚀 **Quiz 5** **(https://q.utoronto.ca/courses/337617/assignments/1205982)**	due by 11:59pm
Sun Mar 10, 2024	🚀 **Quiz 6** **(https://q.utoronto.ca/courses/337617/assignments/1205993)**	due by 11:59pm
Sun Mar 17, 2024	🚀 **Quiz 7** **(https://q.utoronto.ca/courses/337617/assignments/1205985)**	due by 11:59pm
	🚀 **Makeup Midterm Test** **(https://q.utoronto.ca/courses/337617/assignments/1205986)**	
	📝 **Midterm** **(https://q.utoronto.ca/courses/337617/assignments/1259744)**	

Date	Details	Due
	🚀 **Practice Final** [(https://q.utoronto.ca/courses/337617/assignments/1205988)](https://q.utoronto.ca/courses/337617/assignments/1205988)	
	🚀 **Quiz 10** [(https://q.utoronto.ca/courses/337617/assignments/1205987)](https://q.utoronto.ca/courses/337617/assignments/1205987)	
	🚀 **Quiz 8** [(https://q.utoronto.ca/courses/337617/assignments/1205992)](https://q.utoronto.ca/courses/337617/assignments/1205992)	
	🚀 **Quiz 9** [(https://q.utoronto.ca/courses/337617/assignments/1205983)](https://q.utoronto.ca/courses/337617/assignments/1205983)	