

# STA442H1 S: Methods of Applied Statistics

## Winter 2024

Mondays 10:00am - 12:00pm, *Sidney Smith Hall (SS), Room 1073*  
Wednesdays 11:00am - 12:00pm *371 Bloor Street West (FE), Room 230*

### Course Description

Advanced topics in statistics and data analysis with emphasis on applications. Diagnostics and residuals in linear models, introduction to generalized linear models, graphical methods, additional topics such as random effects models, designed experiments, model selection, analysis of censored data, introduced as needed in the context of case studies.

**Pre-reqs:** STA303H1/( STAC67H3, STAC51H3); CSC108H1/ CSC110Y1/ CSC120H1/ CSC148H1/ CSCA08H3/ CSCA48H3/ CSCA20H3/ CSC108H5/ CSC148H5. **Knowledge of programming with R is essential.**

### Instructor Team & Contact Information

**Instructor:** GWENDOLYN EADIE, PHD (*she/her*)

Assistant Professor of Astrostatistics, Department of Statistical Sciences and David A. Dunlap  
Department of Astronomy & Astrophysics

**Office Hours:**

Mondays 12:45pm - 1:15pm (in person, 700 University, 9th floor, Room 9080)

Tuesdays 2:10 - 3:00pm (over Zoom, see Quercus for link)

**E-mail:** gwen.eadie@utoronto.ca

**Teaching Assistants:** DAYI LI and RUI MAO

**Office Hours & location:** tbd

**E-mails:** dayi.li@mail.utoronto.ca and rui.mao@mail.utoronto.ca

We will use [Quercus](#) as our course website and for course announcements, and we will use [Piazza](#) for discussion. You can access Piazza from within Quercus. The syllabus, all course slides, assignments, announcements, grades, zoom link(s) for office hours, etc. will be posted on Quercus.

**If you have a general question about the course, course content, an assignment, etc., then please post a question to Piazza instead of emailing me or the TA, so that others can benefit from the response.** The TAs and I will check Piazza Mondays, Wednesdays, and Fridays by 5pm.

**Emails to myself (the instructor) are only for personal issues, questions, and/or concerns.** I will do my best to respond to emails within 2 working days, and I typically do not respond to emails outside of regular business hours. Due to high email volumes, I will not respond to questions that can be answered via Piazza, the syllabus, etc.

# Course Objectives & Intended Learning Outcomes

By the end of this course, students will be able to . . .

1. Understand that there are different goals to real data analysis and scientific problems (e.g. prediction versus inference).
2. Apply and assess the performance of linear models on real data
3. Understand and use methods of model evaluation and diagnostics in model assessment
4. Describe and explain the concepts of Bayesian inference to a classmate.
5. Write code and documentation for this code to perform regression in a variety of contexts.
6. Write their own, simple, Markov Chain Monte Marcov code.
7. Use and apply Bayesian inference packages such as Stan to real scientific problems.
8. Describe and give some example use cases of generalized linear models (GLMs).
9. apply and present graphical results of GLMs.
10. Use and understand limitations of real data, including missing data and measurement uncertainty.

## Textbooks & Library Resources

**Textbooks referenced in this course:**

- **GHV** = Gelman, Hill, and Vehtari *Regression and Other Stories*, Cambridge University Press (2021).
- **McE** = Richard McElreath *Statistical Rethinking*

**Other books of potential interest:**

- McCullagh, *Ten Projects in Applied Statistics*, Springer (2022)
- Faraway, *Linear Models with R*, 2nd edition, Chapman & Hall/CRC (2005)
- Faraway, *Extending the Linear Model*, Chapman & Hall/CRC (2006)
- Cox and Donnelly, *Principles of Applied Statistics*, Cambridge University Press (2011)
- McCullagh and Nelder, *Generalized Linear Models*, (1989)

## Schedule

Below is a tentative schedule of topics to be covered in class. The schedule is subject to change as needed. Lectures are in-person. The lectures will not be recorded nor distributed unless advised by university policies.

**Mondays:** typically 50 minutes of lecture, followed by a 10 min break. Then 50 minutes of a combination of lecture and/or in-class activities.

**Wednesdays:** typically 50 minutes of lecture and/or in-class activities.

Week	Date	Refs	Topic(s)
1	Jan 8, 10	Syllabus, GHV 6, 7, 8	Course overview and expectations. Review of regression models, common notation, linear regression with a single predictor, fitting regression models
2	Jan 15, 17	GHV 9, 10	Prediction, linear regression with multiple predictors
3	Jan 22, 24	GHV 11	Assumptions, diagnostics, and model evaluation
4	Jan 29, 31	GHV 12	Transformations and regression
5	Feb 5, 7	McE 1-3	overview of and intro to Bayesian inference
6	Feb 12 Feb 14	all above	MIDTERM EXAM Bayesian inference with m&m's chocolates
7	Feb 19, 21	—	<i>Reading Week</i>
8	Feb 26, 28	McE 9.1-9.2	Markov Chain Monte Carlo, Gibbs Sampling, Hamiltonian Monte Carlo, applications with Stan
9	Mar 4, 6	McE 10, 11, GHV 13	Generalized Linear Models (GLMs)
10	Mar 11, 13	GHV 14, 15	more applications of GLMs
11	Mar 18, 20	GHV 11, 22	Penalized regression, cross-validation, nonparametric regression
12	Mar 25, 27	GHV 17,22	Handling missing data
13	Apr 1, 3	McE 16	Bespoke statistical models for scientific inference
14-17	Apr 10-30	all above	FINAL EXAM (date TBD)

## Assessment & Grading

### Overview

- 25% Assignments
  - 4 Homeworks (5% each)
  - 1 Creative Assignment (5%)
- 30% Midterm Exam
- 45% Final Exam

**Homework Assignments:** typically assigned a week and a half before the due date. Submitted via Quercus (and Crowdmark).

**Creative Assignment:** equal in weight to a homework assignment. This is a chance for you to conceptualize and communicate what you have learned about any topic from the course through *any medium you wish*. For example, this could be a drawing, a poem, a creative writing piece, a song, a comic, a diorama, an animation, an infographic, a tiktok video, etc. This assignment will be marked based on (correctly) communicating concepts in a creative fashion. You must demonstrate some *effort* of creativity to receive full marks (i.e. the type of creativity and aesthetics will not be marked). No written reports, presentation slides, etc. Submitted via Quercus if possible, or directly to instructor by the due date.

**Midterm Exam:** given on Monday Feb 12 during regular class time in our regular classroom.

**Final Exam:** during the final exam period, to be scheduled by the university.

## Assessment Due Dates

Week	Due Date	Assessment
2	Jan 19	Homework 1
3	Jan 26	—
4	Feb 2	Homework 2
5	Feb 9	—
6	Feb 12	MIDTERM (Monday, 10am-12pm)
7	—	<i>(Reading Week)</i>
8	Mar 1	—
9	Mar 8	Homework 3
10	Mar 15	—
11	Mar 22	Homework 4
12	Mar 29	—
13	Apr 5	Creative Assignment
14-17	Apr 10 - 30	FINAL EXAM (date TBD)

## Late Assignments

All homework assignments and the creative assignment are due on Fridays. If you are unable to meet the Friday due date, you can submit your work by the following Monday by 4:59pm with no penalty. After this, no late assessments will be accepted unless there is a legitimate reason (e.g., accessibility accommodations, illness, emergency, etc.).

## Missed Assessment Policy

The University of Toronto now has an ACORN Absence Declaration Tool for missed coursework. The tool can be used to declare an absence *once* per academic term (e.g., the winter term) for a maximum period of seven (7) consecutive calendar days. The ACORN Absence Declaration Tool helps you create an official record of your absence that is used to support a request for academic consideration in your courses, without the need to present additional supporting documentation. More info here: <https://registrar.utoronto.ca/policies-and-guidelines/absence-declaration/>

**For all missed assessments:** Please fill out the following form: <https://forms.office.com/r/tJ7a769H9n>. Requests made only through email will not be accepted.

**Missed Assignments:** Please fill out the form above by 4:59pm ET on the Monday after the due date. If only one assignment is missed, then the 5% for that missed assignment will be transferred to the other homework assignments. Beyond this, missed assignments will be given a mark of 0 unless there are extenuating circumstances (e.g., illness, emergency, etc.). In the latter case, please also fill out the form above and the instructor will provide accommodations on a case-by-case basis.

**Missed Midterm:** If you miss the midterm due to illness, emergency, etc. then please use the form above within 72 hours of the midterm date. The instructor will provide accommodations on a case-by-case basis (the format of the accommodation is at the discretion of the instructor, and could be in the form of a make-up test or an oral interview, etc.).

**Missed Final Exam:** Students who do not write their final exam will need to petition for a deferred final exam. Instructors and units cannot excuse a student from writing a final exam nor can they offer an alternative date or format of examination.

# Academic Integrity

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).

The following is a statement directly from Appendix D of the Academic Integrity Handbook: “Academic integrity is one of the cornerstones of the University of Toronto. It is critically important both to maintain our community which honours the values of honesty, trust, respect, fairness and responsibility and to protect you, the students within this community, and the value of the degree towards which you are all working so diligently.” Section B of the University of Toronto’s Code of Behaviour on Academic Matters (<https://governingcouncil.utoronto.ca/secretariat/policies/code-behaviour-academic-matters-july-1-2019>) lists common offenses. For example, it is an offence for students to:

- use someone else’s ideas or words in their own work without acknowledging that those ideas/words are not their own with a citation and quotation marks, i.e. to commit plagiarism
- include false, misleading or concocted citations in their work.
- obtain unauthorized assistance on any assignment. To provide unauthorized assistance to another student. This includes showing another student completed work.
- submit their own work for credit in more than one course without the permission of the instructor.
- falsify or alter any documentation required by the University. This includes, but is not limited to, doctor’s notes.
- use or possess an unauthorized aid in any test or exam.

There are other offences covered under the Code, but these are by far the most common. Please respect these rules and the values which they protect.” More information can also be found here: <https://www.academicintegrity.utoronto.ca>

**All of your assignments will be submitted through Quercus, and will be submitted through the University’s plagiarism detection tool.** Normally, students will be required to submit their course essays to the University’s plagiarism detection tool for a review of textual similarity and detection of possible plagiarism. In doing so, students will allow their essays to be included as source documents in the tool’s reference database, where they will be used solely for the purpose of detecting plagiarism. The terms that apply to the University’s use of this tool are described on the Centre for Teaching Support & Innovation web site (<https://uoft.me/pdt-faq>).

## Generative Artificial Intelligence Tools (e.g. ChatGPT)

Generative Artificial Intelligence (AI) Tools are prevalent nowadays. In this course,

- **The knowing use of generative AI tools**, including ChatGPT and other AI writing and coding assistants, for the completion of, or to support the completion of, an examination, term test, assignment, or any other form of academic assessment, **may be considered an academic offense in this course.**
- **Students may not copy or paraphrase from any generative AI applications**, including ChatGPT and other AI writing and coding assistants, for the purpose of completing assignments in this course.

**As a final note on AI-use:** Beware and be critical/skeptical of answers given by AI tools! It has been shown that tools such as ChatGPT provide very convincing but ultimately totally incorrect explanations about some topics.

## Accessibility Services and 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:

<https://studentlife.utoronto.ca/department/accessibility-services/>

**phone: 416-978-8060**

**email: [accessibility.services@utoronto.ca](mailto:accessibility.services@utoronto.ca)**

The University of Toronto supports reasonable accommodation of the needs of students who observe religious holy days other than those already accommodated by ordinary scheduling and statutory holidays. As mentioned on the webpage below, please let me know if you require accommodations or expect absences, and I will make every reasonable effort to avoid scheduling compulsory activities at these times. More information can be found here:

<https://www.viceprovoststudents.utoronto.ca/policies-guidelines/accommodation-religious/>.

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](http://familycare.utoronto.ca).

## Equity, Diversity, and Inclusion

The University of Toronto is committed to equity, human rights and respect for diversity. All members of the learning environment in this course should strive to create an atmosphere of mutual respect where all members of our community can express themselves, engage with each other, and respect one another's differences. U of T does not condone discrimination or harassment against any persons or communities.

## Land Acknowledgement

*We wish to acknowledge this land on which the University of Toronto operates. For thousands of years it has been the traditional land of the Huron-Wendat, the Seneca, and the Mississaugas of the Credit. Today, this meeting place is still the home to many Indigenous people from across Turtle Island and we are grateful to have the opportunity to work on this land.*