



Course Outline

Topics in Statistics: Applied Bayesian Statistics

STAT*4050/6920

Winter 2024

1) General information

Course Description: (0.5 credits)

This course will be an applied statistics course from the perspective of the Bayesian. We will introduce the Bayesian framework as an intuitive framework for statistical analysis, with an emphasis on modern applied techniques from a conceptual perspective. Topics in this course include:

- The practical differences between Bayesian and frequentist statistics
- Prior beliefs, updating, and statistical evidence
- Bayesian hierarchical models
- Bayesian computation
- The Bayesian workflow – model building and checking

The main tool for analysis in this course will be Stan, a probabilistic programming language designed for Bayesian inference. No prior experience with Stan is assumed, but students should have experience with R or a similar language. I will assume that students have prior experience with statistical modelling (linear regression models and GLMs as seen in STAT*3240, STAT*3510, POPM*6210*01 or similar) and some experience with mathematical statistics (expectations, conditional probability, and probability distributions as seen in STAT*3100 or similar). Graduate students will have additional responsibilities.

Instructor: Dr. Justin Slater

Email: jslate04@uoguelph.ca

Office hours: Tues/Thurs 10:00am - 11:00am in MACN 521

Lecture day/time: Tues/Thurs 8:30am - 9:50am in MCKN 226

Prerequisites: STAT*3110, STAT*3240

2) Learning Outcomes

After successfully completing this course, students will be able to:

- Understand potential advantages and disadvantages to using Bayesian statistics to solve real-world problems.
- Use posterior samples from a Bayesian model to answer scientific questions.
- Implement a basic Markov Chain Monte Carlo algorithm from scratch.
- Fit, assess, and interpret complex statistical models using state-of-the-art Bayesian inference software (Stan).
- Create reproducible data analysis reports using R Markdown.

3) Assessments:

A schedule of assessments and their tentative due dates is shown below:

Course Component	Tentative Due Date	Weight
Assignment 1	Jan 25 th at 11:59pm	15% each Total: 60%
Assignment 2	Feb 16 th at 11:59pm	
Assignment 3	March 8 th at 11:59pm	
Assignment 4	March 29 th at 11:59pm	
Project	April 5 th (proposal) April 15 th (report)	Proposal 5% Report 35% Total: 40%

Assignments are to be submitted on Courselink and will include additional questions for STAT*6920 students.

The expectations of STAT*6920 students' projects will be higher than those of STAT*4050 students. Details will be provided in the project rubric, which will be posted on Courselink some time in the middle of the semester.

4) Course Resources

Course Website

Course material, news, announcements, and grades will be posted to the STAT*4050/6290 Courselink website. You are responsible for checking this site regularly.

Course Notes:

Incomplete notes in the form of lecture slides, and incomplete R code will be provided prior to each lecture. It is expected that students attend lecture and complete the notes/code themselves. Completed lecture slides will not be posted afterwards. If a student misses a lecture, it is their responsibility to catch up on what they have missed. **Course materials, including lecture notes, assessments, and R code are not for redistribution without my permission.**

Recommended Textbooks:

Easier: McElreath, Richard. *Statistical rethinking: A Bayesian course with examples in R and Stan (2nd edition)*. Chapman and Hall/CRC, 2020.

More advanced: Gelman, Andrew, John B. Carlin, Hal S. Stern, and Donald B. Rubin. *Bayesian data analysis (3rd edition)*. Chapman and Hall/CRC, 2014.

Both books are fabulous references. BDA3 is freely available online. Recommended readings will be assigned from these two books (along with other freely available sources).

R resources:

- R and Rstudio: <https://rstudio-education.github.io/hopr/starting.html>
- Rmarkdown: <https://rmarkdown.rstudio.com/>

A variety of R-packages will be introduced throughout the course.

5) Course Policies

Auditors:

For auditors to receive credit in this course, they must complete all 4 assignments. They will be marked for completion only.

Email etiquette:

Students are expected to check their *@uoguelph.ca* email regularly, as this is the official mode of communication between the University and its students. Students may email the instructor but must **include STAT*4050 OR STAT*6290 in the subject line, otherwise your email may be ignored.**

Grading Policies:

Assignments: The assignments are due at 11:59pm on the due date and are to be completed independently. A single compiled pdf, alongside the code that produced that pdf are to be submitted on Dropbox through Courselink. I expect your assignments to be reproducible, meaning that I should be able to compile your code and reproduce your pdf with minimal effort. If you can't hand in an assignment on time because of a valid reason, you must contact me as soon as possible to discuss a potential accommodation.

Discussing problems with your classmates or using search engines/chatbots is encouraged in this class, as this is how you solve problems in the real world. **However, any work that you submit must be entirely your own.** Academic dishonesty, such as plagiarism (including copying all or part of an assignment) and impersonation is grounds for loss of course credit and dismissal.

Late assignments and project components will be penalized at 5% per day up to 3 days. An assignment/project component that is more than 3 days overdue will receive a grade of 0, unless an accommodation is granted.

When you cannot meet a course requirement:

If you find yourself unable to meet a course requirement because of illness or compassionate reasons, please advise the instructor in writing (email), with your name and student id.

Medical notes are generally not required for singular instances of academic consideration, although students may be required to provide supporting documentation for multiple missed assessments or when involving a large part of the course (e.g final report).

Accessibility:

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodations is a shared responsibility of the University, the instructor, and the student. The instructor will do their best to accommodate accessibility needs of the student. The student a, email or approach the instructor with your accessibility concerns.

If the instructor is unable to accommodate the student, or if the student wants a formal accommodation, the student should register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required, however, interim accommodation may be possible while that is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to make a booking at least 14 days in advance, and no later than November 1 (fall), March 1 (winter) or July 1 (summer). Similarly, new or changed accommodations for online quizzes, tests and exams must be approved at least a week ahead of time.

More information: www.uoguelph.ca/sas

Important dates:

The University published important dates for the winter semester here:

<https://calendar.uoguelph.ca/graduate-calendar/schedule-dates/winter-semester/>

The last day to drop this course without academic penalty is April 8.

Course Evaluations:

Students are provided an opportunity to provide course feedback via a formal course evaluation in the last two weeks of the semester. Your instructor will inform you of when these are available. Note that evaluations will not be reviewed until after your instructor has submitted your final grades.

Academic Integrity

The University of Guelph is committed to upholding the highest standards of academic integrity, and it is the responsibility of all members of the University community—faculty, staff, and students—to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff, and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection. Please note: Whether a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

Graduate Calendar – Academic Misconduct

https://www.uoguelph.ca/registrar/calendars/graduate/2018-2019/genreg/sec_d0e2632.shtml

Online behaviour

Inappropriate online behaviour will not be tolerated. Examples of inappropriate online behaviour include:

- Posting inflammatory messages about your instructor or fellow students
- Using obscene or offensive language online

- Copying or presenting someone else's work as your own
- Adapting information from the Internet without using proper citations or references
- Buying or selling term papers or assignments
- Posting or selling course materials to course notes websites
- Having someone else complete your quiz or completing a quiz for/with another student
- Making false claims about lost quiz answers or other assignment submissions
- Threatening or harassing a student or instructor online
- Discriminating against fellow students, instructors or TAs
- Using the course website to promote profit-driven products or services
- Attempting to compromise the security or functionality of the learning management system

Recording of materials:

Any presentation made in relation to coursework may not be recorded without permission from the presenter. Material recorded with permission is restricted to use for this course unless further permission is granted.

Saving assessments

Please save copies of your assessments. You may be asked to resubmit your work at any time.

6) Mental Health services

One out of every five students in Canada experiences some sort of mental health issue at some point in their academic career. If you find yourself facing a mental health crisis, or just need to talk to someone, please consider taking advantage of one of the following resources available to University of Guelph students:

Counselling Services: Visit the Counselling Services website (<https://wellness.uoguelph.ca/counselling>) to get information on resources available to you, both online and in-person. You can also visit them at Health Services (J.T. Powell Building, ext 53244) where they offer individual and group counselling sessions by appointment or walk-in.

Student Support Network: is in the Wellness & Education Promotion Centre in the J.T. Powell Building and offers confidential, peer-based, drop-in support.

Good2Talk: (1-866-925-5454) is a free, 24/7 student hotline that provides professional counselling and referrals for mental health, addictions and well-being.

Here 24/7: (1-844-437-3247) specializes in assessment, referral and appointment booking and is available 24/7 for crisis support.

You are not alone, and you will not be judged for asking for help.