

Faculty of Science Course Syllabus (Section A)
Department of Biology and Department of Mathematics and Statistics
BIOL4069/STAT3069 Statistical Rethinking: Applied Bayesian Statistics
Fall 2021-2022

Dalhousie University is located in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq. We are all Treaty people.

Instructor(s): Aaron MacNeil a.macneil@dal.ca Office hours by email appointment LSC 7088

Lectures: M/W/F 1035-1125 HENRY HICKS 217

Laboratories: None

Tutorials: None

Course delivery: *In-person (online asynchronous as needed) – Note the course will be taught Monday and Wednesday, with Friday used for questions and homework review in a tutorial format, or lecture overflow as needed.*

Course Description

Applied Bayesian statistics using Richard McElreath's popular 'Statistical Rethinking' book, this course provides a broad introduction to applied Bayesian models using R or Python. Examples are drawn from Biology and Social Science examples, in contexts designed to be widely applicable to analysis of observational data across disciplines.

Course Prerequisites

STAT 2060 OR STAT 2080 AND One of: STAT 2450, CSCI 2202, BIOL 3872, or MARI 4600 **Course Exclusion**

Learning Objectives

Students will learn principles of basic modelling theory and Bayesian probability, how to code a Bayesian statistical model, model checking, causal inference, and how to handle hierarchical data structures. The course is designed to give students the tools needed to go off and fit coherent Bayesian models of their own, being confident that they are using the right model for the inferences they wish to make.

Upon completion, students are expected to be capable of:

1. Developing basic Bayesian statistical models across a wide-range of data
2. Interrogating their own models for lack of convergence, model fit, and calibration
3. Generating and apply causal diagrams for causal modelling

Course Materials

- 'Statistical Rethinking' 2nd Ed. Richard McElreath
- *Course Brightspace page: <https://dal.brightspace.com/d2l/home/187199>*

For online/blended course delivery, indicate

- *minimum technology required for course (e.g., laptop, mic, camera, software)*
- *online via brightspace and MS Teams*

Course Assessment

Assessment	Weight (% of final grade)	Date
<i>Weekly homework: One per week (6% each) total of 60%</i>		<i>Due Friday in tutorial</i>
<i>Assignments: Two take-home assignments (20% each) total of 40%</i>		<i>See lecture schedule</i>

Other course requirements

Attendance in class is strongly recommended to review assigned homework.

Conversion of numerical grades to Final Letter Grades follows the Dalhousie Common Grade Scale

A+ (90-100)	B+ (77-79)	C+ (65-69)	D	(50-54)
A (85-89)	B (73-76)	C (60-64)	F	(<50)
A- (80-84)	B- (70-72)	C- (55-59)		

Assignment Grading Rubric

Criteria	Indicators
Format (30%)	Student follows assignment guidelines; code is reproducible and submitted via Brightspace. Full marks given for code that matches all guideline requirements, is submitted via Brightspace, and can be run from another computer without error.
Clarity (20%)	Submitted code is human-readable and can be interpreted easily. Full marks are given for code that is clearly annotated on each line that contains a new procedure, whereby a code-reader can understand clearly what each code block does.
Parsimony (20%)	Submitted code uses a minimum number of steps and follows guidelines from lectures or innovates a better approach. Full marks are given for code that cannot be reduced in length by common conventions taught in class.
Accuracy (30%)	Submitted code accurately reflects underlying data, matching key summary statistics to expected values. Full marks are given for results that closely match those produced by the course instructor.

Course Policies on Missed or Late Academic Requirements

Late homework or assignments are not accepted, with exceptions made on a case-by-case basis for illness, bereavement etc. Students granted an exception will be allowed to submit the work before the end of term.

Course Policies related to Academic Integrity

Plagiarism, cheating, and other misconduct are serious violations of your contract as a Dalhousie student. You are expected to know and abide by [Dalhousie's policies regarding academic misconduct](#). Violations of these policies will be dealt with according to the Faculty [Discipline Process](#).

For this course, plagiarism is defined as code that is identical or eerily similar to that of other students - programmers develop code that reflect their individual styles and these conventions are easily recognized. You are absolutely encouraged to collaborate and consult online forums such as [Stack Overflow](#) for assignments, however submitted work must be your own effort, with **sources of borrowed code clearly indicated in script comments**.

Course Content

September 8: W1L1: The Golem of Prague: Models and why they exist

September 10: W1L2: Garden of Forking Data: From counting outcomes to Bayesian probability

September 13: W2L1: Geocentric Models: Why normal dominates the world

September 15: W2L2: Wiggly Orbits: Building blocks for the real world

September 17: Tutorial

September 20: W3L1: Spurious Waffles: Domain knowledge in model building

September 22: W3L2: Haunted DAG: Causal model building

September 24: Tutorial

September 27: W4L1: Ulysses' Compass: Model validation

September 29: W4L2: Model Comparison: How to decide what to use

October 1: Tutorial

October 4: W5L1: Conditional Manatees: Interactions all the way down

October 6: W5L2: Miracles of Doom: Markov Chain Monte Carlo and how to sample

October 8: Tutorial. [Assignment 1](#): Implementing Bayesian models I - Due Monday October 18th

October 11: Thanksgiving

October 13: W6L1: Maximum entropy & GLMs: Principles of information content

October 15: W6L2: God Spiked the Integers: Binomial & Poisson GLMs

October 18: W7L1: Monsters & Mixtures: Poisson GLMs, survival, zero-inflation

October 20: W7L2: Ordered Categories, Left & Right: Models for politics and social science

October 21: Tutorial

October 25: W8L1: Multilevel Models: Foundations of modern inference

October 27: W8L2: Multilevel Models 2: Building the house

October 29: Tutorial

November 1: W9L1: Adventures in Covariance: Correlation and how to deal with it

November 3: W9L2: Slopes, Instruments and Social Relations: Causal advances

November 5: Tutorial

November 8: Fall Break



November 15: W10L1: Gaussian Processes: Flexible models and what they mean

November 17: W10L2: Missing Values and Measurement Error: Observation-based science

November 19: Tutorial

November 22: W11L1: Generalized linear madness: algebraic models

November 24: W11L2: Ordinary differential models

November 26: Tutorial

November 29: W12L1: Bayesian workflow: before sunrise

December 1: W12L2: Bayesian workflow: after sunset

December 3: Tutorial. Assignment 2: Implementing Bayesian models II - Due December 17th

Faculty of Science Course Syllabus (Section B) (revised June-2021)**Fall/Winter 2021-22***STAT3069 / BIOL 4069*

Please ensure that the following information on University Policies is available to all students in your course. This document should be sent to students in your course along with your Course Syllabus, Section A, or may be copied into your **Course Syllabus (Section A)**.

University Policies and Statements

This course is governed by the academic rules and regulations set forth in the University Calendar and by Senate

Academic Integrity

At Dalhousie University, we are guided in all of our work by the values of academic integrity: honesty, trust, fairness, responsibility and respect (The Center for Academic Integrity, Duke University, 1999). As a student, you are required to demonstrate these values in all of the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity.

Information: https://www.dal.ca/dept/university_secretariat/academic-integrity.html

Accessibility

The Advising and Access Services Centre is Dalhousie's centre of expertise for student accessibility and accommodation. The advising team works with students who request accommodation as a result of a disability, religious obligation, or any barrier related to any other characteristic protected under Human Rights legislation (Canada and Nova Scotia).

Information: https://www.dal.ca/campus_life/academic-support/accessibility.html

Student Code of Conduct

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner—perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution.

Code: https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html

Diversity and Inclusion – Culture of Respect

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness

Statement: <http://www.dal.ca/cultureofrespect.html>

Recognition of Mi'kmaq Territory

Dalhousie University would like to acknowledge that the University is on Traditional Mi'kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel and support. Visit or e-mail the Indigenous Student Centre (1321 Edward St) (elders@dal.ca).

Information: https://www.dal.ca/campus_life/communities/indigenous.html

Important Dates in the Academic Year (including add/drop dates)

https://www.dal.ca/academics/important_dates.html

University Grading Practices

https://www.dal.ca/dept/university_secretariat/policies/academic/grading-practices-policy.html

Please ensure that the following information on Student Resources is available to all students in your course. This document should be made available to students on the course Brightspace page, or elements may be copied into your [Course Syllabus](#).

Student Resources and Support

Advising

General Advising https://www.dal.ca/campus_life/academic-support/advising.html

Science Program Advisors: <https://www.dal.ca/faculty/science/current-students/academic-advising.html>

Indigenous Student Centre: https://www.dal.ca/campus_life/communities/indigenous.html

Black Students Advising Centre: https://www.dal.ca/campus_life/communities/black-student-advising.html

International Centre: https://www.dal.ca/campus_life/international-centre/current-students.html

Academic supports

Library: <https://libraries.dal.ca/>

Writing Centre: https://www.dal.ca/campus_life/academic-support/writing-and-study-skills.html

Studying for Success: https://www.dal.ca/campus_life/academic-support/study-skills-and-tutoring.html

Copyright Office: <https://libraries.dal.ca/services/copyright-office.html>

Fair Dealing Guidelines <https://libraries.dal.ca/services/copyright-office/fair-dealing.html>

Other supports and services

Student Health & Wellness Centre: https://www.dal.ca/campus_life/health-and-wellness/services-support/student-health-and-wellness.html

Student Advocacy: <https://dsu.ca/dsas>

Ombudsperson: https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/where-to-get-help/ombudsperson.html

Safety

Biosafety: <https://www.dal.ca/dept/safety/programs-services/biosafety.html>

Chemical Safety: <https://www.dal.ca/dept/safety/programs-services/chemical-safety.html>

Radiation Safety: <https://www.dal.ca/dept/safety/programs-services/radiation-safety.html>

Scent-Free Program: <https://www.dal.ca/dept/safety/programs-services/occupational-safety/scent-free.html>

Dalhousie COVID-19 information and updates: <https://www.dal.ca/covid-19-information-and-updates.html>