Statistical Methods for Data Analysis and Inference Syllabus

Department of Mathematics and Statistics

STAT 2080 / MATH 2080 Winter 2024

Dalhousie University acknowledges that we are in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq People and pays respect to the Indigenous knowledges held by the Mi'kmaq People, and to the wisdom of their Elders past and present. The Mi'kmaq People signed Peace and Friendship Treaties with the Crown, and section 35 of the Constitution Act, 1982 recognizes and affirms Aboriginal and Treaty rights. We are all Treaty people.

Dalhousie University also acknowledges the histories, contributions, and legacies of African Nova Scotians, who have been here for over 400 years.

Course Instructor(s)

Name	Email	Office Hours
Mike Dowd	michael.dowd@Dal.Ca	MWF, 10:30-11:30, Learning Centre
Joanna Mills Flemming	Joanna.Flemming@Dal.Ca	MWF, 10:30-11:30, Chase 103

This course will be team taught by Professors Dowd and Mills Flemming. Professor Dowd will teach both sections for the first half of the term, and Professor Mills Flemming the second half.

Course Description

This course introduces techniques for data analysis and statistical inference commonly used in the experimental sciences. Major topics include one-way and two-way analysis of variance, simple and multiple regression, as well as parametric and non-parametric statistical tests (see detailed list of topics later in this document).

Course Prerequisites

STAT 1060 or STAT 2060 or DISP.

The material you are expected to be familiar with prior to taking this course is the following:

- Computation and use of various measures of central tendency and variability,

- preparation and interpretation of graphical displays of data such as boxplots, histograms, and scatterplots,
- normal and t distributions and the use of tables for these distributions,
- the difference between populations and samples, parameters, and estimates,
- the concept of sampling distributions and why they are important,
- construction and interpretation of confidence intervals,
- elements of hypothesis testing, including the formation of null and alternative hypotheses and the computation and interpretation of p-values.

Course Exclusions

COMM2502, MGMT 2502, ECON 2280.

Student Resources

A primary resource for extra help is the Mathematics and Statistics Learning Centre in Rm 119 of the Chase Building. It is fully staffed by senior and undergraduate and graduate students who are able to assist you with STAT 2080 content. Please take full advantage of this important resource. For the current schedule please see: https://www.dal.ca/faculty/science/math-stats/about/learning-centre.html.

Course Structure

Course Delivery

This course will be delivered **in-person**. However, in the event of unforeseen events (e.g., public health matters, instructor illness, bad weather), a Zoom link will be provided, and any affected lectures will be delivered online. Students will be informed in advance via Brightspace.

Lectures

Section 1: MWF 9:35-10:25, in LSC C236.

Section 2: MWF 11:35-12:25 in LSC C236.

Tutorial

Thursday 17:35-18:25, DUNN 117.

Course Materials

1. There is no required text for this course. However, some course notes are provided. The books used for STAT 1060 (Stats, Data and Models by DeVeaux, Velleman and Bock), and STAT 2060 (Probability and Statistics by J. Devore) are good references.
2. There is a Brightspace site for the course, in which you are automatically enrolled. Brightspace is used for posting course materials, and communications regarding course logistics.
3. The LON-CAPA (Learning Online Network with Computer-Assisted Personalized Approach) e-learning software is used for assignments.
4. Statistical software is required for this course. We use the R programming language. This state-of-the-art open-source statistical package is available from www.r-project.org for Mac OS, Windows, and Linux. An integrated development environment for R called R-Studio is also used and can be downloaded at posit.co (note that most students use R-studio). The dynamic report generator embedded within R-Studio, called R-markdown, is used for Activities.

Assessment

Component	Weight (% of final grade)	Due Date
Test 1	*15%*	***Wednesday, Feb 7, 2024***
Test 2	*15%*	***Wednesday, Mar 13, 2024***
Final exam	*40%*	*(Scheduled by Registrar)*
Assignments (8)	*20%*	***Jan 19, Jan 26, Feb 2, Feb 16***
		Mar 1, Mar 8, Mar 22, Mar 29
Activities (2)	*10%*	***Jan 15, Apr 5***

- The midterms (50 minutes each) take place **in class** on February 7 and March 13.

- The final exam is a handwritten 3-hour exam and takes place during the regular exam period as scheduled by the registrar.

- Assignments are computer-based and will be done using the CAPA software. They are due on a weekly basis (except for those weeks with tests). Assignment 0 is for practice and does not contribute to your grade. **All other assignments have equal value.**

- Activities will be based on exploring course materials and concepts using R and R-markdown scripts. **Both activities have equal value**.

Other course requirements

There is a weekly tutorial that takes place Thursdays 17:35-18:25 in Dunn 117. There are no marks associated with this tutorial. The tutorial is given by the Teaching Assistant for the course. Its primary purpose is to review assignment materials, and to aid with using statistical software. Tutorials are not mandatory, but you are **strongly encouraged to attend**.

Conversion of numerical grades to final letter grades follows the
Dalhousie Grade Scale

A+ (90-100)	B+ (77-79)	C+ (65-69)	D (50-54)
A (85-89)	B (73-76)	C (60-64)	F (0-49)
A- (80-84)	B- (70-72)	C- (55-59)	

Course Policies on Missed or Late Academic Requirements

- *Assignments:* Late assignments will receive a zero grade. The assignments are online and have a specific time and date they are due. Don't wait until the last minute to submit them, as unexpected technical difficulties often arise.

- *Activities:* If you do not submit an Activity by the due date, you will receive a zero grade.

- *Tests:* If a test is missed for a legitimate reason (e.g., illness), please inform us on the day of the test by emailing the professor and submitting a Student Declaration of Absence form. The value of the test will then be assigned to that of the final exam (e.g., if you miss only Test 1, then your final exam will be worth 55%). If either test is missed without a legitimate excuse, or you fail to inform us of your absence, you will receive a zero grade. There will be no makeup tests.

- *Final Exam:* Proper documentation for an absence is required.

Course Policies related to Academic Integrity

Students are expected to complete their assignments independently.

Learning Objectives

The main objective of this course is to provide a solid practical grounding in data analysis and the foundational statistical methods that one will encounter in scientific research. Towards this end, the central emphasis of the course is on Analysis of Variance (ANOVA) and Linear Regression.

Outcomes:

- A full understanding of the statistical comparison of two means using both parametric and non-parametric methods.

- A thorough understanding of one-way and two-way analysis of variance (including assumptions, setup, calculations of key quantities, interpretation, and post-hoc diagnostics).

- A thorough understanding of correlation as a measure of dependence, including both parametric (Pearson's) and non-parametric (Spearman's) measures of correlation.

- A basic understanding of regression methods for both simple linear regression and multiple regression (assumptions, key quantities and formulae, implementation, interpretation, and graphical assessment via residuals).

- Experience with the statistical analysis of categorical/count data in one-way and two-way tables (e.g., chi-squared tests and contingency tables).

- The ability to use and interpret output from modern statistical software packages.

Course Content

Listed below are the topics that are covered in this course. Note that these may be altered slightly as the term progresses.

- Inference: hypothesis testing and confidence intervals
- Comparison of two means: paired samples and independent samples
- Comparison of two means: permutation test, Wilcoxon rank-sum test
- One-way analysis of variance (ANOVA)
- Bonferroni method for multiple comparisons
- Assessing and verifying statistical model assumptions
- Non-parametric one-way ANOVA: Kruskal-Wallis test
- Two-way ANOVA without interaction
- Two-way ANOVA with interaction, Randomized block designs, post-hoc comparisons of means
- Categorical data, multinomial distribution, and goodness of fit test
- Chi-squared tests and contingency tables
- Scatterplots, Pearson's correlation, Spearman's rank correlation
- Regression and least squares estimators
- Coefficient of determination, residual plots, remedies, and transformation
- Inference in regression
- Multiple regression basics, hypothesis testing and inference
- ANOVA for regression

University Policies and Statements

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 at 1321 Edward St or elders@dal.ca. Additional information regarding the Indigenous Student Centre can be found at: https://www.dal.ca/campus_life/communities/indigenous.html

Internationalization

At Dalhousie, 'thinking and acting globally' enhances the quality and impact of education, supporting learning that is "interdisciplinary, cross-cultural, global in reach, and orientated toward solving problems that extend across national borders." Additional internationalization information can be found at: https://www.dal.ca/about-dal/internationalization.html

Academic Integrity

At Dalhousie University, we are guided in all our work by the values of academic integrity: honesty, trust, fairness, responsibility, and respect. As a student, you are required to demonstrate these values in all 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. Additional academic integrity information can be found at: https://www.dal.ca/dept/university_secretariat/academic-integrity.html

Accessibility

The Student Accessibility Centre is Dalhousie's centre of expertise for matters related to student accessibility and accommodation. If there are aspects of the design, instruction, and/or experiences within this course (online or in-person) that result in barriers to your inclusion, please contact the Student Accessibility Centre (https://www.dal.ca/campus_life/academic-support/accessibility.html) for all courses offered by Dalhousie with the exception of Truro. For courses offered by the Faculty of Agriculture, please contact the Student Success Centre in Truro (https://www.dal.ca/about-dal/agricultural-campus/student-success-centre.html)

Conduct in the Classroom – Culture of Respect

Substantial and constructive dialogue on challenging issues is an important part of academic inquiry and exchange. It requires willingness to listen and tolerance of opposing points of view. Consideration of individual differences and alternative viewpoints is required of all class members, towards each other, towards instructors, and towards guest speakers. While expressions of differing perspectives are welcome and encouraged, the words and language used should remain within acceptable bounds of civility and respect.

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 (Strategic Priority 5.2). Additional diversity and inclusion information can be found at: http://www.dal.ca/cultureofrespect.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. The full Code of Student Conduct can be found at:
https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html

Fair Dealing Policy

The Dalhousie University Fair Dealing Policy provides guidance for the limited use of copyright protected material without the risk of infringement and without having to seek the permission of copyright owners. It is intended to provide a balance between the rights of creators and the rights of users at Dalhousie. Additional information regarding the Fair Dealing Policy can be found at: https://www.dal.ca/dept/university_secretariat/policies/academic/fair-dealing-policy-.html

Originality Checking Software

The course instructor may use Dalhousie's approved originality checking software and Google to check the originality of any work submitted for credit, in accordance with the Student Submission of Assignments and Use of Originality Checking Software Policy. Students are free, without penalty of grade, to choose an alternative method of attesting to the authenticity of their work and must inform the instructor no later than the last day to add/drop classes of their intent to choose an alternate method. Additional information regarding Originality Checking Software can be found at:

https://www.dal.ca/dept/university_secretariat/policies/academic/student-submission-of-assignments-and-use-of-originality-checking-software-policy-.html

Student Use of Course Materials

Course materials are designed for use as part of this course at Dalhousie University and are the property of the instructor unless otherwise stated. Third party copyrighted materials (such as books, journal articles, music, videos, etc.) have either been licensed for use in this course or fall under an exception or limitation in Canadian Copyright law. Copying this course material for distribution (e.g. uploading to a commercial third-party website) may lead to a violation of Copyright law.