

Faculty of Science Course Syllabus

Department of Mathematics & Statistics

STAT 2080 / MATH 2080

Statistical Methods for Data Analysis and Inference

Fall 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.

Instructor:

Bruce Smith, *email:* bruce.smith@dal.ca, *office:* Chase 309

Office hours: Mondays 2-4 PM in Chase 309. Also Thursdays 12:30-1:30 (Sept 12, 19, 26 only), and Wednesdays 10-11 AM beginning October 2.

Teaching Assistant:

Sarah Organ, *email:* sarah.organ@dal.ca

Lecture:

Time: Monday, 17:35-20:25 PM, beginning September 9

Location: LSC 242

Tutorial:

Time: Thursday, 17:35-18:25, **beginning** September 5

Location: LSC 242

Extra Help: The MATH/STAT Learning Centre is located in Chase 119 and will be operating in-person and remotely. It opens on Sept. 3 and support is available Monday through Friday from 11:30am - 4:30pm and Monday through Friday evenings from 6:30-7:30pm, until Dec. 17. Register for the Brightspace "course" at <https://www.dal.ca/faculty/science/math-stats/about/learning-centre.html> to access the online support and see the latest schedule.

Tutors with expertise in statistics will be there and available to answer questions (on a first come first served basis). There are large tables available for groups to work together. **THIS IS YOUR PRIMARY SOURCE FOR EXTRA HELP** – make good use of it!

Course delivery:

- This course is delivered in-person in the form of weekly lectures and tutorials.
- Assignments are online. Exams are in-person and handwritten.

Note: In the event of unforeseen events (e.g., public health matters, instructor illness, bad weather, power outages), a course Zoom link will be provided, and any affected lectures will be delivered online. Students will be informed in advance via Brightspace. Lectures and tutorial are not recorded; some lecture notes and course materials will be provided online.

Course Assessment:

| Component | Weight (% of final grade) | Date |
|--------------------|---------------------------|--|
| <i>Midterm</i> | 30% | <i>Monday Oct 28 (in class time)</i> |
| <i>Final exam</i> | 50% | <i>Scheduled by Registrar; exam period</i> |
| <i>Assignments</i> | 20% | <i>weekly to biweekly</i> |

Marking Scheme Details

- **Assignments:** The lowest two assignment grades will be dropped, and the remaining assignments used to calculate your assignment grade.
- **Midterm:** If you miss the midterm for any reason, the marks associated with it will automatically be transferred to the final exam. This means that if the midterm is missed, your final exam will be worth 80% of your final grade. There are no makeups for the midterm exam.
- **Final grade** will be computed by one of two marking schemes (whichever is higher):
 - Scheme 1: Assignments 20 points, Midterm 30 points, Final 50 points
 - Scheme 2: Assignments 20 points, Final 80 points (i.e., the midterm is dropped if it brings your grade down)

Further Notes:

- The midterm is an in-person, handwritten 2 hour exam that take place during class Oct 28, 17:35-19:35
- The final exam is an in-person, handwritten 3-hour exam and takes place during the regular exam period as scheduled by the registrar.
- You are allowed a two-sided formula sheet for both the midterm and final exam. You will create this yourself (it is not supplied), and you can put anything you want on it.
- Assignments are computer-based and will be done using the CAPA software. These will be due on roughly weekly basis, but due dates adjusted for test weeks and breaks. Assignment 0 is a test assignment and does not contribute to your grade. *All other assignments will have equal value.*

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)

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:

Formal Pre-requisite(s): 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

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. These also provide the basis for an understanding of more advanced statistical methods. 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 Materials:

- There is a Brightspace site for the course, for which you will be automatically enrolled. Brightspace will be used for posting course materials, and communications regarding course logistics.
- The LON-CAPA (Learning Online Network with Computer-Assisted Personalized Approach) e-learning software will be used for assignments.
- The use of statistical software will be required for this course. We will use the R statistical software. 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 base-R called R-Studio will also be used and is recommended. It can be downloaded at posit.co.
- There is no required text for this course. However, some course notes will be 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) will provide further information on the course topics. There is also a tremendous amount of material available online, since the topics we cover are widely taught core techniques in statistics.

Other Course Requirements:

There is a weekly tutorial that takes place Thursdays 17:35-18:25 PM in LSC 242. 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, do example problems, and to demonstrate the statistical software R. Tutorials are not mandatory, but you are strongly encouraged to attend.

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. Everyone in the class will have the same due date/time. No accommodations are possible. Students who transfer into the class late and have missed assignments will have these missed assignments count as part of the two assignments that can be dropped. *Don't wait until the last minute to submit your assignments, as unexpected technical difficulties often arise!*
- **Midterm:** As noted above in the Course Assessment, if the midterm is missed for any reason, its grade is automatically assigned to the final exam. Sick notes and student declaration of absence are not required nor used in this course.
- **Final Exam:** This final exam is required to complete the course. If a student misses the final exam, they must provide proper documentation and a legitimate reason for their absence.

Course Policies related to Academic Integrity:

Students are expected to complete their assignments independently, but encouraged to work together to better understand the material.

Course Content:

Listed below are the topics that will be covered. 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
- 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 design, post-hoc comparisons of means
- Categorical data, multinomial distribution, and goodness of fit test
- χ^2 tests and contingency tables
- Scatterplots, Pearson's correlation, Spearman's rank correlation
- Regression and least squares estimates
- Coefficient of determination, Residual plots, remedies, and transformation
- Inference in regression
- Multiple regression basics, hypothesis testing and inference
- Issues in multiple regression
- ANOVA using regression
- Other special topics

University Policies and Statements

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

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.