# Statistical Methods for Data Analysis and Inference
# STAT 2080/MATH 2080
# Summer B 2024
# Faculty of Science Course Syllabus (Section A)
# Department of Mathematics & Statistics

*Dalhousie University is located in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq. We are all Treaty people.*
*We recognize that African Nova Scotians are a distinct people whose histories, legacies and contributions have enriched that part of Mi'kma'ki known as Nova Scotia for over 400 years.*

**Instructor(s):** Paul Bjorndahl        bjorndahl@dal.ca

**Lectures**: MWF 9:05-10:55am ADT

**Office Hours:** T 12:00-15:00pm ADT, R 12:00-15:00pm ADT

**Course delivery:**
Lectures will be delivered online live via Zoom during the specified lecture time. A Zoom link and recordings of the lectures will be posted on Brightspace. Office hours will also be held online using a Zoom link provided.

The **final exam** will be held in-person on **August 19th** 9:00am-12:00pm. For those unable to attend there will also be a make-up exam on August 27, 4:00-7:00pm. You are encouraged to attend the first seating of the exam on the 19th if possible, so that you have a make-up date if you encounter unforeseeable circumstances.
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## Course Description
The usual sequel to STAT 1060.03 or STAT 2060.03. This course introduces a number of techniques for data analysis and inference commonly used in the experimental sciences. Topics covered include two-sample inference one-way and two-way analysis of variance, correlation, linear regression, and the analysis of categorical and count data. A natural sequel for this course is STAT 3340.03.

## 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 Exclusion
*COMM 2502, MGMT 2502, ECON 2280*

**Course Materials**

- There is no required text for this course. However, some course notes will be provided. It is suggested that 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 a Brightspace site for the course, in which you will be automatically enrolled. Brightspace will be used for posting course materials, online discussion forums, 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 focus on using the R statistical software. This state-of-the-art open-source statistical package is available from https://cran.r-project.org/ for Mac OS, Windows, and Linux.

**Online Delivery:**

- Students are expected to have a computing device capable of connecting to the internet for viewing lectures, doing online assignments, and using R.
- Students connecting to online resources from outside Canada are responsible for ensuring awareness and compliance with any applicable laws in the country from which they are connecting.
- All assignments and exam open and close dates are scheduled for Atlantic Daylight Time (ADT).

**Course Assessment**

| Assessment | Weight (% of final grade) | Date |
|---|---|---|
| *Assignments* | | |
| Assignment 1 | 4% | Due Jul. 7th 11:59 P.M ADT |
| Assignment 2 | 4% | Due Jul. 14th 11:59 P.M ADT |
| Assignment 3 | 4% | Due Jul. 21th 11:59 P.M ADT |
| Assignment 4 | 4% | Due Jul. 28th 11:59 P.M ADT |
| Assignment 5 | 4% | Due Aug. 11th 11:59 P.M ADT |
| R assignment | 5% | Due Aug. 17th 11:59 P.M ADT |
| *Mid-term* | | |
| Take-home Midterm Exam | 15% | Open Jul. 24-26th |
| *Final exam* | | |
| 3 hour In-person Final Exam | 60% | Aug. 19th |

**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) | | |

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### 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.
- Mid-term: If the mid-term is missed for a legitimate reason (e.g., illness), please inform us on the day of the test. The value of the Mid-term will then be assigned to that of the final exam (e.g., the final exam will be worth 75%). If the mid-term 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 mid-terms.
- Final Exam: Proper documentation for an absence is required.

### Course Policies related to Academic Integrity

Students are expected to complete their assignments independently.

### 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 - Kruskall-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
- $\chi^2$ 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
- Special topics and review

### 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.

# 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.

Faculty of Science

# Student Resources and Support

## University Policies and Programs

Important Dates in the Academic Year (including add/drop dates):
http://www.dal.ca/academics/important_dates.html

Classroom Recording Protocol: https://www.dal.ca/dept/university_secretariat/policies/academic/classroom-recording-protocol.html

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

Grade Appeal Process: https://www.dal.ca/campus_life/academic-support/grades-and-student-records/appealing-a-grade.html

Sexualized Violence Policy: https://www.dal.ca/dept/university_secretariat/policies/health-and-safety/sexualized-violence-policy.html

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

## Learning and Support Resources

General Academic Support – Advising (Halifax): https://www.dal.ca/campus_life/academic-support/advising.html

General Academic Support – Advising (Truro): https://www.dal.ca/about-dal/agricultural-campus/ssc/academic-support/advising.html

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

On Track (helps you transition into university, and supports you through your first year at Dalhousie and beyond): https://www.dal.ca/campus_life/academic-support/On-track.html

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

Indigenous Connection: https://www.dal.ca/about-dal/indigenous-connection.html

Elders-in-Residence (The Elders in Residence program provides students with access to First Nations elders for guidance, counsel, and support. Visit the office in the Indigenous Student Centre or contact the program at elders@dal.ca or 902-494-6803: https://cdn.dal.ca/content/dam/dalhousie/pdf/academics/UG/indigenous-studies/Elder-Protocol-July2018.pdf

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

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

South House Sexual and Gender Resource Centre: https://southhousehalifax.ca/about/

LGBTQ2SIA+ Collaborative: https://www.dal.ca/dept/vpei/edia/education/community-specific-spaces/LGBTQ2SIA-collaborative.html

Dalhousie Libraries: http://libraries.dal.ca/

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

Dalhousie Student Advocacy Services: https://www.dsu.ca/dsas?rq=student%20advocacy

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

Human Rights and Equity Services: https://www.dal.ca/dept/hres.html

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

Study Skills/Tutoring: http://www.dal.ca/campus_life/academic-support/study-skills-and-tutoring.html

Faculty of Science Advising Support: https://www.dal.ca/faculty/science/current-students/undergrad-students/degree-planning.html

## Safety

Biosafety: http://www.dal.ca/dept/safety/programs-services/biosafety.html

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

Radiation Safety: http://www.dal.ca/dept/safety/programs-services/radiation-safety.html

Laser Safety: https://www.dal.ca/dept/safety/programs-services/radiation-safety/laser-safety.html