

Regression and Analysis of Variance Syllabus

Department of Mathematics and Statistics

STAT 3340/MATH 3340 Fall 2023

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
Bruce Smith	bruce.smith@dal.ca	TR 10:30-12:00 Chase 309

Course delivery: In person. Lectures will NOT be recorded. TR 1:05-2:25 , LSC 236

Course Description

A thorough treatment of the theory and practice of regression analysis. Topics include: fitting general linear models using matrices, optimality of least squares estimators (Gauss-Markov theorem), inferences, simple and partial correlation, analysis of residuals, case-deletion diagnostics, polynomial regression, transformations, use of indicator variables for analysis of variance and covariance problems, model selection, and an introduction to nonlinear least squares. This course makes extensive use of computer packages.

Course Prerequisites

Math 1030.03 AND STAT 2060.03 or MATH 2060.03 AND STAT 2080.03 or MATH 2080.03 or ECON 2280.03 or 3338.03, AND STAT 2450.03. (Stat2450 may be taken as a co-requisite.)

Course Objectives/Learning Outcomes

1. Calculate the least squares intercept and slope given (x_i, y_i) data.
2. Evaluate expectation and variance of linear combinations of random variables using matrix operations.
3. Calculate least squares estimates for the multiple regression model using matrix operations.
4. Prove that the least squares estimates are unbiased and evaluate their covariance matrix.
5. Calculate and interpret entries in the analysis of variance table.
6. Calculate case deletion diagnostics given residuals and leverage values.
7. Determine adequacy of regression models using residual plots, leverage measures and case deletion diagnostics.
8. Choose a transformation of the response to produce variance homogeneity, using computer plots and likelihood methods.
9. Select an appropriate multiple regression model given plots and descriptions of the variables.

10. Describe the importance and use of the Gauss-Markov and Cochran's theorem in regression modelling.
11. Construct confidence intervals for model parameters given computer output or formulae for the standard error.
12. Carry out hypothesis tests on single or several model parameters to determine whether some variables can be removed from a model, using computer output.
13. Given replicate observations, test for lack of fit of a model.
14. Use the statistical package R to plot and manipulate data and to fit simple and multiple regression models.
15. Use R to calculate automatic variable selection strategies, given a response and several predictor variables.

Course Materials

- Recommended reading: Introduction to Linear Regression Analysis, 5th Edition, Montgomery, Peck and Vining. A copy will be put on 2 hour reserve in Killam library.
- A linear algebra reference: Matrix Theory and Linear Algebra, Selinger, online at <https://www.mathstat.dal.ca/~selinger/linear-algebra/downloads/LinearAlgebra.pdf>
- Most assignments will require use of the statistical software package R. You can download the software at <http://www.r-project.org/>
- Rstudio, with the Markdown addon is required to organize assignments. It is available at <https://www.rstudio.com/>
- Lecture notes, assignments, etc., are at [chase.mathstat.dal.ca/~bsmith/stat3340](https://www.mathstat.dal.ca/~bsmith/stat3340)
- Grades will be posted to Brightspace.

Course Assessment

Component	Weight (% of final grade)	Date
Midterm exam	20%	Wednesday, October 18, 6:30-8:00 PM
Final exam	40%	(Scheduled by Registrar)
Assignments	6 assignments totalling 40%	roughly every two weeks.

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 Policies

Assignments are to be submitted to Brightspace. Each assignment is to be submitted as a single pdf file, with questions answered in the order given.

Late assignments will not be accepted.

It is expected that each student will write up their assignment independently. Students submitting identical assignments will receive a mark of 0 for that assignment.

If you are ill on the day of a test, you must advise me of this fact before the test, and you will need to submit a Student Declaration of Absence form before you can write a make-up test.

Course Content

- Multiple linear regression and its matrix formulation
- Assessing model adequacy and transformations
- Regression diagnostics (influential points and multicollinearity)
- Special types of regression: polynomial and indicator variable regression
- Model building and variable selection
- Special topics (causal inference, spline based models - time permitting)

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>