Carleton University

ECON 4708/ECON 5880: Economic Data Science - Analytics

Fall 2021

Professor Thomas Russell

General Information

Instructor: Thomas Russell

Phone: TBA

Email: thomas.russell3@carleton.ca

TA: TBA

Lectures: Wednesdays 2:35 pm - 5:25 pm EST, Tory Building 447.

Office Hours: By appointment, location TBA.

Course Webpage: Brightspace

Course Objectives: The goal of this course is to introduce students to some of the most popular machine learning algorithms, and to demonstrate "off-the-shelf" applications of these algorithms to economic problems. The course assumes that students have sufficient background in statistics, probability theory, and multivariate linear regression. The course will focus primarily on supervised machine learning algorithms, and may cover linear models, LASSO and ridge regression, logistic regression, nonparametric regression, decisions trees and random forests, support vector machines, and neural networks. The course will also introduce students to programming in R, and will expose students to a variety of datasets from economics that are amenable to analysis using machine learning methods. No prior programming experience is required.

Course Preclusions: None.

Course Prerequisites: For ECON 4708, ECON 2708 with a grade of C+ or higher; and ECON 4706 (or equivalent) with a grade of C+ or higher. For ECON 5880, by permission of the department.

Lectures

Attendance of in-person lectures is considered mandatory. Lecture recordings will not be available.

Programming Requirements

Students will be required to use R for the assignments. Programming in R will be taught during lecture. R is a free and open-source programming language and environment used for statistical computing. Next to Python, it is one of the most in-demand languages for data science. Most of the programming in class will be done using Jupyter notebooks, although students may also find it useful to install RStudio. Instructions on how to install R, RStudio and Jupyter notebooks will be posted on the course website before the first lecture. These programs should be installed before the first class.

Office Hours

Office hours will be by appointment only, and may take place either online using Zoom or in person. Email the course instructor to set up an appointment.

Evaluation

- Assignment I — 20%. To be posted on the course website on September 29, 2021. Due on October 20, 2021, at 11:59 pm EST. To be submitted via the course website.
- Midterm — 25%. The midterm will take place in class on October 20, 2021.
- Assignment II — 20%. To be posted on the course website on November 17, 2021. Due December 8, 2021, at 11:59 pm EST. To be submitted via the course website.
- Final Exam— 35%. The final exam will be administered during the exam period, sometime between December 11 - 23, 2021. The final exam will be scheduled later in the term and more details will be released at that time.

Assignments

Students must work in groups of at least two and at most three individuals. Students who cannot form a group may contact the instructor to be matched with another team member. Only one assignment per group needs to be submitted – list all groups members on your assignments. Assignments will require students to apply programming skills learned in class to a mix of theoretical and applied questions. All assignments will be submitted via the course website. Students will submit both a written portion of the assignment

(containing any mathematical derivations or explanations required to answer the assignment questions), as well as meticulously labelled R code used to answer any of the programming-based questions. Assignment marks may be deducted if any supporting code is not clearly labelled and/or explained. **Late assignments will be penalized 1 mark for each minute they are late (e.g. 5 minutes late means a 5 mark deduction from your total assignment score).**

Students registered in ECON 5880 will be required to answer additional assignment questions relative to students registered in ECON 4708.

Midterm Exam

The midterm will be administered in class on October 20, 2021, and will cover lecture material up to and including the lecture on October 13, 2021. Students are not permitted to collaborate on the midterm exam and any suspected collaboration may be investigated as an act of academic misconduct.

There will not be a make up exam for those who miss a midterm. Those unable to complete the midterm for a valid reason will have the weight of the midterm shifted to the final exam, resulting in a final exam worth 60%. However, for those unable to complete a midterm, documentation is required, e.g. a doctors note or a police report. The documentation provided by students for missed or incomplete midterms will be subject to verification by the instructor. Submitting a forged note is regarded as a serious academic misconduct. Students who miss the midterm exam and fail to provide sufficient documentation will receive a score of zero.

Students registered in ECON 5880 will be required to answer additional midterm exam questions relative to students registered in ECON 4708.

Final Exam

The final exam will be administered during the final exam period from December 11 - 23, 2021. Students will not permitted to collaborate on the final exam and any suspected collaboration may be investigated as an act of academic misconduct. The final exam will cover lecture material up to and including the final lecture on December 8, 2021.

For those unable to complete the final exam in the scheduled time, documentation is required, e.g. doctors note or police report. The documentation provided by students for missed or incomplete final exams will be subject to verification by the instructor. Submitting a forged note will be regarded as a serious

academic offence. Students who miss the final exam and fail to provide sufficient documentation will receive a score of zero. Application to write a deferred final examination must be made at the Registrars Office.

Students registered in ECON 5880 will be required to answer additional final exam questions relative to students registered in ECON 4708.

Important Dates

Table 1 displays a list of important dates. The evaluation dates below are subject to change.

Dates	**Event**
September 8	Fall Term Begins
September 29	Assignment I Posted
October 20	Midterm Exam (during lecture)
	Assignment I Due
October 25 - 29	Fall Break, no classes.
November 17	Assignment II Posted
December 8	Assignment II Due at 11:59pm EST
December 10	Fall Term Ends
December 11 - 23	Final Exam Period

Table 1: Important dates for ECON 4708.

Textbooks and Reading Materials

Although we will use a variety of references in this course, our main reference (not required) will be:

- **(ISLR2)** James, G., Witten, D., Hastie, T., & Tibshirani, R. (2021). An Introduction to Statistical Learning with Applications to R, *Second Edition*. Springer New York.

The lecture material will also draw from the following sources:

- Abadie, A., & Kasy, M. (2019). Choosing Among Regularized Estimators in Empirical Economics: The Risk of Machine Learning. The Review of Economics and Statistics, 101(5), 743–762. https://doi.org/10.1162/rest_a_00812
- Athey, S. (2017). Beyond prediction: Using big data for policy problems. Science, 355(6324), 483–485. https://doi.org/10.1126/science.aal4321
- Athey, S. (2019). The Impact of Machine Learning on Economics. In The economics of artificial intelligence (pp. 507-552). University of Chicago Press. nber.org/system/files/chapters/c14009/c14009.pdf

- Bishop, C. M. (2006). Pattern Recognition and Machine Learning. Springer Science and Business Media.
- Hastie, T., Tibshirani, R., & Friedman, J. (2009). The Elements of Statistical Learning: Data Mining, Inference, and Prediction. Springer Science & Business Media.
- Mohri, M., Rostamizadeh, A., & Talwalkar, A. (2018). Foundations of machine learning. MIT press.
- Mullainathan, S., & Spiess, J. (2017). Machine Learning: An Applied Econometric Approach. Journal of Economic Perspectives, 31(2), 87–106. https://doi.org/10.1257/jep.31.2.87
- Shalev-Shwartz, S., & Ben-David, S. (2014). Understanding machine learning: From theory to algorithms. Cambridge university press.
- Shmueli, G. (2010). To Explain or to Predict? Statistical Science, 25(3), 289–310. https://doi.org/10.1214/10-STS330
- Varian, H. R. (2014). Big Data: New Tricks for Econometrics. Journal of Economic Perspectives, 28(2), 3–28. https://doi.org/10.1257/jep.28.2.3

Tentative Course Outline

The tentative course outline is displayed in Table 2. Depending on the pace of the lectures, this course outline may be subject to modification.

Additional Information

Email Communication

Communication outside of class, tutorials and office hours will be done through email. **For security purposes, please communicate only using your carleton.ca email address.** Please include the course name "ECON 4708" in the subject line of your email. You can expect to receive a response to your email within 48 hours. However, communication outside of class hours should occur only in exceptional cases; in particular, email is not the appropriate medium to ask questions about course material. Students who request clarification on course material through email will be directed to ask their question during class or office hours.

Course Standing

Standing in a course is determined by the course instructor subject to the approval of the Faculty Dean. This means that grades submitted by the instructor may be subject to revision. No grades are final until

Topic #	Lecture Dates	Topic	Readings
1	September 8, 2021 September 15, 2021	Introduction to Data Science, Intro to R	**(ISLR2)**: Ch. 1 & 2
2	September 22, 2021 September 29, 2021	Linear Regression, Shrinkage, and Model Selection	**(ISLR2)**: Ch. 3, 5 & 6
3	October 6, 2021 October 13, 2021	Nonlinear Extensions	**(ISLR2)**: Ch. 7.
—	October 20, 2021	Midterm Exam (In class)	
—	October 25 - 29, 2021	Fall Break: No Classes	
4	November 3, 2021 November 10, 2021	Logistic Regression, Decision Trees, and Random Forests	**(ISLR2)**: Ch. 4 & 8
5	November 17, 2021 November 24, 2021	Support Vector Machines	**(ISLR2)**: Ch. 9
6	December 1, 2021 December 8, 2021	Neural Networks and Deep Learning	**(ISLR2)**: Ch. 10

Table 2: A tentative course outline for ECON 4708.

they have been approved by the Dean. Application to write a deferred final examination must be made at the Registrars Office.

Academic Misconduct and Plagiarism

Please be aware that plagiarism is serious offence. For information on policies surrounding academic misconduct, visit the following link to Carleton University Academic Integrity Policy. For information on how to avoid academic misconduct, visit the following link to "Pammett on Plagiarism and Paraphrasing."

Copyright of Course Materials

The lectures and course materials (including all slides, handouts, recorded lecture videos, exams, tutorial materials, and other similar materials) are protected by copyright. The course instructor is the exclusive owner of the copyright and intellectual property of all course materials. You may take notes and make copies of course materials for your own educational use. You may not reproduce or distribute lecture notes, videos, or other course materials publicly without the express written consent of the instructor.

Requests for Academic Accommodation

You may need special arrangements to meet your academic obligations during the term. For an accommodation request, the processes are as follows (copied and pasted from the Academic Accommodations Website):

Pregnancy

Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, visit the Equity Services website.

Religious Obligations

Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, visit the Equity Services website.

Academic Accommodations for Students with Disabilities

If you have a documented disability requiring academic accommodations in this course, please contact the Paul Menton Centre for Students with Disabilities (PMC) at 613-520-6608 or pmc@carleton.ca for a formal evaluation or contact your PMC coordinator to send your instructor your Letter of Accommodation at the beginning of the term. You must also contact the PMC no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, meet with your instructor as soon as possible to ensure accommodation arrangements are made. For more details, visit the Paul Menton Centre website.

Survivors of Sexual Violence

As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and where survivors are supported through academic accommodations as per Carleton's Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit: `carleton.ca/sexual-violence-support`

Accommodation for Student Activities

Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please

contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, see the policy.

Fall 2021 Pandemic Measures

All members of the Carleton community are required to follow COVID-19 prevention measures and all mandatory public health requirements (e.g. wearing a mask, physical distancing, hand hygiene, respiratory and cough etiquette) and mandatory self-screening prior to coming to campus daily.

If you feel ill or exhibit COVID-19 symptoms while on campus or in class, please leave campus immediately, self-isolate, and complete the mandatory symptom reporting tool. For purposes of contact tracing, attendance will be recorded in all classes and labs. Participants can check in using posted QR codes through the cuScreen platform where provided. Students who do not have a smartphone will be required to complete a paper process as indicated on the COVID-19 website.

All members of the Carleton community are required to follow guidelines regarding safe movement and seating on campus (e.g. directional arrows, designated entrances and exits, designated seats that maintain physical distancing). In order to avoid congestion, allow all previous occupants to fully vacate a classroom before entering. No food or drinks are permitted in any classrooms or labs.

For the most recent information about Carleton's COVID-19 response and required measures, please see the University's COVID-19 webpage and review the Frequently Asked Questions (FAQs). Should you have additional questions after reviewing, please contact covidinfo@carleton.ca

Please note that failure to comply with University policies and mandatory public health requirements, and endangering the safety of others are considered misconduct under the Student Rights and Responsibilities Policy. Failure to comply with Carleton's COVID-19 procedures may lead to supplementary action involving Campus Safety and/or Student Affairs.