

Carleton University

ECON 4708/ECON 5880: Economic Data Science - Analytics

Fall 2022

Professor Thomas Russell

General Information

Instructor: Thomas Russell

Phone: TBA

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TA: TBA

Lectures: Wednesdays 2:35 pm - 5:25 pm EST, Richcraft Hall Room 3201.

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, bayesian methods, 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 also 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 28, 2022](#). Due on [October 19, 2022](#), at 11:59 pm EST. To be submitted via the course website.
- Midterm — 25%. The midterm will take place in class on [October 19, 2022](#).
- Assignment II — 20%. To be posted on the course website on [November 9, 2022](#). Due [November 30, 2022](#), 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 10 - 22, 2022](#). The final exam will be scheduled later in the term and more details will be released at that time.

Assignments

Students can work in groups of one or two individuals. 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 19, 2022](#), and will cover lecture material up to and including the lecture on [October 12, 2022](#).

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 10 - 22, 2022](#). The final exam will cover lecture material up to and including the final lecture on [December 7, 2022](#).

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 7	First Class
September 28	Assignment I Posted
October 19	Midterm Exam (during lecture) Assignment I Due
October 24 - 28	Fall Break, no classes.
November 16	Assignment II Posted
December 7	Assignment II Due at 11:59pm EST
	Last Class
December 10 - 22	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 references (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.
- **(PRML)** Bishop, C. M. (2006). Pattern Recognition and Machine Learning. Springer Science and Business Media.
- **(GPML)** Williams, C. K., & Rasmussen, C. E. (2006). Gaussian processes for machine learning (Vol. 2, No. 3, p. 4). Cambridge, MA: MIT press.

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

- 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” or “ECON 5880” 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 they have been approved by the Dean. Application to write a deferred final examination must be made at the Registrars Office.

Topic #	Lecture Dates	Topic	Readings
1	September 7, 2022	Introduction to Data Science, Intro to R	(ISLR2) : Ch. 1 & 2
2	September 14, 2022 September 21, 2022	Linear Regression, Shrinkage, and Model Selection	(ISLR2) : Ch. 3, 5 & 6
3	September 28, 2022	Nonlinear Extensions	(ISLR2) : Ch. 7.
4	October 5, 2022 October 12, 2022	Logistic Regression, Decision Trees, and Random Forests	(ISLR2) : Ch. 4 & 8
—	October 19, 2022	Midterm Exam (In class)	
—	October 24 - 28, 2022	Fall Break: No Classes	
5	November 2, 2022 November 9, 2022	Support Vector Machines	(ISLR2) : Ch. 9
5	November 16, 2022 November 23, 2022	Bayesian Methods	(PRML) Ch. 3.3 (GPML) Ch. 2
6	November 30, 2022 December 7, 2022	Neural Networks and Deep Learning	(ISLR2) : Ch. 10

Table 2: A tentative course outline for ECON 4708.

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 [Academic Integrity and Offenses of Conduct](#).

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](#).

Covid-19 Information

It is important to remember that COVID is still present in Ottawa. The situation can change at any time and the risks of new variants and outbreaks are very real. There are [a number of actions you can take](#) to lower your risk and the risk you pose to those around you including being vaccinated, wearing a mask, staying home when you're sick, washing your hands and maintaining proper respiratory and cough etiquette.

Feeling sick? Remaining vigilant and not attending work or school when sick or with symptoms is critically important. If you feel ill or exhibit COVID-19 symptoms do not come to class or campus. If you feel ill or exhibit symptoms while on campus or in class, please leave campus immediately. In all situations, you must follow Carleton's [symptom reporting protocols](#).

Masks: Carleton has paused the [COVID-19 Mask Policy](#), but continues to strongly recommend masking when indoors, particularly if physical distancing cannot be maintained. It may become necessary to quickly reinstate the mask requirement if pandemic circumstances were to change.

Vaccines: Further, while proof of vaccination is no longer required as of May 1 to attend campus or in-person activity, it may become necessary for the University to bring back proof of vaccination requirements on short notice if the situation and public health advice changes. Students are strongly encouraged to get a full course of vaccination, including booster doses as soon as they are eligible, and submit their booster dose information in [cuScreen](#) as soon as possible. Please note that Carleton cannot guarantee that it will be able to offer virtual or hybrid learning options for those who are unable to attend the campus.

All members of the Carleton community are required to follow requirements and guidelines regarding health and safety which may change from time to time. For the most recent information about Carleton's COVID-19 response and health and safety requirements please see the [University's COVID-19 website](#) and review the [Frequently Asked Questions \(FAQs\)](#). Should you have additional questions after reviewing, please contact covidinfo@carleton.ca.