

# Carleton University

ECON 4709/ECON 5880 W: Economic Data Science - Applications

Winter 2023

Professor Thomas Russell

## General Information

**Instructor:** Thomas Russell

**Phone:** TBA

**Email:** thomas.russell3@carleton.ca

**TA:** TBA

**Lectures:** Fridays 11:35 am - 2:25 pm, ME 3356.

**Office Hours:** By appointment, Online (Zoom) or Loeb A806.

**Course Webpage:** Brightspace

**Course Objectives:** The goal of this course is to demonstrate how machine learning algorithms can be used in economic applications, going beyond simple prediction tasks. The course will introduce students to a growing theoretical and applied literature in economics that uses machine learning tools to learn about causal or structural parameters, and to make optimal policy choices. Topics will include double/debiased machine learning, counterfactual proxies and synthetic control, learning optimal treatment assignment and optimal taxation and insurance policies, among others. The course will highlight the contributions of economists to the machine learning literature, and will emphasize applications.

There will be no written examinations in this course. Instead, students will have to complete two assignments as well as a major empirical project. For the empirical project, students must establish their own research questions, and must demonstrate mastery of the concepts taught in the course. Students will also need to present their project proposal and final findings to the class.

**Course Preclusions:** None.

**Course Prerequisites:** For ECON 4709, at least a C+ in ECON 4708. For ECON 5880 W, at least a C+ in ECON 5880 F.

## Lectures

Attendance of in-person lectures is considered mandatory, and class participation will be graded. Lecture recordings will not be available.

## Technology Requirements

Students will be required to use LaTeX for their empirical project. Students may be required to use R for the assignments.

## 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

- Class participation — 10%. Marks will be deducted for missing class, or for failing to regularly engage with class discussion.
- Assignment I — 15%. To be posted on the course website on February 3, 2023. Due on February 17, 2023, at 11:59 pm EST. To be submitted via the course website.
- Assignment II — 15%. To be posted on the course website on March 17, 2023. Due March 31, 2023 at 11:59 pm EST. To be submitted via the course website.
- Empirical Project Proposal Presentation—5%. Each student must present for 15 min. Presentations will take place on March 3rd during class.
- Empirical Project Final Presentation—10%. Each student must present for 30 min. Presentations will take place on April 7th during class.
- Empirical Project Written Submission—45%. Due on April 12, 2023 at 11:59 pm EST. To be submitted via the course website.

Topic #	Lecture Dates	Topic
1	January 13, 2023 January 20, 2023	Introduction: Prediction versus Explanation
2	January 27, 2023 February 3, 2023	Double/Debiased Machine Learning
3	February 10, 2023 February 17, 2023	Counterfactual Proxies and Synthetic Control Methods
—	February 20 - 24, 2023	Winter Break: No Classes
4	March 3, 2023 March 10, 2023	Welfare Maximization and Learning Optimal Policies
5	March 17, 2023 March 24, 2023	Machine Learning for Optimal Taxation and Insurance
6	March 31, 2023 April 7, 2023	Recent Research in Econometrics and ML
—	April 12, 2023	Last Day of Class

Table 1: A tentative course outline for ECON 4709/ECON 5880.

## Assignments

Students may 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 concepts 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.

## Tentative Course Outline

The tentative course outline is displayed in Table 1. Depending on the pace of the lectures, this course outline may be subject to modification. In particular, certain topics could be added or removed.

Dates	Event
January 9	Winter Term Begins
February 3	Assignment I Posted
February 17	Assignment I Due at 11:59 pm EST
February 20 - 24	Winter Break, no classes.
March 3	Empirical Project Proposal Presentations
March 17	Assignment II Posted
March 31	Assignment II Due at 11:59 pm EST
April 7	Empirical Project Final Presentations
April 12	Winter Term Ends
	Empirical Project Written Submission Due at 11:59 pm EST

Table 2: Important dates for ECON 4709/5880.

## Important Dates

Table 2 displays a list of important dates. The evaluation dates below are subject to change.

## Textbooks and Reading Materials

There is no required textbook for this course. Instead the lecture material will be drawn from a variety of different sources. Required readings below are marked with an asterisk \*.

### Topic 1: Introduction, Prediction versus Explanation

- \* 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](https://nber.org/system/files/chapters/c14009/c14009.pdf)
- \* Breiman, L. (2001). Statistical modeling: The two cultures (with comments and a rejoinder by the author). *Statistical science*, 16(3), 199-231.
- Kleinberg, J., Ludwig, J., Mullainathan, S., & Obermeyer, Z. (2015). Prediction policy problems. *American Economic Review*, 105(5), 491-95.
- \* 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>
- \* Shmueli, G. (2010). To Explain or to Predict? *Statistical Science*, 25(3), 289–310. <https://doi.org/10.1214/10-STS330>

- \* Storm, H., Baylis, K., & Heckelei, T. (2020). Machine learning in agricultural and applied economics. *European Review of Agricultural Economics*, 47(3), 849-892.
- 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>

## **Topic 2: Double/Debiased Machine Learning**

- Belloni, A., & Chernozhukov, V. (2013). Least squares after model selection in high-dimensional sparse models. *Bernoulli*, 19(2), 521-547.
- Belloni, A., Chernozhukov, V., & Hansen, C. (2014). High-dimensional methods and inference on structural and treatment effects. *Journal of Economic Perspectives*, 28(2), 29-50.
- Chernozhukov, V., Hansen, C., & Spindler, M. (2015). Valid post-selection and post-regularization inference: An elementary, general approach. *Annu. Rev. Econ.*, 7(1), 649-688.
- \* Chernozhukov, V., Chetverikov, D., Demirer, M., Duflo, E., Hansen, C., Newey, W., & Robins, J. (2018). Double/debiased machine learning for treatment and structural parameters.

## **Topic 3: Counterfactual Proxies and Synthetic Control Methods**

- Abadie, A. (2021). Using synthetic controls: Feasibility, data requirements, and methodological aspects. *Journal of Economic Literature*, 59(2), 391-425.
- \* Athey, S., Bayati, M., Doudchenko, N., Imbens, G., & Khosravi, K. (2021). Matrix completion methods for causal panel data models. *Journal of the American Statistical Association*, 116(536), 1716-1730.
- \* Chernozhukov, V., Wüthrich, K., & Zhu, Y. (2021). An exact and robust conformal inference method for counterfactual and synthetic controls. *Journal of the American Statistical Association*, 116(536), 1849-1864.
- \* Doudchenko, N., & Imbens, G. W. (2016). Balancing, regression, difference-in-differences and synthetic control methods: A synthesis (No. w22791). National Bureau of Economic Research.

## **Topic 4: Welfare Maximization and Learning Optimal Policies**

- \* Athey, S., & Wager, S. (2021). Policy learning with observational data. *Econometrica*, 89(1), 133-161.
- \* Kitagawa, T., & Tetenov, A. (2018). Who should be treated? empirical welfare maximization methods for treatment choice. *Econometrica*, 86(2), 591-616.
- \* Mbakop, E., & Tabord-Meehan, M. (2021). Model selection for treatment choice: Penalized welfare maximization. *Econometrica*, 89(2), 825-848.

## Topic 5: Machine Learning for Optimal Taxation and Insurance

\* Kasy, M. (2018). Optimal taxation and insurance using machine learning—Sufficient statistics and beyond. *Journal of Public Economics*, 167, 205-219.

## Topic 6: Recent Research in Econometrics and Machine Learning

TBD.

## 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 4709/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.

### 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 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](mailto: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](http://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](#).