

Carleton University

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

Winter 2025

Professor Thomas Russell

General Information

Instructor: Thomas Russell

Email: thomas.russell3@carleton.ca

Office Location: Loeb Building B846

Office Hours: By appointment

The Course

Course Delivery: In-person only

Lectures: Monday 2:35 pm - 5:25 pm, Check Carleton Central for location

TA: TBA

Brightspace Course Webpage: TBA

Course Description: Application of data science and machine learning methods to real-world economic problems. Students will apply their data science knowledge in hands-on projects to answer topical research questions. This course has a strong practical focus.

Learning 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

| Dates | Event |
|------------------------|--|
| January 6, 2025 | First Class |
| January 27, 2025 | Assignment I Posted |
| February 10, 2025 | Assignment I Due at 11:59 pm EST |
| February 17 - 21, 2025 | Winter Break, no classes. |
| March 3, 2025 | Empirical Project Proposal Presentations |
| March 10, 2025 | Assignment II Posted |
| March 24, 2025 | Assignment II Due at 11:59 pm EST |
| March 31, 2025 | Empirical Project Final Presentations |
| April 7, 2025 | Empirical Project Final Presentations |
| | Last class |
| | Empirical Project Written Submission Due at 11:59 pm EST |

Table 1: Important dates for ECON 4709/5880.

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.

Course Calendar

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

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

Lectures

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

| Topic # | Lecture Dates | Topic |
|---------|---|--|
| 1 | January 6, 2025 January 13, 2025 January 20, 2025 | Introduction to Causal Inference |
| 2 | January 27, 2025 February 3, 2025 February 10, 2025 | Double/Debiased Machine Learning |
| — | February 17 - 21, 2025 | Winter Break: No Classes |
| 3a | February 24, 2025 | Counterfactual Proxies and Synthetic Control Methods |
| — | March 3, 2025 | Empirical Project Proposal Presentations |
| 3b | March 10, 2025 March 17, 2025 | Synthetic Control Methods (cont'd) Synthetic Control Methods (cont'd) |
| 4 | March 24, 2025 | Welfare Maximization and Learning Optimal Policies |
| — | March 31, 2025 | Empirical Project Presentations |
| — | April 7, 2025 | Empirical Project Presentations, Last Day of Class |

Table 2: A tentative course outline for ECON 4709/ECON 5880.

Programming Requirements

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

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

[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.

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 January 27, 2025. Due on February 10, 2025, at 11:59 pm EST. To be submitted via the course website.
- Assignment II — 15%. To be posted on the course website on March 10, 2025. Due March 24, 2025 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—15%. Each student must present for 30 min. Presentations will take place on March 31st and April 7th during class.
- Empirical Project Written Submission—40%. Due on April 7, 2025 at 11:59 pm EST. To be submitted via the course website.

Assignments

Students may work in groups of one to three 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).**

The use of generative artificial intelligence (AI) tools (e.g. ChatGPT) is prohibited. Any use of generative AI tools to produce assessed content is considered a violation of academic integrity standards as per the statement on Plagiarism. Re-use of the same piece of work previously submitted for credit in another course is also prohibited.

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

Satisfactory Performance Criteria

Students must fulfill all of the course requirements, including the final exam, in order to achieve a passing grade.

Deferred Final Exam

Students who do not write the final examination because of illness or other circumstances beyond their control may apply to write a deferred final examination by contacting the Registrar's Office no later than three working days after the original final examination was scheduled. In the event that a student writes a deferred examination, the deferred examination will carry the same weight as the final examination in determining the course grade. Any deferred examination will not be identical to the original final examination.

E-proctoring

E-proctoring will not be used for evaluations in this course.

Additional Information

Email Communication

Communication outside of class 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" or "ECON 5880" in the subject line of your email. You can expect to receive a response to your email within two business days. You will not receive a response on weekends or holidays, or outside normal business 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.

Copyright of Course Materials

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