New Directions in Causal Inference

Ryan T. Moore*

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Course Information

New Directions in Causal Inference
DYNAMICS Research Group
15 July - 17 July 2024
Monday-Wednesday 10:00-15:00 CEST (UTC+02:00)
Luisenstraße 56, Raum 220

Instructor Information

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Course Description

This workshop is designed to introduce some recent developments in causal inference, selected in consultation with DYNAMICS Ph.D. students. The first module exposes students to techniques from data science and statistical learning and their application in causal inference problems. The second module considers the concept of sensitivity from several different perspectives. The third module introduces important new approaches to and understandings about the well-known difference-in-differences design.

Prerequisites

Students should be familiar with the rudiments of the potential outcomes model for causal inference, as well as topics in introductory statistics such as null hypothesis significance tests, confidence intervals, and linear regression. Students should be familiar with analyzing data with code, preferably in

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R or Python. It will be helpful if students have background in techniques for causal inference from experiments and observational data, but we will strive to build ideas from the ground up. Students without familiarity or experience in these topics are also welcome. Students are not expected to review the resources on this syllabus prior to the workshop.

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Calendar

Day 1: Monday, 15 July 2024

Data science methods in causal inference

- 13:00-14:00: Introductions. Building models. Social science and data science goals. Cross-validation. Regression/decision trees. Random forests.
- 14:00-15:00: Homogeneous and heterogeneous effects. The CATE. Causal forests.
- 15:00-16:00: Break
- 16:00-17:00: Variable selection. LASSO methods for causal inference.
- 17:00-18:00: Lab exercise

Resources

- Breiman (2001)
- Hernán, Hsu, and Healy (2019)
- James et al. (2021)

- Wager and Athey (2018)
- Zheng and Yin (2023)
- Athey and Wager (2019)

- Hernán and Robins (2024)

Day 2: Tuesday, 16 July 2024

Sensitivity analyses

- 10:00-11:00: Sensitivity to model specification. All possible regressions. Matching as pre-processing.
- 11:00-12:00: Sensitivity to an unidentifiable parameter. Mediation.
- 12:00-13:00: Break
- 13:00-14:00: Sensitivity to unobserved confounders
- 14:00-15:00: Lab exercise

Resources

- Hebbali (2024)
- Ho et al. (2007)
- Blackwell and Strezhnev (2022)

- Imai, Keele, and Yamamoto (2010)

- Keele (2022)
- Rosenbaum (2020)

Day 3: Wednesday, 17 July 2024

Modern difference-in-difference designs

- 10:00-11:00: Canonical difference-in-difference (DiD) designs. The Calloway-Sant'Anna approach to multiple time periods.
- 11:00-12:00: Models and aggregations for DiD
- 12:00-13:00: Break
- 13:00-14:00: Extra time, review, questions
- 14:00-15:00: Lab exercise

Resources

- Card and Kreuger (1994)
- Callaway and Sant'Anna (2021)
- Goodman-Bacon (2021)

References

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James, Gareth, Daniela Witten, Trevor Hastie, and Robert Tibshirani. 2021. *An Introduction to Statistical Learning with Applications in R*. 2nd ed. New York, NY: Springer.

Keele, Luke J. 2022. *rbounds: Perform Rosenbaum Bounds Sensitivity Tests for Matched and Unmatched Data*. https://CRAN.R-project.org/package=rbounds.

Rosenbaum, Paul. 2020. *Design of Observational Studies*. Second. New York, NY: Springer.

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