

0365-4093: Causal Inference

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Course Website: Moodle Office Hours: By email

Class Hours: Thursdays 15:00-18:00

Office: Sheriber 229

Class Room: ???

Course Description

It is well known that correlation does not necessarily imply causation. In this course, we will ask what is a causal parameter, and how can we estimate such parameters (and under what assumptions). Course materials and lecture slides will be made available on Moodle.

Prerequisites/Corequisites

Prerequisites: Good knowledge of basic probability, statistics and regression. The ability to write code for simulations and data analysis. I will be using **R**, but you may use any software/language you feel comfortable with (but it is your responsibility to google and find needed solutions).

Course Outline

The first part of the course will focus on the core concepts and methods for causal inference. These include:

- Definition of causal effects: the potential outcome framework, causal estimands, confounding, assumptions.
- Classical methods: regression, inverse probability of treatment weighting, propensity score matching.
- Do-calculus and directed acyclic graphs, d-separation, the back-door criterion, structural equation modeling
- Revisiting confounding; selection bias.
- Sensitivity analyses.

Then, the tentative plan is to consider the following topics, as time permits, and without committing to any order whatsoever

- Typical statistical/data problem through the causal inference lens. E.g., missing data; measurement error.
- Utilizing machine learning for causal inference.
- Instrumental variables.
- Causal mediation analysis
- More design and methods: Difference in differences; negative outcome control; regression discontinuity.
- Doubly-robust methods

Homework Assessments

Few homework assignments will be given during the semester. In general, homework may include (reasonable) theoretical questions, data analysis, simulations and may refer to additional reading materials. You are highly encouraged to take them seriously.

You are required to submit all homeworks, and the grade accounts towards your final course grade. Identical solutions will receive zero grade.

Final Exam (unless stated differently on TAU's official website)

- Moed A: June 30, 2021
- Moed B: July 27, 2021

Grading Policy

- 85% of your grade will be determined by the final exam.
- 15% of your grade will be determined by homework assignments.
- Homework assignments counts towards the final grade for those who passed the final exam only.

Readings

None of these books or papers cover the majority of the course by itself. Nevertheless, I definitely recommend to take a pick if you are interested.

- Hernán MA, Robins JM (2019). Causal Inference. Boca Raton: Chapman & Hall/CRC, available online at <https://www.hsph.harvard.edu/miguel-hernan/causal-inference-book/>

- Pearl, J. Causality. (2009). Cambridge university press.
- Pearl, J., Glymour, M., & Jewell, N. P. (2016). Causal inference in statistics: A primer. John Wiley & Sons.
- Rosenbaum, P. R. (2002). Observational studies. Springer, New York, NY
- Imbens, G. W., & Rubin, D. B. (2015). Causal inference in statistics, social, and biomedical sciences. Cambridge University Press.
- Pearl, Judea, and Dana Mackenzie. (2018) The Book of Why: the new science of cause and effect.
- Pearl, J. (2009). Causal inference in statistics: An overview. Statistics surveys, 3, 96-146.