

MATH-336

Randomization and causation

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Cursus	Sem.	Type
Mathematics	BA6	Opt.
Statistics	MA2	Obl.

Language of teaching	English
Credits	5
Session	Summer
Semester	Spring
Exam	Written
Workload	150h
Weeks	14
Hours	4 weekly
Courses	2 weekly
Exercises	2 weekly
Number of positions	

Summary

This course covers formal frameworks for causal inference. We focus on experimental designs, definitions of causal models, interpretation of causal parameters and estimation of causal effects.

Content

- Experimental design
 - Randomisation
 - Matched pairs, block designs, (fractional) factorial designs and latin squares
- Defining a causal model
 - Causal axioms
 - Falsifiability
 - Structural equations
 - Causal directed acyclic graphs
 - Single world intervention graphs
- Interpretation of causal parameters
 - Individual and average level effects
 - Mediation and path specific effects
 - Instrumental variables
 - Statistical inference: Estimands, estimators and estimates
 - Relation to classical statistical models
 - Doubly and multiply robust estimators

Keywords

Causality; Causal inference; Randomisation; Experimental design: Structural equation models; Causal Graphs; Estimands.

Learning Prerequisites**Required courses**

The students are expected to know the basics of statistical theory and probability theory. The courses “probability” (Math-230), “statistics” (Math-240) and “linear models” (Math-341).

Recommended courses

Courses in regression models and statistical inference.

Important concepts to start the course

Likelihood theory and principles of statistical testing. Experience with R is an advantage, but is not required.

Learning Outcomes

By the end of the course, the student must be able to:

- Design experiments that can answer causal questions
- Describe the fundamental theory of causal models
- Critique assess causal assumptions and axioms.
- Distinguish between interpretation, identification and estimation
- Describe when and how causal effects can be identified and estimated from non-experimental data.
- Estimate causal parameters from observational data.

Transversal skills

- Demonstrate the capacity for critical thinking
- Communicate effectively, being understood, including across different languages and cultures.

Teaching methods

Classroom lectures, where I will use Beamer slides and the blackboard.

Assessment methods

Final written exam and continuous assessment.

Dans le cas de l'art. 3 al. 5 du Règlement de section, l'enseignant décide de la forme de l'examen qu'il communique aux étudiants concernés.

Resources

Bibliography

Teaching resources

- Hernan, M.A. and Robins, J.M., 2020. Causal inference: What if?
- Pearl, J., 2009. Causality. Cambridge university press.

Ressources en bibliothèque

- [Causal Inference / Hernan & Robins \(draft\)](#)
- [Causality / Pearl](#)

Moodle Link

- <https://go.epfl.ch/MATH-336>