MGT-416

Causal inference

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Cursus	Sem.	Type
Electrical and Electronical Engineering	MA2, MA4	Opt.
Financial engineering	MA2, MA4	Opt.
Management, Technology and Entrepreneurship minor	E	Opt.
Managmt, tech et entr.	MA2, MA4	Opt.
Systems Engineering minor	E	Opt.

Language of teaching	English
Credits	4
Session	Summer
Semester	Spring
Exam	During the semester
Workload	120h
Weeks	14
Hours	**3 weekly**
Lecture	2 weekly
Exercises	1 weekly
Number of positions	

Summary

Students will learn the core concepts and techniques of network analysis with emphasis on causal inference. Theory and application will be balanced, with students working directly with network data throughout the course.

Content

- Introduction: What is causal inference?
- Review of Useful Probability concepts
  - Random variable, predictors, divergences
- Introduction to Applications
  - Computational neuroscience
  - Financial markets
  - Social networks
- Pearl Causality
  - Causal Bayesian Networks (CBNs)
  - Learning CBNS: Faithfulness and identifiably
  - Algorithms
- Potential Outcome Model
  - Counterfactuals and identification problems
  - Graphical causal models
- Randomized Experiments
  - Identification of causes in randomized experiments
  - Effect modification
- Causality in Times Series
  - Granger causality
  - More general linear predictors

- Beyond linear models and Granger causality
- Directed information graphs
- Efficient algorithms

- Concrete Applications
  - Computational neuroscience
  - Financial markets
  - Social networks

Keywords

Causality, structure learning, network inference

Learning Prerequisites

Required courses

This course attempts to be as self contained as possible, but it does approach the topic from a quantitative point of view and, as such, students should be comfortable with the basics of (*i.e.* have taken at least one course in) the following topics before enrolling:

- Statistics
- Probability Theory
- Linear Algebra
- Calculus (integral and differential)
- Programing in Pythor and Matlab

As course work will be largely computational, experience with at least one programming language is also required.

Important concepts to start the course

Konwlege of probability and calculus as well as programming is a must.

Learning Outcomes

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

- Identify situations in which a problem/data can be thought of as a network.
- Analyze data appropriately using a variety of network analytic techniques.
- Interpret the results of applying network analytics.
- Propose action based on sound interpretation of network analytics.

Transversal skills

- Continue to work through difficulties or initial failure to find optimal solutions.
- Demonstrate the capacity for critical thinking
- Use both general and domain specific IT resources and tools
- Access and evaluate appropriate sources of information.

Teaching methods

In class with supporing problem solving sessions.

Expected student activities

TA problem solving sessions, homework, exams, projects

Assessment methods

Regular individual assignments: 30%
Midterm exam: 30%
Final project: 40%

Supervision

Office hours	Yes
Assistants	Yes
Forum	No

Resources

Notes/Handbook

course notes

Moodle Link

- https://go.epfl.ch/MGT-416