

MATH 4824C: Causal Inference

Course outline - Spring 2024

Instructor:

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Office hours: By appointment.

Teaching Assistant: Shuoxun Xu, sxubk@connect.ust.hk

Course descriptions: This course is concerned with the statistical theory and methodology of causal inference with applications in precision medicine. Tentative topics include:

potential outcomes, average treatment effects, randomized experiments, covariate adjustment, regression discontinuity designs, observational studies, confounders, sensitivity analysis, propensity scores, matching, doubly robust estimators, difference-in-difference, instrumental variables, heterogeneous treatment effects and optimal treatment regimes.

Prerequisite: MATH 3423 and MATH 3424. Students without prerequisite need to seek approval from the course instructor to take this course.

Intended Learning Outcomes:

Upon successful completion of this course, students should be able to:

- Gain a deep understanding of statistical principles and frameworks of causal inference;
- Master different statistical methodologies in causal inference to estimate treatment effects in both randomized experiments and observational studies;
- Know the basic underlying theories of statistical methodologies in causal inference
- Solve real-world problems using appropriate statistical methodologies in causal inference.

Course Material:

- The textbook is *A First Course in Causal Inference* by Peng Ding;
- Slides and notes with remarks will be uploaded to Canvas.

Assessment:

Assignments: 20%.

Mid-term: 20% or 0%.

Final: 60% or 80% whichever is higher.

Main References:

- *Causal Inference for Statistics, Social, and Biomedical Sciences: An Introduction* by Imbens, Guido W. and Rubin, Donald B., Cambridge University Press.
- *Causal Inference.* by Hernan M. A., Robins James M., Chapman & Hall/CRC.

Acknowledgement: I am grateful to Zhichao Jiang for sharing the course materials and some course materials are also credited to Fan Li and Kosuke Imai.