Causal Inference for the Social Sciences I

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Instructional Team

Instructor

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Instructor

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Course outline

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We cover methods including

- Randomization-based analysis for experiments, in Fisher's or Neyman's style
- Instrumental variables & principal stratification
- Propensity scores and matching
- Omitted variable sensitivity analysis

Part 1: The randomized experimental ideal

- Introduction to potential outcomes and random assignment
- Estimation and inference in fully controlled randomized experiments

Part 2: Imperfectly controlled randomized experiments

- Noncompliance: When subjects don't comply with experiment's treatment
- Attrition: When subjects don't report their outcomes

Part 3: Observational studies (when subjects self-select into treatment)

- Matching and assessments of "covariate balance"
- Depending on interest, other designs we may cover include regression discontinuity, difference-in-differences, interrupted time series, synthetic control, etc.

Part 4: Sensitivity analysis

- How would inferences change should crucial assumptions be false?

Course outline

- Part 1 of the course is very conceptual, covering essential topics in statistics but from a new randomization- or design-based perspective
    - ⋆ This part of the course is often the most challenging
- Parts 2 - 4 emphasize computation in `R`
    - Especially `R`'s `optmatch` package

Objectives, Audience, Prerequisites & Materials

Audience and Prerequisites

- The typical student is an applied scientist who plans to use causal inference in their research
- Exposure to `R` is helpful, but not necessary
- Familiarity with statistical concepts is assumed: random variables, expectations, distribution functions, etc ...
    - Familiarity with regression, maximum likelihood, etc is less important

Learning objectives

Students will learn to:

1. Distinguish, apply and evaluate needs for causal inference assumptions flowing research design.

2. Perform randomization inferences for randomized trials in R, including those with clustered or stratified treatment allocation and/or imperfect compliance. Appropriately adapt these inference strategies to observational studies, and to diagnostics including covariate balance.

3. Perform or critique statistical adjustments for observational studies with the linear model and/or matching.

4. Implement testing, estimation, and adjustment methods covered in the course using R, in replicable scripts combining R and markdown.

Textbooks and assignments

- Primary textbook: Rosenbaum (2017)
  - Supplementary textbooks: Rosenbaum (2002, 2010); Imbens and Rubin (2015); Gerber and Green (2012)
- Three homework assignments
  - Mix of conceptual questions and applied questions with data analysis using `R`

References

Gerber, A. S. and D. P. Green (2012). *Field Experiments: Design, Analysis, and Interpretation*. New York, NY: W.W. Norton.

Imbens, G. W. and D. B. Rubin (2015). *Causal Inference for Statistics, Social, and Biomedical Sciences: An Introduction*. New York, NY: Cambridge University Press.

Rosenbaum, P. R. (2002). *Observational Studies* (2nd ed.). New York, NY: Springer.

Rosenbaum, P. R. (2010). *Design of Observational Studies*. New York, NY: Springer.

Rosenbaum, P. R. (2017). *Observation and Experiment: An Introduction to Causal Inference*. Cambridge, MA: Harvard University Press.