Causal Inference

Tuesdays, Thursdays: 15:00-16:20

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Course directory for summaries of lectures and problem sets:
http://biosun01.biostat.jhsph.edu/~cfrangak/biostat_causal

Evaluation: four problem sets and a report.
The instructor acknowledges sharing of valuable ideas and material with Donald Rubin and Guido Imbens.

SYLLABUS

The course covers the topics outlined below. The articles listed comprise relevant reference material. Starred articles are included in a course packet.

1. Introduction and Framework.
   1 Introduction.
   2 Framework of potential outcomes and assignment mechanism.
      *Neyman (1923, pp. 465-468), *Rubin (1990),
   3 Historical review.
   4 Notes and outline of the course.

2. The completely randomized assignment.
   1 Fisher’s mode of inference on focusing on the null hypothesis.
   2 Neyman’s mode of inference; covariates, efficiency considerations.
      *Neyman (1923, p. 468-472)
3. Treatment assignment with known and varying probabilities

1 Assumption of assignment; studies that have this form.

2 Fisher’s mode of inference, limitations.

3 Neyman’s mode of inference, limitations.

   Horwitz and Thompson (1952).

4. Ignorable treatment assignment and propensity scores.

1 Studies we can address with this template; assumption of ignorability.

2 Role of models for the outcome.
   (1) Likelihood mode of inference; estimation under additivity of effects, nonadditivity.
   (2) Small number of important covariates, matching, subclassification, weighting, modeling; limitations with large number of covariates.


3 Role of propensity score.
   (1) Definition, main properties.
   Case study for:
   (2) fitting and diagnostics for the propensity score.
   (3) using the propensity score.


   (4) comparison of propensity score with other methods: a case study


4 Sensitivity analysis and other issues


5 Propensity scores for multiple groups

6 Bayesian inference (*Rubin, 1978)

* denotes references.
5. Studies with treatments at multiple times: case of sequentially ignorable assignment.

1 Introduction: what studies we consider.

2 Problems with standard methods.

3 Estimating causal effects with full modelling.

4 Estimating causal effects by limited modelling:
   marginal structural models and estimation.

6. Studies with nonignorable noncompliance and instrumental variables

1 Introduction: studies with treatment-noncompliance.

2 Assumptions of instrumental variables with potential outcomes.

3 Estimating causal effects of interest.

7. Studies with multiple partially controlled factors

1 Partially controlled studies.
   (1) What causal effects are of interest.
   (2) Standard definitions.
   (3) The framework of principal stratification.
      *Frangakis and Rubin (2002)

2 Studies with noncompliance to treatment and incomplete outcomes.
   (1) Invalidity of intention-to-treat analysis even for the intention-to-treat effect.
   (2) Estimation of causal effects.
      Case study: evaluating school choice on student performance
Case study: evaluating needle exchange programs
*Frangakis et al. (2004)

Case study: evaluating vaccine trials
*Gilbert et al. (2003).

Case study: estimating missing data related to death using interventional designs
References - articles with * are available in a course packet


