The Statistics of Causal Inference in the Social Sciences
Political Science C236A
Statistics C239A

Professor Jasjeet Singh Sekhon

Class: 4–7pm Wed
130 Wheeler

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Description
Approaches to causal inference using the potential outcomes framework. Covers randomized experiments with and without noncompliance, observational studies with and without ignorable treatment assignment, instrumental variables, regression discontinuity, sensitivity analysis, and permutation inference. Applications are drawn from a variety of fields including political science, economics, sociology, public health, and medicine.

Prerequisites
A multivariate regression course with linear algebra, upper division probability and statistics, and familiarity with high-level programming languages. PS236a and PS236b or Statistics 133, 134, and 135 are recommended. The programming language used in the course is R.
If you need to review material, please consult David Freedman’s excellent Statistical Models: Theory and Practice or John Fox’s Applied Regression Analysis, Linear Models, and Related Methods, which includes examples using the R programming language.

Evaluation
Final grades will be based on a series of homework assignments (30% of final grade), a midterm (30%), a term paper or final exam (30%), and class and section participation (10%). Student have the choice between a term paper and a final exam.
It is recommended that students write the term paper jointly with one or at most two other students. Experience has shown that this greatly facilitates learning as well as increases the likelihood that the paper will eventually become a published article.

Weekly readings and homework assignments are the norm. It is highly recommended that students form study groups in order to complete the homework assignments. Although it is recommended that people work together in order to complete the assignments, students must hand in their own individual answers. Photocopies and other reproductions of someone else’s answers are not acceptable. Students should hand in the answers to the problem sets, and all computer code written to find those answers.

During exams, students are not allowed to communicate or cooperate with anyone in any way about exam. Any questions should be asked directly to me and the GSI. To repeat: for exams, one is not allowed to use study groups, online help forms, the writing center, or any other form of help aside from those that are explicitly allowed on the exam instructions. If in doubt, ask.

Incomplete: all course material must be handed in by the first day of class of the spring semester unless an exemption is explicitly granted.

Date for the midterm: week of November 18.

When you email me about the course, please start the subject of the email with the text inside of the following quotes: “[CI:]” (note the square brackets, and ignore the quotes).

## Course Software and Books

The programming language for this course is the R. It is available for download from: [http://www.r-project.org/](http://www.r-project.org/) R is open source software (released under the GNU public license).

The books listed below are available at various online bookstores. These books are not required, but most purchase them because we assume that you have access to them when needed.

- Rubin, Donald. 2006. *Matched Sampling for Causal Effects*. Cambridge University Press. ISBN 0521674360. Note: this is a collection of articles that you can also find on JSTOR.


The following books may be of additional help:


This book is less technical than Rosenbaum’s *Observational Studies*. The book is also available online via Cal’s contract with Springer-Verlag: [http://www.springerlink.com/content/978-1-4419-1212-1/#section=627451&page=1](http://www.springerlink.com/content/978-1-4419-1212-1/#section=627451&page=1)
Course outline

1. Causality

   The potential outcomes framework for causal inference.


   Extra reading:


2. Statistical Modeling: Foundations and Limitations

   - Freedman Chapter 3 (Freedman 1991): “Statistical Models and Shoe Leather.”

   For extra readings see the rest of the Freedman volume, especially:


3. Randomized Experiments and Controlling Bias in Observational Studies

   Properties of experiments, basic implementations, and illustrations of observational studies based on approximate experimental design.

     Cochran and Rubin (1973): “Controlling Bias in Observational Studies: A Review”
Extra readings:

- Przeworski (In Press) “Is the Science of Comparative Politics Possible?”
- Cochran (1965): “The Planning of Observational Studies of Human Populations”
- Cochran (1983): Chapters 1 and 7

4. Randomization Inference

Fisherian and permutation Inference, and the Lady Tasting Tea

- Rosenbaum (2002b ch 2): Observational Studies

Extra reading:

- Freedman Chapter 8: “What is the Chance of an Earthquake?”
- Pitman (1937b): “Significance Tests Which May be Applied to Samples From any Populations”
- Pitman (1937a): “Significance Tests Which May be Applied to Samples from any Populations. II. The Correlation Coefficient Test”
- Pitman (1938): “Significance Tests which can be Applied to Samples from any Populations. III. The Analysis of Variance Test”

5. Univariate Matching Methods for Controlling Bias in Observational Studies

Experimental and observational studies where assignment to treatment is done on observables. Stratification and matching.

- Rubin (2006) Chapters 3 to 5:
  “Matching to Remove Bias in Observational Studies” Rubin (1973a)
  “The Use of Matched Sampling and Regression Adjustment to Remove Bias in Observational Studies” Rubin (1973b)
  “Assignment to a Treatment Group on the Basis of a Covariate”
- Rosenbaum (2002b) Chapter 3.1–3.3

6. The Propensity Score

Logistic regression and the fundamentals of propensity score matching

- Handout on general linear models
• Rub inc{2006} Chapters 10, 11 and 14 all with Paul R. Rosenbaum:
  “The Central Role of the Propensity Score in Observational Studies” Rosenbaum and
  Rub inc{1983}
  “Assessing Sensitivity to an Unobserved binary Covariate in an Observational Study with Binary Outcome”
  “The Bias Due to Incomplete Matching”

• Sek hon{2004c}: The Varying Role of Voter Information Across Democratic Societies

• Morgan and Harding{2006}: ‘Matching Estimators of Causal Effects: Prospects and
  Pitfalls in Theory and Practice’

Also see Rosenbaum and Rubin{1984}; Rubin and Thomas{2000}.

7. Regression Discontinuity Design

• Thistlethwaite and Campbell{1960}: “Regression-Discontinuity Analysis: An alternative to the ex post facto experiment”

• Lee{2008}: “Randomized Experiments from Non-random Selection in U.S. House Elections”


• Hahn, Todd, and van der Klaauw{2001}: “Identification and Estimation of Treatment Effects with a Regression-Discontinuity Design”

Extra reading:


8. Multivariate Matching

*Mahalanobis distance, and Equal Percent Bias Reduction*

• Rub inc{2006} Chapters 8 and 9:
  “Bias Reduction Using Mahalanobis-Metric Matching” Rub inc{1980}
  “Using Multivariate Matched Sampling and Regression Adjustment to Control Bias in Observational Studies” Rub inc{1979}

9. Genetic Matching

*Automatic balance optimization, evaluating balance and the LaLonde controversy*

• Diamond and Sek hon{2013}: “Genetic Matching for Estimating Causal Effects”

• Sek hon and Grieve{2012}: “A Matching Method for Improving Covariate Balance in Cost-Effectiveness Analyses.”

• LaLonde{1986} [JSTOR]

• Dehejia and Wahba{1999} [JSTOR]

• Smith and Todd{2001}

10. Natural Experiments
11. Matching Examples Using Observational Data

**Political Science**

- **Gordon and Huber** (2010): “The Effect of Electoral Competitiveness on Incumbent Behavior”
- **Gilligan and Sergenti** (2009): “Evaluating UN Peacekeeping with Matching to Improve Causal Inference”

**Economics**


**Other**

- **Christakis and Iwashyna** (2003): “The Health Impact of Health Care on Families: A matched cohort study of hospice use by decedents and mortality outcomes in surviving, widowed spouses”

12. Instrumental Variables (IV)

- **Angrist and Krueger** (2001): “Instrumental Variables and the Search for Identification: From Supply and Demand to Natural Experiments”

Application, and use of randomization inference to correct an issue:


13. **(Regression) Adjustment to Experimental Data**

• **Lin et al. (2013):** “Agnostic Notes on Regression Adjustments to Experimental Data: Reexamining Freedman’s Critique.” [http://tinyurl.com/9378kmk](http://tinyurl.com/9378kmk)

• **Miratrix, Sekhon, and Yu (2013a):** Adjusting Treatment Effect Estimates by Post-Stratification in Randomized Experiments

Extra readings:

• **Freedman (2008a):** “On regression adjustments to experimental data.”

• **Freedman (2008d):** “Randomization does not justify logistic regression”

• **Freedman (2008b):** “On regression adjustments in experiments with several treatments”

14. **Blocking in Experiments**

• **Lock Morgan and Rubin (2012):** “Rerandomization to improve covariate balance in experiments”

• **Imbens (2011):** “Experimental Design for Unit and Cluster Randomized Trials”

• **Higgins and Sekhon (2013):** “Improving Experiments by Optimal Blocking: Minimizing the Maximum Within-block Distance”

• **Miratrix, Sekhon, and Yu (2013b):** “Adjusting Treatment Effect Estimates by Post-Stratification in Randomized Experiments”

15. **External Validity: Better LATE Than Nothing**

• **Deaton (2009):** “Instruments of Development: Randomization in the tropics, and the search for the elusive keys to economic development”


• **Hartman, Grieve, Ramsahai, and Sekhon (forthcoming):** “From SATE to PATT: Combining Experimental with Observational Studies to Estimate Population Treatment Effects”

16. **Sensitivity Analysis for Hidden Bias and other Helpful Suggestions**

• **Rosenbaum (2002b):** chapters on sensitivity analysis

• **Rosenbaum (2005):** why more data (even big data) isn’t necessarily better. Also links Mill to Fisher.

17. **Application: Fixing Broken Experiments and a Controversy**

• Imai, Kosuke. "Do Get-Out-The-Vote Calls Reduce Turnout? The Importance of Statistical Methods for Field Experiments." American Political Science Review
• Green and Gerber Reply

18. SYNTHETIC COHORTS
When good matches cannot be found: create a new unit

• Abadie, Diamond, and Hainmueller (2010): Synthetic control methods for comparative case studies: Estimating the effect of California’s tobacco control program

19. FULL AND OPTIMAL MATCHING

• Hansen (2004)

20. APPLICATION: VOTING IRRGULARITIES

• Wand, Shotts, Sekhon, Walter R. Mebane, Herron, and Brady (2001): The Butterfly Did It: The Aberrant Vote for Buchanan in Palm Beach County, Florida
• Mebane and Sekhon (2004): Robust Estimation and Outlier Detection for Overdispersed Multinomial Models of Count Data

21. PRE-TEST PROBLEMS

• Freedman (1983): “A Note on Screening Regression Equations”

References


