Tentative Course Syllabus

**Stat 293/393 - Design of Experimental and Non-experimental Studies**

Spring 2023

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**Course description:** This is a graduate-level course on causal inference: learning what intervention work, when, and how. We will study old principles and new proposals for the design and analysis of experimental and non-experimental (observational) studies. This course is geared towards methodological research in causal inference.

**Course requirements:** To read all the readings and think independently and critically about them. To present one or two readings in class. For letter grade, to write a final project report and to present it to the class.

**Course grading:** Letter grade or Pass/Fail. The grade will depend on class participation, the readings presentations, and the final project presentation and written report. Ideally, the final project will be a first step towards a publishable research paper. Options for the final project are to: read about a statistical method for causal inference (covered or not covered in class) and carry out a simulation study or data analysis to illustrate the method; conduct a thorough analysis of a data set using some of the methods covered in class; or develop a new statistical method or theoretical result that could be an extension of an existing method or theoretical result.

**Course prerequisites:** Stat 211 or equivalent *and* permission of the instructor.

**Topics and tentative course readings:**

- Week 1 (01/27/2023): Experimental and non-experimental studies.
  - Design of Observational Studies, Chapters 1-4
    PR Rosenbaum
    Springer (2020)

- On the Implied Weights of Linear Regression for Causal Inference
  A Chatopadhyay, JR Zubizarreta
  Biometrika (2023), in press

- Week 2 (02/03/2023): Sensitivity analysis.
  - Sensitivity Analysis
    CB Fogarty
    Handbook of Matching and Weighting Adjustments for Causal Inference (2023)
  - Sensitivity Analyses Informed by Tests for Bias in Observational Studies
    PR Rosenbaum
    Biometrics (2023), in press

- Week 3 (02/10/2023): Evidence factors.
  - Design of Observational Studies, Chapters 20, 21
    PR Rosenbaum
    Springer (2020)
  - Evidence Factors
    B Karmakar
    Handbook of Matching and Weighting Adjustments for Causal Inference (2023)

- Week 4 (02/17/2023): Effect modification or treatment effect heterogeneity.
  - Effect Modification in Observational Studies
    K Lee, JY Hsu
    Handbook of Matching and Weighting Adjustments for Causal Inference (2023)
  - Treatment Heterogeneity with Survival Outcomes
    Y Xu, N Ignatiadis, E Sverdrup, S Fleming, S Wager, N Shah
    Handbook of Matching and Weighting Adjustments for Causal Inference (2023)

- Week 5 (02/24/2023): Generalization, transportation, aggregation.
  - A Review of Generalizability and Transportability
    I Degtiar, S Rose
    Annual Review of Statistics and Its Application (2023) 10
  - Causal Inference Methods for Combining...
    B Colnet et al.
    arXiv:2011.08047v4 (2023)

- Week 6 (03/03/2023): Simultaneous inference.
  - Multiplicity Considerations in Clinical Trials
    A Dmitrienko, RB D'Agostino Sr
    New England Journal of Medicine (2017) 378 (22), 2115-2122

- Traditional Multiplicity Adjustment Methods in Clinical Trials
  A Dmitrienko, RB D'Agostino Sr
  Statistics in Medicine (2013) 32 (29), 5172-5218

- Week 7 (03/10/2023): Difference-in-differences and event studies.
  - What's Trending in Difference-in-Differences? A Synthesis of...
    J Roth, PHC Sant'Anna, A Bilinski, J Poe
    arXiv:2201.01194v3
  - Revisiting Event Study Designs: Robust and Efficient Estimation
    K Borusyak, X Jaravel, J Spiess
    arXiv preprint (2021) arXiv:2108.12419v1

- Week 8 (03/17/2023): Spring recess.

- Week 9 (03/24/2023): Synthetic experiments and synthetic controls.
  - Synthetic Controls for Experimental Design
    A Abadie, J Zhao
    arXiv:2108.02196v2 (2022)
  - Bayesian Nonparametric Common Atoms Regression for Generating...
    NK Chandra, A Sarkar, JF de Groot, Y Yuan, P Müller
    arXiv:2201.00068v2 (2022)

- Week 10 (04/31/2023): Mediation.
  - Mediation Analysis: A Practitioner's Guide
    TJ VanderWeele
    Annual Review of Public Health (2016) (37), 17–32
  - Weighting Estimators for Causal Mediation
    DL Coffman, MS Schuler, TQ Nguyen, and DF McCaffrey
    Handbook of Matching and Weighting Adjustments for Causal Inference (2023)

- Week 11 (04/07/2023): Discontinuity designs and optimal threshold selection.
  - Regression Discontinuity Designs
    MD Cattaneo, R Titiunik
    Annual Review of Economics (2022) (14), 821–851
  - Safe Policy Learning under Regression Discontinuity Designs
    Y Zhang, E Ben-Michael, K Imai
    arXiv:2208.13323v2 (2022)

- Week 12 (04/14/2023): Conformal inference.
  - Conformal Inference of Counterfactuals and Individual Treatment Effects
    L Lei, EJ Candes
    Journal of the Royal Statistical Society, Series B (2021) (83), 911–938

- Doubly Robust Calibration of Prediction Sets under Covariate Shift
  Y Yang, AK Kuchibhotla, EJ Tchetgen Tchetgen
  arXiv:2203.01761v3 (2022)

- Week 13 (04/21/2023): Final project presentations (each presentation will be allotted 15-20 mins. followed by 5 mins. of questions).