Syllabus
POLI 273: Causal Inference, Spring 2020
Professor: Kirk Bansak
Teaching Assistant: Mackenzie Lockhart

Time & Room
Class: Thursday, 3:00 - 5:50pm Pacific Time
Section: TBD

Professor: Kirk Bansak
Contact: kbansak@ucsd.edu
Office Hours: Wednesday, 9:00am - 12:00pm (sign-up details below)

TA: Mackenzie Lockhart
Contact: mwlockha@ucsd.edu
Office Hours: Tuesday, 9:00am - 11:00am (or by appointment)

1 Overview
This is part of the course sequence on quantitative political methodology—the application of statistical methods to problems in political science and public policy. The goal of the course sequence is to teach you (1) to understand and (2) to confidently apply a variety of statistical methods and research designs that are essential for political science and public policy research.

Building on the previous courses, which covered math, probability, linear regression, and other statistical models, this class provides a survey of more advanced empirical tools for political science research. The focus is on statistical methods for causal inference, i.e. methods designed to address research questions that concern the impact of some potential cause (e.g. an intervention, a change in institutions, economic conditions, government policies) on some outcome (e.g. vote choice, income, election results, levels of violence).

We cover a variety of causal inference designs and methods. These include experiments, matching, regression, difference-in-differences, panel methods, synthetic control methods, instrumental variable estimation, regression discontinuity designs, power analysis, and sensitivity analysis.

We will analyze the strengths and weaknesses of these methods, and throughout the course we will illustrate the methods with applications drawn from various fields, including political science, public policy, economics, public health, and sociology. The ultimate goal of this course is to provide students with adequate methodological skills for conducting causal empirical research in their own fields of substantive interest.

1.1 Prerequisites
A willingness to work hard on possibly unfamiliar material is key. In addition to introductory statistics and probability, we assume that you have a reasonably good knowledge of linear regression (meaning that you probably should have taken at least one graduate class on this subject, such as POLI 204B). Knowledge of the maximum likelihood method is useful, but not required.

Students are also expected to be reasonably proficient in the statistical software R. We will allow the use of other software packages that you may be more familiar with. However, the teaching staff will only provide
support in R, all in-class coding examples/exercises will be in R, and there will be questions on problem sets and exams that require coding up functions, running simulations, and performing other tasks for which other software may not necessarily be well-suited.

1.2 Class Requirements

Readings
The syllabus lists the required readings. This required reading should be completed prior to lecture in a given week. Students are expected to read the material very carefully. You may even find it helpful to read the material multiple times.

Problem Sets
This is a methodological course in which you will develop skills in understanding and applying statistical methods. You can only learn statistics by doing statistics, and therefore you will be required to complete weekly problem sets. The problem sets are intensive and consist of analytical problems, computer simulations, and data analysis. Problem sets will be graded on a (+,✓,-) scale.

Problem sets should be completed and submitted using R Markdown, a markup language for producing well-formatted HTML documents with embedded R code and text (including \LaTeX) outputs. R Markdown requires installation of the knitr package. We recommend using RStudio, an IDE for R, which is set up well for the creation of R Markdown documents.

More about RStudio can be found here:
http://www.rstudio.com/

R Markdown can be found here:
http://rmarkdown.rstudio.com/

We encourage students to work together on the assignments, but you always need to write your own solutions, and we ask that you make a solo effort at all the problems before consulting others. In particular, you should not copy someone else’s answers or computer code. We also ask that you write the names of your co-workers on your assignments. For analytical questions, you should include your intermediate steps, as well as comments on those steps when appropriate. For data analysis questions, include annotated code as part of your answers. All results should be presented so that they can be easily understood.

Exams
There will be a final exam and a midterm exam. You are required to work on both exams alone.

The midterm exam is timed take-home exam. You will have flexibility in terms of when you begin the exam. However, once you begin, you will have a pre-specified amount of time to complete the exam.

The final exam will consist of a week-long take-home exam that is similar to a more extensive problem set.

Grading
Grades will be based on:

- Homework assignments (35% of final grade)
- Midterm exam (30% of final grade)
- Final exam (35% of final grade)
2 Logistics

2.1 Class Meetings

All class meetings will be conducted online at our scheduled class time (Thursday 3:00pm - 5:50pm Pacific Time) via the video-conferencing platform Zoom. It is recommended that everyone tries to connect through our Zoom link in advance of our first class meeting to ensure the software is working properly.

In addition, all class meetings will be recorded and posted on our canvas.ucsd.edu page. However, students are highly encouraged to attend class at the scheduled meeting time in order to have the opportunity to participate and ask questions in real time. Individuals who do not want to have their surroundings visible are encouraged to use Zoom’s virtual background feature, if feasible, or to participate without video. Please also be mindful of others who may not wish to be visible or recorded in the background.

2.2 Recitation Sections

Weekly recitation sections will be held. The section will cover a review of the theoretical material and also provide help with computing issues. The TA will run the sections and can give more detail.

2.3 Office Hours

I will hold office hours from 9:00am to 12:00pm Pacific Time on Wednesdays via Zoom. Please make sure to sign up for office hours in advance using the following Cal-endly link. If you would like to meet but have class during my office hours, please email me to arrange an alternative time.

2.4 Teaching Assistant

Mackenzie Lockhart (mwlockha@ucsd.edu) will be the teaching assistant for this course. He will be holding office hours on Tuesdays from 9:00am to 11:00am Pacific Time via Zoom. Mac’s office hours will be on a first-come, first-served basis. If you cannot make this time, please contact him by email to coordinate a different time.

2.5 Course Website

As our primary course website, we will use Piazza.

You can sign up on the Piazza course page directly from the above address. There are also free Piazza apps for mobile devices.

We will distribute course materials, including lecture slides and problem sets on our Piazza website. There is also a question-and-answer platform that is easy to use and designed to get you answers to questions quickly. It supports code formatting, embedding of images, and attaching of files.

If you have non-personal questions related to course material or logistics, we encourage you to post these questions on Piazza rather than emailing the course instructors. Using Piazza will allow students to see and
learn from other students’ questions. Course instructors will regularly check the board and answer questions posted, although everyone else is also encouraged to contribute to the discussion and help answer questions. Participating on the Piazza forum, in addition to attending recitation sections and office hours, is a valuable way to supplement your own learning of the course material. Please be respectful and constructive in your participation on the forum.

In addition, we will also use our canvas.ucsd.edu page for a few select functions, including to record/access grades and post lecture recordings.

2.6 Computation

In this course we will exclusively use R.

2.7 Required Books

• Most required readings are from the following two textbooks:
  – Morgan, Stephen L. and Christopher Winship. 2015. Counterfactuals and Causal Inference: Methods and Principles for Social Research, Second Edition. Cambridge University Press. (This is the second edition of a standard reference for applied researchers for most topics covered in the first part of the course. There are considerable differences between the first and second edition. The assigned readings correspond to the second edition.)

Useful Summary Articles

• The following papers summarize the main methods learned in this course. They are dense and detailed, and you might not understand all of the details the first time you read through them. However, if you plan to conduct applied empirical work that involves causal inference, you should revisit these again and again as reference.

Optional Books

• The following books are optional but may prove useful for additional coverage of some of the course topics.
  • Causal Inference

- *Experiments*

- *Matching*

- *Panel Methods*

### 3 Tentative Course Schedule

The following is a preliminary schedule of the assignments and topics we will cover in this course. More details on each topic and the associated readings can be found in the Course Outline section.

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<th>Introduction and Potential Outcomes Model</th>
<th>PS1 out</th>
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<td>Week 2</td>
<td>Randomized Experiments</td>
<td>PS1 in; PS2 out</td>
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<tr>
<td>Week 3</td>
<td>Randomized Experiments</td>
<td>PS2 in; PS3 out</td>
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<td>Week 4</td>
<td>Causal Effects under Selection on Observables</td>
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<td><em>Subclassification, Matching</em></td>
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<td>Week 5</td>
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<td>PS4 in</td>
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<td>Causal Effects under Selection on Time-Invariant Unobservables</td>
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<td><em>Difference-in-Differences</em></td>
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<td>Week 7</td>
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<td><em>Panel Methods, Synthetic Control Methods</em></td>
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<td>Week 8</td>
<td>Additional Designs and Methods</td>
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<td>Week 10</td>
<td>Distributional Effects</td>
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<td>Week 11</td>
<td>Final Exam Week</td>
<td>Final</td>
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4 Course Outline

The following is an outline of course topics. Notice that required readings are marked with a (⋆).

4.1 Introduction

• Overview, Course Requirements, Course Outline

4.2 The Potential Outcome Model

• Counterfactual Responses and the Fundamental Identification Problem
• Estimands and Assignment Mechanisms
• Heterogeneity and Selection

Readings

• Morgan and Winship: Chapter 1-2. (⋆)
• Angrist and Pischke: Chapter 1. (⋆)

4.3 Randomized Experiments

4.3.1 Theory

• Identification of Causal Effects under Randomization
• Implementation, Estimation, Diagnostics, Blocking
• Threats to Validity

4.3.2 Statistical Inference

• Variance Estimation under the Neyman Model
• Inference for Clustered Designs
• Randomization Inference
• The Bootstrap
• Power Analysis

Readings: Theory and Inference in Experiments

• Angrist and Pischke: Chapter 2. (⋆)
• Angrist and Pischke: Chapter 8. (⋆)
• Athey, Susan, and Guido W. Imbens. 2016. The Econometrics of Randomized Experiments.


**Readings: Application of Experiments**


**Readings: Application of Natural Experiments**

• Hyde, Susan D. 2007. The Observer Effect in International Politics: Evidence from a Natural Experiment. *World Politics* 60(1): 37-63. (⋆)


**Readings: Review Articles**


**Readings: Methodological Guides**


### 4.4 Causal Effects under Selection on Observables

#### 4.4.1 Theory

- Identification under Selection on Observables

- Subclassification

**Readings**

- Morgan and Winship: Chapters 3-4. (⋆)


#### 4.4.2 Matching Methods

- Covariate Matching

- Balance Checks

- Properties of Matching Estimators

**Readings: Matching Theory**

- Morgan and Winship: Chapter 5. (⋆)


• Stuart, Elizabeth A. 2009. Matching methods for causal inference: A review and a look forward

• Rubin: Chapters 3 to 5.


**Readings: Matching Applications**


### 4.4.3 Propensity Score Methods

• Identification, Propensity Score Estimation, Matching on the Propensity Score, Weighting on the Propensity Score, Reweighting methods

**Readings: Propensity Score Methods Theory**

• Morgan and Winship: Chapter 5. (⋆)

• Rubin: Chapters 10, 11 and 14 (all with Paul R. Rosenbaum).


**Readings: Propensity Score Methods Applications**


### 4.4.4 Regression

• Agnostic Regression framework, Non-parametric Regression, Identification with Regression

**Readings**

• Angrist and Pischke: Chapter 3. (⋆)

• Morgan and Winship: Chapters 6-7. (⋆)


### 4.4.5 Conclusion: Selection on Observables

• Can Non-Experimental Methods Recover Causal Effects?

**Readings: Comparison of Experimental and Non-experimental Methods**


4.4.6 Sensitivity Analysis

- Nonparametric Bounds
- Formal Sensitivity Tests

Readings

- Morgan and Winship: Chapter 12 (*)

4.5 Causal Effects under Selection on Time-Invariant Unobservables

4.5.1 Difference-in-Differences Estimators

- Identification, Estimation, Falsification tests

Readings: DID Theory

- Angrist and Pischke: Chapter 5.2-5.4 (*)

Readings: DID Applications

4.5.2 Panel Data Methods

- Fixed Effects and Random Effects Estimation

Readings: Panel Methods Theory

- Angrist and Pischke: Chapter 5.1 (⋆)
- Angrist and Pischke: Chapter 8 (⋆)

Readings: Panel Methods Applications


4.5.3 Synthetic Control Methods

Readings

4.6 Additional Designs and Methods

4.6.1 Instrumental Variables

- Identification: Using Exogenous Variation in Treatment Intake Given by Instruments
- Imperfect Compliance in Randomized Studies
- Wald Estimator, Local Average Treatment Effects, 2SLS

Readings: Instrumental Variable Theory and Methods

- Angrist and Pischke: Chapter 4 (∗)
- Morgan and Winship: Chapter 8
- Morgan and Winship: Chapter 9 (∗)

Readings: Instrumental Variable Critique


Readings: Instrumental Variable Applications

4.6.2 The Regression Discontinuity Design
- Sharp and Fuzzy Designs, Identification, Estimation, Falsification Checks

Readings: RDD Theory
- Angrist and Pischke: Chapter 6 (⋆)

Readings: RDD Applications

4.7 Distributional Effects
4.7.1 Quantile Regression

Readings
- Angrist and Pischke: Chapter 7 (⋆)


4.7.2 Distributional Effects in Difference-in-Differences

*Readings*


4.7.3 Instrumental Variables for Quantile Effects

*Readings*


4.8 Possible Additional Topics

4.8.1 Attrition

4.8.2 Causal Mediation

4.8.3 Machine Learning for Causal Inference
5 Policies

5.1 Students with Disabilities

Students requesting accommodations for this course due to a disability must provide a current Authorization for Accommodation (AFA) letter issued by the Office for Students with Disabilities (https://osd.ucsd.edu/). Students are required to discuss accommodation arrangements with instructors and OSD liaisons in the department well in advance of any exams or assignments. The OSD Liaison for the Department of Political Science is Joanna Peralta; please connect with her via the Virtual Advising Center (https://stark.ucsd.edu/students/vac/) as soon as possible.

5.2 Academic Advising

Students who have questions pertaining to Political Science academic advising are asked to reach out the Department’s Graduate Advisor, Julie Choi, who can be reached via the Virtual Advising Center (https://stark.ucsd.edu/students/vac/). Academic advising questions often include (but not limited to): add/drop deadlines, course enrollment policies, planning major and minor requirements, quarter-by-quarter plans, department petitions and paperwork, and referrals to campus and student support services.

5.3 UC San Diego Principles of Community

The University of California, San Diego is dedicated to learning, teaching, and serving society through education, research, and public service. Our international reputation for excellence is due in large part to the cooperative and entrepreneurial nature of the UC San Diego community. UC San Diego faculty, staff, and students are encouraged to be creative and are rewarded for individual as well as collaborative achievements.

To foster the best possible working and learning environment, UC San Diego strives to maintain a climate of fairness, cooperation, and professionalism. These principles of community are vital to the success of the University and the well being of its constituents. UC San Diego faculty, staff, and students are expected to practice these basic principles as individuals and in groups.

For the complete UC San Diego Principles of Community, see:
https://ucsd.edu/about/principles.html
6 Resources

Library Help and Research Tools:  https://library.ucsd.edu/ask-us/triton-ed.html

Writing Hub:  https://commons.ucsd.edu/students/writing/index.html

Supplemental Instruction:  https://commons.ucsd.edu/academic-support/supplemental-instruction/si-students.html

Tutoring:  https://commons.ucsd.edu/academic-support/content-tutoring/index.html

Mental Health Services:  https://caps.ucsd.edu

Community Centers:  Learn about the different ways UC San Diego explores, supports, and celebrates the many cultures in our diverse community.  https://students.ucsd.edu/student-life/diversity/index.html

Accessibility:  https://disabilities.ucsd.edu/

Basic Needs:  Any student who has difficulty accessing sufficient food to eat every day, or who lacks a safe and stable place to live, and believes this may affect their performance in this course, is encouraged to contact: foodpantry@ucsd.edu and basicneeds@ucsd.edu

March, 2020