SOC 8890: Applied Causal Inference

Lecture time: Weds 11:45-2:15pm
Lecture location: 1114 Social Sciences Building

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Office hours: Tues 1:00-3:00pm
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Course Description

Over the past twenty years, there have been many developments in the designs we use to study cause and effect in quantitative social science. But causal inference isn't just a set of estimation methods; it is a broad framework that focuses on precision in asking research questions, as well as carefully defining the assumptions required to answer those questions. Despite theoretical and empirical advances in this framework, causal inference remains a confusing and ambiguous term. What "counts" as causal inference? Who is doing it? Am I doing causal inference? If I'm not conducting an experiment, should I simply avoid using the language and logic of causal inference?

This course takes a holistic approach to these questions and is designed for population scientists—demographers, sociologists, epidemiologists, psychologists, economists—interested in developing a broad understanding of causal inference concepts and methods.

Students will learn how to implement a variety of causal methods, but methods are only one part of applying the principles of causal inference. The causal inference literature can be overwhelming and contradictory, spanning many disciplines that all use different terminology. Many of the causal concepts and methods covered in this course are relatively new and remain the subject of debate. This course will therefore be interactive and involve presenting and discussing debates related to causal inference. Students will learn to engage with issues of causal inference and figure out how they relate to their own research agendas.

Students will develop a final project throughout the course, which must be based on a causal question rather than a descriptive or predictive question. This does not mean that the project must be able to produce "gold standard" causal evidence (and as we will discuss, the very idea that there is a clear "hierarchy of causal evidence" is contested). It means the project must be motivated by a question like this:

> "I'm interested in whether and how X causes / impacts / benefits / patterns / is linked to / shapes / is associated with Y?"

As we will discuss throughout the course, there are specific assumptions that must be made to argue that X in fact causes Y, and these assumptions depend on your theoretical causal estimand. It is very difficult in practice to ever meet all these assumptions in a single study, especially in observational social science, and triangulation across many studies and methods is crucial. Any question that

sounds like the question above is well-suited for the final project and will be informed by the holistic counterfactual reasoning developed in this course.

Last, this course touches on several areas of professionalization for population scientists. We will discuss how the concepts of causal inference learned in class can help students be critical consumers of academic studies, as well as effective peer reviewers.

Prerequisites

This is not a math or statistics course. It is also not a course in statistical programming. Students with stronger quantitative and coding backgrounds may be able to do a deeper dive into some of the methods covered in Weeks 8-14, but an introductory course in graduate social statistics is the only requirement (e.g., SOC 5811/8811), and students at this level of training will be able to complete all the assignments and achieve the learning goals below. This course may also be appropriate for advanced undergraduates.

Learning Goals

By the end of this course, students will be able to:

1. Understand and describe the broad uses and limitations of quantitative causal inference.
2. Use counterfactual reasoning to define estimands and ask precise research questions.
3. Implement the methods covered in this course.
4. Provide effective and thoughtful academic peer review of research designs.
5. Pursue a feasible quantitative study based on their final project.

Evaluation

- **Problem Sets (10%):** The two problem sets are based on R code and interpretation of results. These will not be exercises in writing R code. I will provide all example datasets and code for implementing methods covered in class. Students will run this code and interpret the results. Evaluation will be based on this written interpretation. The purpose of these problem sets is primarily to give students code templates for implementing the methods covered in class for use in their own research projects.

- **Leading Discussion Days (25%):** On Discussion Days, I will start with some framing of the readings and issues covered. The students who signed up to lead discussion that day will then briefly present on the main issues discussed in the readings and lead a class discussion (e.g., pose questions to the class, help frame the issues, etc.). The readings for Discussion Days are not focused on specific methods, but instead on a broader problem or controversy in the causal inference literature—especially issues that different disciplines have different perspectives on. These will be conceptual and philosophical issues, not statistical issues. Students will only be expected to lead the discussion once.

- **Presentation of research question for final project (25%):** On Presentation Day, each student will present a research question for their final project. Students should present a specific causal research question that they hope to examine in their study. These presentations will not be evaluated based on students choosing an appropriate method to

answer their research question, though students might wish to conclude their presentations with some ideas. Presentations will only be evaluated based on the theoretical material covered in Weeks 1-5 regarding constructing a causal research design. Presentations should be around 10-15 minutes and include:

1. The research question with a well-defined causal estimand.
2. Discussion of causal assumptions and potential biases.
3. Potential datasets that could be used for estimation.

After each presentation, I will provide suggestions to help guide the final project and open it up to the rest of the class to do the same.

- **Final project (40%):** Students will incorporate feedback from their presentations and extend their proposed research question into a final project. The goal of this final project is not to produce a complete academic paper, but instead to produce a plausible analysis plan for a well-defined quantitative study. The final project document will include:

  1. The research question with a well-defined causal estimand.
  2. Discussion of causal assumptions and potential biases.
  3. Description of the dataset to be used and the relevant variables.
  4. Description of the estimation strategy.
  5. Description of strategies for evaluating assumptions and potential sources of bias.
  6. Discussion of what we can learn from this study and what we might be able to explore in the future with better data.

  <u>These final projects are not coding exercises and will not be evaluated based on producing results.</u> Producing results involves a lot of work outside the scope of this course, including writing code to wrangle data, summarize results, and create visualizations. Students with stronger coding backgrounds may of course do all this while working on their final project, and I will provide plenty of examples in R for implementing the methods covered throughout the course. Ideally, this final project will serve as the foundation of a publishable research paper for all students—but for the purposes of evaluation in this course, final projects will only be evaluated based on the written conceptual items above.

Course Schedule

There is only one required book for this course: *Counterfactuals and Causal Inference: Methods and Principles for Social Research* by Morgan & Winship (I refer to this as M&W in the schedule below). I will also refer to sections and concepts from *Causality and the People's Health* by Schwartz & Prins throughout the course, but this book is optional. I will provide all other readings on the course website, which will include articles from sociology, demography, epidemiology, political science, law, and economics.

I have included a few extra readings (**) for students who are particularly interested in certain subjects; these readings are optional and typically more difficult than the required readings.

I will potentially make changes to this schedule depending on student interest, unforeseen circumstances, etc. I will announce any changes to the schedule in class and keep the syllabus updated on Canvas.

Week	Topic	Reading, etc.
Part 1: Counterfactuals and Causal Estimands		
1 (9/4)	**How do we learn about cause and effect?** What is "causal inference?" Is it a moving target—empirically, socially, politically? How are causal inference methods well-suited (or not) to our different research questions?	No reading.
2 (9/11)	**No class**	
3 (9/18)	**Potential outcomes — Foundation.** The fundamental problem of causal inference, average treatment effects, core assumptions (exchangeability, positivity, consistency).	M&W Chapters 1-2.
4 (9/25)	**Potential outcomes — DAGs and causal estimands.** Drawing causal fields, directed acyclic diagrams (DAGs), defining causal estimands, the problem of infinite regress, additional	M&W Chapter 3. Lundberg, I., Johnson, R., and Stewart, B.M. (2021). "What is your estimand? Defining the target quantity connects statistical evidence to theory." *American Sociological Review*.

	assumptions of intervention effects (e.g., SUTVA) vs. realized causal effects.	**Schwartz, S. and Prins, S.J. (2024). *Causality and the People's Health.* (Part 1). **Phelan, J., Link, B., and Tehranifar, P. (2010). "Social conditions as fundamental causes of health inequalities: theory, evidence, and policy implications." *Journal of Health and Social Behavior.*
5 (10/2)	**Moderation and heterogeneous treatment effects.** Classic and modern designs for evaluating variation in treatment effects.	Xie, Y., Brand, J., and Jann, B. (2012). "Estimating heterogeneous treatment effects with observational data." *Sociological Methodology.* Brand, J. and Xie, Y. (2010). "Who benefits most from college? Evidence for negative selection in heterogeneous economic returns to higher education." *American Sociological Review.*
6 (10/9)	**Mediation and decomposition.** Causal mediation analysis, path-specific effects, demographic decomposition.	M&W Chapter 10. Wang, A. & Arah, O.A. (2015). "G-computation demonstration in causal mediation analysis." *European Journal of Epidemiology.* Vanderweele, T.J. (2014). "A unification of mediation and interaction: A 4-way decomposition." *Epidemiology.* **Kosuke, I., Keele, L., Tingley, D., and Yamamoto, T. (2011). "Unpacking the black box of causality: Learning about causal mechanisms from experimental and observational studies." *American Political Science Review.*
7 (10/16)	***Discussion Day* — "Non-manipulable exposures."** No causation without manipulation?	Howe, C. et al. (2022). "Recommendations for using causal diagrams to study racial health disparities." *American Journal of Epidemiology.* Sen, M. and Wasow, O. (2016). "Race as a bundle of sticks: Designs that estimate effects of seemingly immutable characteristics." *Annual Review of Political Science.* Kohler-Hausmann, I. (2019). "Eddie Murphy and the dangers of counterfactual causal thinking about detecting racial discrimination." *Northwestern University Law Review.* **Schwartz, S. and Prins, S.J. (2024). *Causality and the People's Health.* (Part 2).

8 (10/23)	***Presentation Day.*** Students present research questions for final projects.	No reading.
Part 2: Causal Methods		
9 (10/30)	**Conditioning on observables — Foundation.** Common estimators for average treatment effects (regression adjustment, propensity weighting, machine learning), causal assumptions.	M&W Chapter 6. **Brand, J., Zhou, X., and Xie, Y. (2023). "Recent developments in causal inference and machine learning." *Annual Review of Sociology.*
10 (11/6)	**Conditioning on observables — More estimators, sensitivity analysis.** Evaluating causal assumptions, e-values, estimators for other causal effects (e.g., mediation estimands). **Time-varying treatments and causal mediation — Introduction to g-methods.** Overview of time-varying causal assumptions, the g-formula, marginal structural models. **Problem Set 1 due.**	Naimi, A., Cole, S., and Kennedy, E. (2016). "An introduction to g-methods." *International Journal of Epidemiology.* **Wodtke, G., Harding, J., and Elwert, F. (2011). "Neighborhood effects in temporal perspective: The impact of long-term exposure to concentrated disadvantage on high school graduation." *American Sociological Review.* **Sudharsanan, N. and Bijlsma, M.J. (2021). "Educational note: causal decomposition of population health differences using Monte Carlo integration and the g-formula." *International Journal of Epidemiology.* **Imai, K. & Kim, S. (2019). "When should we use unit fixed effects regression models for causal inference with longitudinal data?" *American Journal of Political Science.*
11 (11/13)	***Discussion Day* — Causal triangulation.** How do we build an evidence base for a causal relationship across many studies?	Spirling, A. & Stewart, B. (2024). "What good is a regression? Inference to the best explanation and the practice of political science research." *Working Paper*.
12 (11/20)	**Difference-in-differences — Foundation and modern event studies.** Classic difference-in-differences, examples of policy and program evaluation, event studies. **Problem Set 2 due.**	*Causal Inference: The Mixtape*, Section 9.1-9.4. **Chaisemartin, C. and D'Haultfœuille, X. (2023). "Two-way fixed effects and differences-in-differences with heterogeneous treatment effects: a survey." *The Econometrics Journal.*

13 (11/27)	**Thanksgiving**	
14 (12/4)	***Discussion Day* — Interdisciplinary tensions.** What is the best causal method? How do causal methods constrain what kind of questions we ask?	Matthay, Ellicott C., et al. (2020). "Alternative causal inference methods in population health research: Evaluating tradeoffs and triangulating evidence." *SSM - Population Health.* Smith, H. (2003). "Some thoughts on causation as it relates to demography and population studies." *Population and Development Review.* Bhrolcháin, M.N. and Dyson, T. (2007). "On causation in demography: Issues and illustrations." *Population and Development Review.*
15 (12/11)	***Discussion Day* — Causal inference, incrementalism, and understanding (changing?) the social world.** **Final Project due on 12/20.**	Schwartz, S., Prins, S.J., Campbell, U.B., and Gatto, N.M. (2016). "Is the 'well-defined intervention assumption' politically conservative?" *Social Science and Medicine.* Hu, L. (2021). "Race, policing, and the limits of social science." *Boston Review.* De Mesquita, E.B. (2019). "The perils of quantification." *Boston Review.* Go, J. (2023). "Unveiling power, or why social science's task is explanation." *British Journal of Sociology.* **Stevenson, M. (2023). "Cause, effect, and the structure of the social world." *Working Paper.* **Schwartz, S. and Prins, S.J. (2024). *Causality and the People's Health.* (Part 3).

COLLEGE OF LIBERAL ARTS POLICIES

GRADES: University academic achievement is graded under two systems: A-F (with pluses and minuses) and S-N. Choice of grading system and course level (1xxx/3xxx/4xxx) is indicated on the registration website; changes in grade scale may not be made after the second week of the semester. Some courses may be taken under only one system; limitations are identified in the course listings. The Department of Sociology requires A-F registration in courses required for the major/minor. University regulations prescribe the grades that will be reported on your transcript.

A Represents achievement that is outstanding relative to the level necessary to meet course requirements (4.00 grade points)
A- 3.67 grade points
B+ 3.33 grade points
B Achievement significantly above the level necessary to meet course requirements (3.00 grade points)
B- 2.67 grade points
C+ 2.33 grade points
C Achievement that meets the basic course requirements in every respect (2.00 grade points)
C- 1.67 grade points
D+ 1.33 grade points
D Achievement worthy of credit even though it fails to meet fully the course requirements (1.00 grade point)
F Performance that fails to meet the basic course requirements (0 grade points)
S Represents achievement that is satisfactory, which is equivalent to a C- or better.
N No credit. Its use is now restricted to students not earning an S on the S-N grade base
I Incomplete, a temporary symbol assigned when the instructor has a "reasonable expectation" that you 1) can successfully complete unfinished work on your own no later than one year from the last day of classes and 2) believes that legitimate reasons exist to justify extending the deadline for course completion. The instructor may set date conditions for make-up work
W Official withdrawal from a course after the end of the second week of the semester.

CLASS ATTENDANCE: As a student, you are responsible for attending class and for ascertaining the particular attendance requirements for each class or department. You should also learn each instructor's policies concerning make-up of work for absences. Instructors and students may consult the CLA Classroom, Grading, and Examination Procedures Handbook for more information on these policies (https://policy.umn.edu/education/makeupwork).

COURSE PERFORMANCE AND GRADING: Instructors establish ground rules for their courses in conformity with their department policies and are expected to explain them at the first course meeting. This includes announcement of office hours and location, the kind of help to be expected from the instructor and teaching assistants, and tutorial services, if available. The instructor also describes the general nature of the course, the work expected, dates for examinations and paper submissions, and expectations for classroom participation and attendance. Instructors determine the standards for grading in their classes and will describe expectations, methods of evaluation, and factors that enter into grade determination. The special conditions under which an incomplete (I) might be awarded also should be established. The college does not permit you to submit extra work to raise your grade unless all students in the class are afforded the same opportunity.

CLASSROOM BEHAVIOR: You are entitled to a good learning environment in the classroom. Students whose behavior is disruptive either to the instructor or to other students will be asked to leave (the policies regarding student conduct are outlined on-line at https://communitystandards.umn.edu/policies-and-procedures/what-kind-consequences-could-i-face

ELECTRONIC DEVICES: University instructors may restrict or prohibit the use of personal electronic devices in his or her classroom, lab, or any other instructional setting. For the complete policy, visit: http://policy.umn.edu/education/studentresp

SCHOLASTIC CONDUCT: The University Student Conduct Code defines scholastic dishonesty as follows:
Scholastic Dishonesty means plagiarizing; cheating on assignments or examinations; engaging in unauthorized collaboration on academic work; taking, acquiring, or using test materials without faculty permission; submitting false or incomplete records of academic achievement; acting alone or in cooperation with another to falsify records or to obtain dishonestly grades, honors, awards, or professional endorsement; altering, forging, or misusing a University academic record; or fabricating or falsifying data, research procedures, or data analysis. **Students cannot evade (intentionally or unintentionally) a grade sanction by withdrawing from a course before or after the misconduct charge is reported. This also applies to late withdrawals, including discretionary late cancellation (also known as the "one-time-only drop").** For the complete policy, visit: http://regents.umn.edu/sites/default/files/policies/Student_Conduct_Code.pdf

STUDENT MENTAL HEALTH AND STRESS MANAGEMENT: As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. University of Minnesota services are available to assist you with addressing these and other concerns you may be experiencing. You can learn more about the broad range of confidential mental health services available on campus via http://www.mentalhealth.umn.edu/.

A REMINDER OF RELEVANT POLICIES AND PROCEDURES
* SOCIOLOGY DEPARTMENT POLICIES *

GRADE INFORMATION: Grades are due in the Office the Registrar within 3 business days after the final examination. No information regarding grades will be released by the department office staff to anyone except designated personnel in Records and college offices. Students may access their own grades through the MyU Portal.

INCOMPLETES: It is the instructor's responsibility to specify conditions under which an Incomplete (I) grade is assigned. Students should refer to the course syllabus and talk with the instructor as early as possible if they anticipate not completing the course work. Coursework submitted after the final examination will generally be evaluated down unless prior arrangements are made in writing by the instructor. University policy states that if completion of the work requires the student to attend class in substantial part a second time, assigning an "I" grade is NOT appropriate. Incompletes are appropriate only if the student can make up the coursework independently with the same professor. Students need to have completed a substantial portion of the course in order to be even considered for an Incomplete.

MAKE-UP EXAMINATIONS: Arrangements for special examinations must be made directly with the instructor who taught the course and who is responsible for approving and supervising the examination or making individual arrangements. Circumstances for missing an exam include, but are not necessarily limited to: verified illness, participation in athletic events or other group activities sponsored by the University, serious family emergencies, subpoenas, jury duty, military service, and religious observances. It is the responsibility of the student to notify faculty members of such circumstances as far in advance as possible.

GRADE CHANGES: Grades properly arrived at are not subject to renegotiation unless all students in the class have similar opportunities. Students have the right to check for possible clerical errors in the assignment of grades by checking with the instructor and/or teaching assistant.

Students with justifiable complaints about grades or classroom procedures have recourse through well-established grievance procedures. You are expected to confer first with the course instructor. If no satisfactory solution is reached, the complaint should be presented in writing to the department Director of Undergraduate Studies or the Coordinator of Undergraduate Advising (909 Soc Sci). If these informal processes fail to reach a satisfactory resolution, other formal procedures for hearing and appeal can be invoked.

DISABILITY SERVICES: Students with disabilities that affect their ability to participate fully in class or to meet all course requirements are encouraged to bring this to the attention of the instructor so that appropriate accommodations can be arranged. For more info contact Disability Resource Center in 180 McNamara. https://disability.umn.edu. This publication/material is available in alternative formats upon request. Please contact the Coordinator of Undergraduate Advising at socadvis@umn.edu or visit the Department of Sociology in 909 Social Sciences Building, 271 19th Ave SE, Minneapolis, MN 55455

SEXUAL HARASSMENT: "Sexual harassment" means unwelcome sexual advances, requests for sexual favors, and/or other verbal or physical conduct of a sexual nature. Faculty, Graduate Students, and full time Staff are Mandated Reporters for prohibited conduct. Such behavior is not acceptable in the University setting. If you have experienced sexual misconduct, discrimination, harassment, or related retaliation; or if you have questions about any EOAA-related issue, please contact Equal Opportunity and Affirmative Action (EOAA) at (612) 624-9547 or eoaa@umn.edu For the complete policy, visit policy.umn.edu/hr/sexharassassault

SOCIOLOGY PROGRAMS INFORMATION: The Sociology Department offers two options for the Bachelor of Arts degree and a Bachelor of Science degree. Students interested in majoring in Sociology should view the online-information session about the major. Due to COVID-19, further information can be obtained from the following persons via email or online at http://cla.umn.edu/sociology

General information, Sociology Department – soc@umn.edu
Coordinator of Undergraduate Advising, Bobby Bryant – socadvis@umn.edu
Director of Undergraduate Studies, Prof. Teresa Swartz – tswartz@umn.edu
Soc Honors Faculty Representative, Prof. Teresa Swartz – tswartz@umn.edu
Director of Graduate Studies, Professor Michelle Phelps – phelps@umn.edu
Graduate Program Associate, Becky Drasin – drasi001@umn.edu

Undergraduate jobs, internships, volunteer and research opportunities, scholarships, and much more can be found in the Undergraduate Resources site - https://sociologyundergrad.wordpress.com/