SI 311.062: Causal Inference

Winter 2026

School of Information

University of Michigan

Last Updated: January 19th 2026

Note: This is a working document. I will be fine-tuning the course outline and assigned readings for the first few weeks of class. Please check the late updated date above for the most current version

Time and Location
Mondays and Wednesdays 4:00PM - 5:30PM
2462 Mason Hall (MH)

Instructor of Record
Hanna Hoover
Email: hooverha@umich.edu

Office Hours
Fridays 12:00pm - 4:00pm 514 Collegian (333 Maynard) or bookable virtual office hours through Google meet

Course Description
This course will explore methods to determine cause-effect relationships from data. It covers techniques like matching, instrumental variables, regression discontinuity, and

differences-in-differences equipping students to evaluate interventions, policies, and experimental treatments. Emphasis is placed on designing studies and analyzing observational data to draw credible causal conclusions.

Textbook
We will be broadly following the outline of Causal Inference: The Mixtape by Scott Cunningham. The textbook is available online. I will also be utilizing materials from The Effect by Nick Huntington-Klein.

Learning Objectives
- Differentiate between causation and correlation, and explain the fundamental challenges in causal inference compared to prediction.
- Apply probability concepts and statistical reasoning to analyze and interpret data relevant to causal effect estimation.
- Construct and evaluate formal frameworks for causality, including potential outcomes, randomized experiments, and observational study designs.
- Assess strengths, limitations, and assumptions underlying key causal inference methods (e.g., matching, regression, instrumental variables, difference-in-differences, synthetic controls).
- Synthesize evidence from different methods, and communicate the ethical considerations and practical implications of causal analysis to diverse audiences.

Expectations
- Complete the assigned readings prior to class.
- Attend all the lectures. Lectures will be recorded and available on Canvas. These recordings are to *complement* your learning, not to substitute your in-class attendance.
- Complete and submit assignments on time.
- Communicate with the instructor when issues arise.
- Engage during class. This means staying focused on the lecture content materials (i.e. not multitasking on your computer, airpods out/headphones off).

Prerequisites
There are no prerequisites for this course. Students who are familiar with statistical concepts (sampling, distributions, hypothesis testing, etc..) and with particular python libraries (pandas, numpy, etc…) will be in a particularly good position at the beginning of this course.

Assessments

- **Homework assignments** will generally be due every other week. The content of the homework assignments will vary from week to week - from coding exercises to evaluating a causal inference approach. Homework assignments will be submitted through Canvas.

- **Quizzes** will generally alternate every other week. The content of the quizzes will closely resemble the previous week's homework assignment. Quizzes will take place at the beginning of class. You will have 10 minutes to complete the quiz. If you arrive late to class, you will not receive any additional time to complete the quiz. To accommodate absences, the lowest quiz grade will be dropped.

- **Group Paper Presentations** Students will be assigned to groups (given a sufficient enrollment) to read, review, and present a short slidedeck on an academic publication utilizing the causal inference technique of the week. Students will select a paper from a predetermined list of available papers that best aligns with their interests. The in-class presentation will be between 5-10 minutes in length. More information regarding this assessment will be available on Canvas.

- **Podcast Reflection** Students will select one podcast episode from a provided set of podcast series to listen to and provide a brief written reflection. Additional information will be provided through Canvas.

- **Lecture Attendance** is mandatory. I will take attendance at the beginning of class using the Attendance tool in Canvas. If you arrive late to class, you will only receive 80% towards your attendance for that day. If you will miss class for a particular lecture, please let me know ahead of time. You may miss two lectures without penalty. **However, you must email to alert the instructor which two lectures you would like to miss without penalty.**

- **Midterm Exam** The midterm exam is scheduled to take place February 25th during class time (4:00pm - 5:30pm).

- **Final Exam** The final exam will take place on Thursday, April 23 from 1:30 pm - 3:30 pm. The location of the final exam is our usual classroom (2462 Mason Hall). The final exam will be cumulative.

Extra credit opportunities There are several ways to obtain extra credit in this course.

- **NameCoach (0.5%)** Record your name through NameCoach in Canvas. This assignment has no due date. Email me once you have uploaded your name so you receive credit.

- **Course Evaluation (0.5%)** At the end of the semester, if enough students complete the course evaluation each student will receive a bonus half percentage point. If the completion rate is more than or equal to 60%, everyone earns 0.1%. If the completion rate is more than or equal to 75%, everyone earns 0.25%. If the completion rate is more than or equal to 90%, everyone earns 0.5%.

Assessment	Weight
Homework Assignments (x5)	20%
Quizzes (x5)	15%
Group Paper Presentation	7.5%
Podcast Reflection	2.5%

Lecture Attendance	5%
Midterm Exam	20%
Final Exam	30%
Total	**100%**

Grading Policy
I reserve the right to reassign weights of assignments if there is a compelling reason to do so. In the final calculation of the letter grade for the course, I will round the total numerical grade to the next whole number. For example, someone earning a total of 92.7 percent in the course will be rounded to 93 and thus earning an A in the course.

Late Assignments You will receive a 20% grade penalty for each day an assignment is late.If an assignment is more than 5 days late, you will receive a 0 for that assignment. If you have an extenuating circumstance and need to request an extension, I am much more likely to grant an extension *prior* to the submission deadline. Be proactive and advocate for your needs.

Late Adds If you add this course after the first day of class, please email the instructor to ensure that you will not be deducted attendance points.

Letter Grade Cutoff Points

Grade	Percentage Earned
A+	100+%
A	93%-99%
A-	90%-92%
B+	87%-89%
B	83%-86%
B-	80%-82%
C+	77%-79%
C	73%-76%
C-	70%-72%
D+	76%-69%
D	63%-66%

D-	60%-62%
E	0%-59%

Weekly Course Schedule

Week	Topics and Assignments	Assessments Due
Week 1 - January 7th	Topics: Foundational ideas	
Week 2 - January 12th & 14th	Topics: Probability review	• Drop/add deadline January 18th
Week 3 - January 19th (NO CLASS) & January 21st	Topics: Potential outcomes notation	• Homework #1 due January 23rd 11:59pm
Week 4 - January 26th & January 28th	Topics: Randomized Control Trials	• Quiz #1 - January 26th 4:00pm • Group 1 Paper Presentation
Week 5 - February 2nd & February 4th	Topics: Matching and Propensity Score Methods	• Group 2 Paper Presentation • Homework #2 due February 6th 11:59pm
Week 6 - February 9th & February 11th	Topics**:** Directed Acyclic Graphs (DAGs) and Observational Data	• Quiz #2 - February 9th 4:00pm • Group 3 Paper Presentation
Week 7 - February 16th and February 18th	Topics: Controlled Regression	• Group 4 Paper Presentation • Homework #3 due February 20th 11:59pm
Week 8 - February 23rd & February 25th	Topics: Controlled Regression (continued) **Midterm exam on February 25th**	
Week 9 - March 2nd &	**No Class - Spring Break**	

March 4th		
Week 10 - March 9th & March 11th	Topics: Instrumental Variables	● Quiz #3 - March 9th 4:00pm ● Group 5 Paper Presentation
Week 11 - March 16th & March 18th	Topic: Regression Discontinuity Design	● Group 6 Paper Presentation ● Homework #4 due March 20th 11:59pm
Week 12 - March 23rd & March 25th	Topic: Differences-in-Differences (two-way fixed effects)	● Quiz #4 0 March 23rd 4:00pm ● Group 7 Paper Presentation
Week 13 - March 30th & April 1st	Topic: Differences-in-Differences (modern approaches)	● Group 8 Paper Presentation ● Homework #5 due April 3rd 11:59pm
Week 14 - April 6th & April 8th	Topic: Synthetic Controls	● Quiz #5 - April 6th 4:00pm ● Group 9 Paper Presentation
Week 15 - April 13th & April 15th	Topic: Advance Topics and Review	● Podcast Reflection due April 17th 11:59pm
Week 16 - April 20th & April 23rd	**Final exam on April 23rd 1:30pm - 3:30pm**	

Weekly Topics

Week 1 - January 7th
- Foundational ideas
    - Causal inference vs prediction
    - Correlation and causality are different concepts
    - Occurring first does not mean causality (post hoc ergo propter hoc)
    - Causality may mask correlations (i.e. causation != high correlation)
- The fundamental problem with causal inference

Week 2 - January 14th: Probability review
- Events
- Conditional probability
- Venn diagrams and sets (needed for conditional probability)

- Contingency tables
- Variance
    - Difference between standard deviation and standard error
- Covariance
- Population model
- Mean independence
- Hypothesis testing
- Randomization inference

Week 3 - January 21st: Potential outcomes notation

- Formal definition of causality
- Counterfactual thinking
- Average treatment effects
- Conditional average treatment effects

Week 4 - January 28th: Randomized Controlled Trials (A/B testing)

- Why randomization “works”
- Experimental design
- Estimating average treatment effects
- Threats to validity

Week 5 - February 4th: Matching and Propensity Score Methods

- Introduction to matching
- Propensity score estimation and inverse propensity score weighting
- Use in causal inference

Week 6 - February 11th: Directed Acyclic Graphs (DAGs) and Observational Data

- Graphical representation and causal relationships
- Colliders and confounders
- Backdoor criterion
- Types of observational data
- Sources of biases (selection, measurement)

Week 7 - February 18th: Controlled Regression - Part 1

- Linear regression and causality
- Assumptions and limitations
- Controlling for confounders

Week 8 - February 25th: Controlled Regression - Part 2

- OLS is BLUE
- Logit/probit/tobit
- **Midterm Exam: February 25th**

Week 9 - March 4th - Spring Break - No class

Week 10 - March 11th: Instrumental Variables (IV)

- What are instruments?
- Examples and validity
- Two-stage least squares
- Complied average causal effect
- Sensitivity analysis and robustness checks

Week 11 - March 18th: Regression Discontinuity Designs (RDD)

- Sharp, fuzzy, and donut designs
- Examples
- Assumptions and implementation
- Sensitivity analysis and robustness checks

Week 12 - March 25th: Difference-in-Difference - Two Way Fixed-Effects

- Policy evaluation and natural experiments
- Time-varying treatments

- Assumptions
- Estimation and interpretation
- Sensitivity analysis and robustness checks
- Recent developments

Week 13 - April 1st: Difference-in-Difference - Modern Approaches

- Time-varying treatments
- Assumptions
- Estimation and interpretation
- Sensitivity analysis and robustness checks

Week 14 - April 8th: Synthetic Controls

- Evaluation when a single unit receives treatment
- Assumptions and variants
- Sensitivity analysis and robustness checkers
- Calculation of p-values

Week 15 - April 15th: Advance topics and review

- Placebo tests and falsification
- Mediation analysis
- Ethical implications
- Causal machine learning (pitch Karthik's course)
- Summary and synthesis of course
- Final review and Q&A

Study days - April 22nd, 25, and 26

Final examinations - April 23rd 1:30pm - 3:30pm

Academic Integrity and Misconduct

UMSI follows Rackham's policies for academic integrity and misconduct for the doctoral program and has adopted similar policies for the MSI, MHI, MADS, and BSI programs. These are detailed in program-specific student handbooks available on the UMSI Current Students webpage. All breaches of academic and professional integrity should be reported by emailing umsi.academicintegrity@umich.edu (for bachelor's and master's students) or the director of the doctoral program (for Ph.D. students). The faculty member should meet with the student individually and ask for their response to the allegation, and include this in an email reporting the incident. For significant issues the student will also meet with the associate director of academic programs and student life or the director of the doctoral program. The overall goal of addressing violations is usually educational for the first offense. The faculty instructor determines the impact on the assignment or course grade; sanctions may include no credit for non-original work or permission to redo and submit original work for partial credit. The associate director of academic programs and student life may assign additional sanctions such as requiring the student to write a paper on plagiarism, and/or requiring the student to complete an online tutorial about academic integrity. All reported violations will be documented centrally. Repeat offenses will result in more severe sanctions such as academic probation or, with consultation from the Academic Discipline Committee (includes Associate Dean for Academic Affairs, Executive Director of Academic and Student Affairs, and Associate Director of Academic Programs and Student Life) and the university general counsel, dismissal from the program. Unless otherwise specified in an assignment all submitted work must be your own, original work. Any excerpts, statements, or phrases from the work of others must be clearly identified as a quotation, and a proper citation provided. Any violation of the School's policy on Academic and Professional Integrity (stated in program-specific student handbooks) will result in serious penalties, which might range from failing an assignment, to failing a course, to being expelled from the program. Violations of academic and professional integrity will be reported to the UMSI

Office of Academic and Student Affairs. The faculty instructor determines consequences impacting assignment or course grades; the School may impose additional sanctions.

ChatGPT and Generative AI Policy
The use of generative AI tools is permitted in this course for the following activities:

- Brainstorming and refining your idea
- Finding information on your topic
- Drafting an outline to organize your thoughts
- Checking grammar and style

The use of generative AI tools is not permitted in this course for the following activities:

- Completing group work that your group has assigned to you.
- Writing a draft of a writing assignment.
- Writing entire sentences, paragraphs or papers to complete class assignments.

If there is a strong suspicion of utilizing any of such tools for completing any of the above, the Associate Director of Academic Programs and Student Life, who serves as the academic integrity officer for UMSI, will be alerted of the incident and the student will have the opportunity to discuss the situation fully with them to find a resolution.

Accommodations for Students with Disabilities
If you think you need an accommodation for a disability, please let me know at your earliest convenience. Some aspects of this course, the assignments, the in-class activities, and the way we teach may be modified to facilitate your participation and progress. As soon as you make me aware of your needs, we can work with the Office of Services for Students with Disabilities (SSD) to help us determine appropriate accommodations. SSD (734-763-3000; ssd.umich.edu) recommends students request disability-related academic accommodations via the Accommodate system, a core electronic case management system that will assist students, faculty, instructors, and staff in requesting, approving, and implementing disability-related accommodations. I will treat any information that you provide in as confidential a manner as possible.

Student Wellbeing
Students may experience stressors that can impact both their academic experience and their personal well-being. These may include academic pressure and challenges associated with relationships, mental health, alcohol or other substances, identities, finances, food insecurity, or other external stressors.
If you are experiencing concerns, seeking help is a courageous thing to do for yourself and those who care about you. If the source of your stressors is academic, please contact UMSI's academic success team via umsi.academicsuccess@umich.edu or me so that we can find solutions together. For personal concerns, U-M offers the following resources:

- Counseling and Psychological Services (CAPS) - confidential; For mental health support, you can access CAPS by calling the central office at (734) 764-8312 or by emailing the School of Information Embedded CAPS Psychologist, Ashley Evearitt, Psy.D., at evearitt@umich.edu. If you are in crisis, please call CAPS at 734.764.8312, or the UM Psychiatric Emergency Services (PES) at 734.936.5900, or 911. Directions to PES are here: http://www.psych.med.umich.edu/contact/er.asp
- Dean of Students Office - 734-764-7420; provides support services to students and manages critical incidents impacting students and the campus community
- Ginsberg Center for Community Service Learning - 734-763-3548; opportunities to engage as learners and leaders to create a better community and world

- Maize and Blue Cupboard at the University of Michigan provides food, kitchen and cooking supplies, personal and household items, and support services for studnets experiencing food insecurity.
- Multi-ethnic Student Affairs (MESA) - 734-763-9044; diversity and social justice through the lens of race and ethnicity
- Office of Student Conflict Resolution - 734-936-6308; offers multiple pathways for resolving conflict
- Office of the Ombuds - 734-763-3545; students can raise questions and concerns about the functioning of the university.
- Services for Students with Disabilities (SSD) - 734-763-3000; accommodations and access to students with disabilities
- Sexual Assault Prevention and Awareness Center (SAPAC) - confidential; 734-764-7771 or 24-hour crisis line 734-936-3333; addresses sexual assault, intimate partner violence, sexual harassment, and stalking
- Spectrum Center - 734-763-4186; support services for LGBTQ+ students
- Trotter Multicultural Center - 734-763-3670; intercultural engagement and inclusive leadership education initiatives
- University Health Service (UHS) - 734-764-8320; clinical services include nurse advice by phone, day or night
- Well-being for U-M Students website - searchable list of many more campus resources
- Wolverine Wellness - confidential; 734-763-1320; provides Wellness Coaching and much more