

The George Washington University

Department of Statistics

STAT 6289-11 Spring 2022

Causal Inference

Syllabus

Meeting time: Mondays 3:30pm—6:00pm

Location: GELM 609

Instructor: Dr. Lin Wang

Email: linwang@gwu.edu

Office address: Rome Hall 769

Remote Office hours: Mondays 2-3pm & Wednesdays 6-7pm

Join Live Classes

<https://gwu-edu.zoom.us/j/92801812184?pwd=UzZjQjNJby9Ta2Q4L2FQQlQ5Q0xmUT09>

Meeting ID: 928 0181 2184

Passcode: 124656

Join Remote Office Hours

Please join my personal meeting room on Zoom:

<https://gwu-edu.zoom.us/my/linwang>

Recording:

Classes will be recorded. Recordings will be shared on Blackboard. Please be aware that if we return to in-person classes later, the recording quality depends on the devices in the classroom and may not be perfect.

Prerequisites

This course assumes familiarity with basic linear algebra, mathematical probability and statistics, and linear regression.

I will do computation and model some methods using R, so R proficiency is important.

Course Overview and Topics

We need to know the relationship between cause and effect in many domains, yet this relationship is often elusive. The difficulty of identifying causal relationships lies at the concretization of causality and the imagination of a counterfactual universe. This course aims to present the fundamentals of how to conceptualize causality and make causal determinations using experimental and observational data.

When experiments can be performed, randomizing the “treatment” variable of interest and estimating causal effects are generally straightforward. However, we often cannot randomize treatments of interest. This course will start with the most basic randomized experiments to more complex methods for making inferences about the causal relationship from observational data. We will cover the following topics.

1. A review of linear regression and generalized linear regression (Week 1)
2. Potential outcomes and counterfactual reasoning (Week 2)
3. Randomized experiments and designs (Week 3)
4. Classical causal analysis for randomized experiments (Weeks 4 and 5)
5. Assumptions of observational study for causal effect; Propensity score (Week 6)
6. Estimation of propensity score (Week 7)
7. Stratification and subclassification (Week 8)
8. Matching and trimming (Week 9)
9. Sensitivity analysis (Week 11)
10. Instrumental variable estimation (Week 12)
11. New developments and applications of causal inference (Weeks 13 and 14)

Learning Outcomes

As a result of completing this course, students will be able to:

1. Know what assumptions are required to make causal claims
2. Make causal inference from experimental data
3. Balancing covariates in observational data to study causal effect
4. Perform independent study on new developments of causal inference
5. Design your research to maximize the credibility of causal claims

Textbooks

Imbens GW, Rubin DB (2015). Causal Inference for Statistics, Social, and Biomedical Sciences: An Introduction. Cambridge University Press.

Hernán MA, Robins JM (2020). Causal Inference: What If. Boca Raton: Chapman & Hall/CRC. You can download this book at <https://www.hsph.harvard.edu/miguel-hernan/causal-inference-book/>

Workload:

Other than the 2.5 hours of lectures, it is expected that the student would spend about 6-8 hours a week studying and preparing for the class. This time may be evenly split between writing solutions to homework problems, and reading in the textbooks and lecture slides, and preparing for the exams and final project.

Grading

- Homework assignments: 30%
- Midterm exam: (March 21, in class), 30%
- Final project and presentation: 40%

There will be 5--6 homework assignments, each of which may include short answer questions and real data projects. **Coding and programming are required for data analysis. You are required to show your results for data analysis and attach your coding to your report.**

The midterm exam will be open book. Discussion of midterm with fellow students is not allowed. We need completely independent work for the midterm exam.

Final Project

For the final project, you are required to write a short research paper and present your research in class. The paper should target at one of the following two aspects:

1. applying a method learned in this course (in class or from required reading papers) to an empirical problem of substantive interest
2. methodological innovation: extending the methods learned in this course to general settings and environments

Focus on the research question, data, empirical strategy, results and conclusions; omit lengthy literature reviews, theoretical background, etc.

Key attribute: follow the guidelines of the course in terms of maximizing and characterizing the credibility of causal claims.

Coauthoring is strongly encouraged. Please build your team with two to four students. In the paper, clearly state the contribution of each member. Grading is based on the team's performance and each student's contribution and presentation.

Class Policy:

Late homework submission will not be accepted.

Make-up exams: Except for medical cases (with proper documentation), there will be no make-ups.

The final project cannot be made up.

University Policy on Observance of Religious Holidays

In accordance with University policy, students should notify faculty during the first week of the semester of their intention to be absent from class on their day(s) of religious observance. For details and policy, see "Religious Holidays" at provost.gwu.edu/policies-procedures-and-guidelines

Academic Integrity Code

Academic Integrity is an integral part of the educational process, and GW takes these matters very seriously. Violations of academic integrity occur when students fail to cite research sources properly, engage in unauthorized collaboration, falsify data, and in other ways outlined in the Code of Academic Integrity. Students accused of academic integrity violations should contact the Office of Academic Integrity to learn more about their rights and options in the process. Outcomes can range from failure of assignment to expulsion from the University, including a transcript notation. The Office of Academic Integrity maintains a permanent record of the violation.

More information is available from the Office of Academic Integrity at studentconduct.gwu.edu/academic-integrity. The University's "Guide of Academic Integrity in Online Learning Environments" is available at studentconduct.gwu.edu/guide-academic-integrity-online-learning-environments. Contact information: rights@gwu.edu or 202-994-6757.

Support for Students outside The Classroom

Virtual academic support

A full range of academic support is offered virtually in fall 2020. See coronavirus.gwu.edu/top-faqs for updates.

Tutoring and course review sessions are offered through Academic Commons in an online format. See academiccommons.gwu.edu/tutoring

Writing and research consultations are available online. See academiccommons.gwu.edu/writing-research-help

Coaching, offered through the Office of Student Success, is available in a virtual format. See studentsuccess.gwu.edu/academic-program-support

Academic Commons offers several short videos addressing different virtual learning strategies for the unique circumstances of the fall 2020 semester. See academiccommons.gwu.edu/study-skills. They also offer a variety of live virtual workshops to equip students with the tools they need to succeed in a virtual environment. See tinyurl.com/gw-virtual-learning

Writing Center

GW's Writing Center cultivates confident writers in the University community by facilitating collaborative, critical, and inclusive conversations at all stages of the writing process. Working alongside peer mentors, writers develop strategies to write independently in academic and public settings. Appointments can be booked online. See gwu.mywconline.

Academic Commons provides tutoring and other academic support resources to students in many courses. Students can schedule virtual one-on-one appointments or attend virtual drop-in sessions. Students may schedule an appointment, review the tutoring schedule, access other academic support resources, or obtain assistance at academiccommons.gwu.edu.

Disability Support Services (DSS) 202-994-8250

Any student who may need an accommodation based on the potential impact of a disability should contact Disability Support Services to establish eligibility and to coordinate reasonable accommodations.

disabilitysupport.gwu.edu

Counseling and Psychological Services 202-994-5300

GW's Colonial Health Center offers counseling and psychological services, supporting mental health and personal development by collaborating directly with students to overcome challenges and difficulties that may interfere with academic, emotional, and personal success.

healthcenter.gwu.edu/counseling-and-psychological-services

Safety and Security

- In an emergency: call GWPD 202-994-6111 or 911
- For situation-specific actions: review the Emergency Response Handbook at safety.gwu.edu/emergency-response-handbook
- In an active violence situation: Get Out, Hide Out, or Take Out. See go.gwu.edu/shooterpret
- Stay informed: safety.gwu.edu/stay-informed

Title IX statement:

The George Washington University (GW) and its faculty are committed to creating a safe and open learning environment for all students. If you or someone you know has experienced sexual harassment, including sexual assault, dating or domestic violence, and stalking, please know that help and support are available. GW strongly encourages all members of the community to take action, seek support, and report incidents of sexual harassment to the Title IX Office. You may contact the Title IX Office at 202-994-7434 or at titleix@gwu.edu or learn more by visiting titleix.gwu.edu.