



DSO 670 – Current Topics in Operations Management
Spring 2025 – Bridging Predictions and Interventions in Social Systems
Units: 3 units
Spring 2025
Thursdays, 1:00-3:50PM

Location: HOH 506

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Office Hours: TBD
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Course Description

This is a PhD-level research seminar on the interfaces of causal inference, operational analysis of complex systems, machine learning, and algorithmic fairness.

Many organizations across business and e-commerce, healthcare, and the public sector, seek to deliver the right intervention, to the right person, at the right time. This requires going beyond pure prediction to intervening to improve outcomes, and requires going beyond average-level guarantees to stronger guarantees of fairness, equity, and individualized efficacy.

First, we will briefly introduce causal decision-making via heterogeneous treatment effects, off-policy learning from prior A/B tests, algorithmic fairness, sequential generalizations via offline and causal reinforcement learning, and improved estimation via orthogonal statistical learning. The bulk of the course will center on student presentations on potential topics such as: optimization of operational systems, algorithmic auditing, A/B testing on platforms, text data, reliability and robustness, human-AI complementarity, and fair/equitable decision-making. There is a course project (theoretical or empirical). These allow for significant tailoring to student theoretical or empirical interests.

Throughout, there is an emphasis on equity and reliability in automated decision making and algorithmic fairness. This is not restrictive and includes varied applications such as computational advertising on Facebook, ranking on LinkedIn, recommender systems, pricing, algorithmic hiring, AI for public policy, and many more.

The course discusses novel applications for those who already are familiar with causal inference, while including just enough background for those new to causal inference to access the research frontier and should be complementary to other offerings.

Learning Objectives

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

- Describe the Neyman-Rubin potential outcomes framework for causal inference and use it to model interventions and their outcomes.
- Assess challenges to causal identification that arise in practice and assess validity of assumptions of potential methods.
- Analyze and optimize optimal treatment regimes and estimate their value.
- Design an evaluation of a new intervention and describe the pros/cons of different evaluation metrics.
- Analyze potential inequitable, unfair or unreliable impacts of new interventions prior to deployment, and design evaluations to monitor performance.
- Formulate novel research questions in this domain.

Prerequisites and/or Recommended Preparation: Students are expected to be familiar with probability. Recommended preparation includes some background in one or more of optimization, machine learning, statistics, and/or econometrics.

Course Notes

Copies of lecture slides will be uploaded to Brightspace.

It may be helpful to reference the following freely available textbooks for more detail on particular topics, although the course will not linearly proceed through them:

Chernozhukov, Hansen, Kallus, Spindler, Syrgkanis, Applied Causal Inference Powered by ML and AI. (ACI/ML/AI)

Agarwal, Jiang, Kakade, Sun, Reinforcement Learning: Theory and Algorithms

Hernan MA, Robins JM, Causal Inference: What If

Partial list of papers:

An updated list will be updated later on to Brightspace. Students may contact the instructor to presentation of other related papers. A list of automated decision-making systems for presentation will also be circulated for potential presentation.

Fundamentals:

Kennedy, Semiparametric doubly robust targeted double machine learning: a review.

Foster and Syrgkanis, Orthogonal Statistical Learning

Hines, Oliver, et al. Demystifying statistical learning based on efficient influence functions.

Uehara et al, A review of off-policy evaluation in reinforcement learning

Athey and Wager, Policy Learning with Observational Data

Kallus, Zhou. Minimax-optimal policy learning under unobserved confounding.

Fairness and Dynamics

Barocas, Hardt, Narayanan. Fairness and Machine Learning: Limitations and Opportunities

Liu et al. Delayed impact of fair machine learning

Hu and Chen, Fair classification and social welfare

Reliability and Calibration

Van Der Laan et al, Causal isotonic calibration for heterogeneous treatment effects

Zhao et al, Calibrating predictions to decisions: A novel approach to multi-class calibration

Causal Models of Data Bias

Bao et al. It's COMPASlicated: The Messy Relationship between RAI Datasets and Algorithmic Fairness Benchmarks

Coston et al. Counterfactual risk assessments, evaluation, and fairness

Operations and Fairness

Bertsimas et al, The price of fairness & On the efficiency-fairness trade-off

Tang et al. Learning optimal and fair policies for online allocation of scarce societal resources from data collected in deployment

Balseiro et al. Survey of Dynamic Resource Constrained Reward Collection Problems: Unified Model and Analysis

Methodology: Constrained optimization

Agarwal et al., A reductions approach to fair classification

Aghaei et al. Learning optimal and fair decision trees for non-discriminative decision-making

Automated Decision Systems, Fairness, and Due Process

Marx et al., Predictive multiplicity in classification.

Cooper, A. Feder, et al. Arbitrariness and social prediction: The confounding role of variance in fair classification.

Wang et al. Against Predictive Optimization: On the Legitimacy of Decision-Making Algorithms that Optimize Predictive Accuracy

Strategic incentives

Harris et al. Strategic instrumental variable regression: Recovering causal relationships from strategic responses.

Ngo et al. Incentivizing compliance with algorithmic instruments

Wager et al. Experimenting in equilibrium.

Causal effects of predictions: Performative prediction

Perdomo et al., Performative prediction

Integrating Qualitative/Quantitative Data into Causal Inference: NLP and LLMs

Yu et al., Optimal matching for observational studies that integrate quantitative and qualitative research

Grading Breakdown

There will be several graded deliverables for the class:

- *Pre-Class Paper Check-Ins*: Short questions on Brightspace before each paper presentation class. Easy if students read the paper. *Graded as Pass/No-Pass/Not-Complete*

- *During-Class Participation:* Students prepare at least two discussion questions before each paper presentation class. *Graded as Pass/No-Pass/Not-Complete*
- *Post-Class Presentation Feedback:* Students will be asked to complete brief constructive feedback on student presentations to help colleagues improve. *Graded as Pass/No- Pass/Not-Complete*
- There will be one short homework assignment to implement basic estimators and evaluations.
- *Paper Presentation:* Students will sign up for 1 or 2 papers to present throughout the semester. Building strong presentation skills is KEY to academic and professional success. This presentation should cover:
 - Overview of the main contributions of the paper
 - Presentation of the model and key results
 - Critique of the paper and possible extensions

To prepare a successful presentation, you should closely read the paper and gain a thorough understanding of the results. This usually requires a lot of work in tracking down and understanding background sources, filling in the missing mathematical details, etc. For a typical paper, you should allocate about a week for this step. You are encouraged to approach others (including students and me) for help with following specific analyses that you find essential.

Carefully select the material you will present. The most common mistake is trying to present all the results and their proofs in the paper. This would take about a week for a typical paper - you are still likely to be in the middle of preliminary results by the time your hour is up. The trick is to present intuition and main ideas behind the proofs rather than the details. Generally, you can only present proof outlines for one or two major results, skipping the mathematical details. Try to understand where the paper fits in within the context of the results presented in the course. Give the audience a sense of the contribution of the paper.

To help students build their presentation skills, each presenter is REQUIRED to complete a multi-step process:

- Before their presentation, the presenting student should do a "practice run" of their talk with at least two students (at least one of whom should be from our class). After the practice run, presenters should take time to debrief with the students. What were the best parts of the presentation? What needs work?
- The practice run and debrief should be completed on Zoom and recorded. You will need to submit the link to the Zoom recording on Brightspace as your deliverable. *Graded as Pass/No-Pass/Not-Complete*
- After you've incorporated the feedback from the practice run, you should schedule a time to meet with me (Angela) to go through the slides of your talk and sort out any other presentation questions. *Graded as Pass/No-Pass/Not-Complete*
- Present your chosen paper in class using PowerPoint or equivalent in your talk.

- **Course Project**

Students may work individually or in groups up to 2. (Project expectations scale with the size of the group). Students may choose one of the following three types of projects:

1. Reproduce, understand, and simplify:

- Theoretical track: You must fully understand the proofs and rewrite and/or simplify them in your own words. Sometimes a paper considers a relatively general setting and the analysis can be quite complicated. In this case you should aim at scrutinizing the results and presenting them in the cleanest

possible way. Ask yourself: What's the most essential part of the analysis? Can you simplify the assumptions without trivializing the results?

- Empirical track: If you are an empirical researcher, you may select this track. You may select a seminal applied paper and revisit with novel methods. You should establish that more complex methodology or estimands could provide substantively interesting new results. You must engage with novel methods for inference, estimation, or partial identification and/or develop robustness checks.
2. Novel research. Pick a new research topic and work on it. Be sure to discuss with me before you settle on the topic. There are two types of novel research projects:
- Theoretical / Methodology / Modeling
You may choose to develop a new estimand and/or estimation approach for a new setting. You may also choose to design a new evaluation for a potential intervention, prediction model, or automated decision system.
 - Empirical
If you are an empirical researcher, you may select this track. You may outline an interesting empirical problem and apply novel methodology. You must provide a comprehensive discussion of identification assumptions and propose robustness checks. (You need not complete all the robustness checks).

Something between 1 & 2

I would encourage most of you to start in this category. The idea is to reproduce the proofs of existing results and see if you can extend the analysis to a more challenging and/or interesting setting. This way, even if you do not get the new results before the end of semester, your project will just fall back to category 1.

- Project proposal
You are expected to submit a short 1-page project proposal in the middle of the semester. The proposal should consist of a short paragraph describing your project topic, the papers you plan to work on, and the original research question (if applicable). You are encouraged to choose paper presentations in anticipation of project topics.

Assessment Tool (assignments)	% of Grade
Participation/Discussion	15%
Homework	5%
Presentation	40%
Course Project	40%
TOTAL	100%

Course Schedule:

	Topics	Deliverables
Week 1	Causal Inference: Neyman-Rubin Potential Outcomes	
Week 2	Causal Estimation: Double-Robustness and Orthogonal Estimation	
Week 3	Causal Identification: Unobservables and Partial Identification	
Week 4	Causal Decisions: Off-Policy Evaluation and Optimal Treatment Regimes	Lecture / Student Presentations
Week 5	Algorithmic Fairness	Homework
Week 6	Causal Decisions and Algorithmic Fairness	Lecture / Student Presentations
Week 7	Special Topics: Student Presentations	
Week 8	Special Topics: Student Presentations	
Week 9	Special Topics: Student Presentations	Project Proposal
Week 10	Special Topics: Student Presentations	
Week 11	Special Topics: Student Presentations	
Week 12	Special Topics: Student Presentations	
Week 13	Special Topics: Student Presentations	
Week 14	Special Topics: Student Presentations	
Week 15	Project Presentations	Project Presentation

Assignment Submission Policy

There will be one or two homework assignments. Assignments should be typed up in Latex with code attached (if applicable). Homework can be submitted on Brightspace. Late assignments are worth 50% (within 3 days).

Academic Integrity

The University of Southern California is foremost a learning community committed to fostering successful scholars and researchers dedicated to the pursuit of knowledge and the transmission of ideas. Academic misconduct is in contrast to the university's mission to educate students through a broad array of first-rank academic, professional, and extracurricular programs and includes any act of dishonesty in the submission of academic work (either in draft or final form).

This course will follow the expectations for academic integrity as stated in the [USC Student Handbook](#). All students are expected to submit assignments that are original work and prepared specifically for the course/section in this academic term. You may not submit work written by others or “recycle” work prepared for other courses without obtaining written permission from the instructor(s). Students suspected of engaging in academic misconduct will be reported to the Office of Academic Integrity.

Other violations of academic misconduct include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

Academic dishonesty has a far-reaching impact and is considered a serious offense against the university. Violations will result in a grade penalty, such as a failing grade on the assignment or in the course, and disciplinary action from the university itself, such as suspension or even expulsion.

For more information about academic integrity see the [student handbook](#) or the [Office of Academic Integrity’s website](#), and university policies on [Research and Scholarship Misconduct](#).

Please ask your instructor if you are unsure what constitutes unauthorized assistance on an exam or assignment or what information requires citation and/or attribution.

Use of AI Generators

In this course, I encourage you to use artificial intelligence (AI)-powered programs to help you with assignments that indicate the permitted use of AI. AI is permitted to use to help with the course project but cannot be used to generate text of the report. AI code generation is not permitted for use on the homework. You should also be aware that AI text generation tools may present incorrect information, biased responses, and incomplete analyses; thus they are not prepared to produce text that meets the standards of this course. To adhere to our university values, you must cite any AI-generated material (e.g., text, images, etc.) included or referenced in your work and provide the prompts used to generate the content. Using an AI tool to generate content without proper attribution will be treated as plagiarism and reported to the Office of Academic Integrity. Please review the instructions in each assignment for more details on how and when to use AI Generators for your submissions.

If found responsible for an academic violation, students may be assigned university outcomes, such as suspension or expulsion from the university, and grade penalties, such as an “F” grade on the assignment, exam, or in the course.

Course Content Distribution and Synchronous Session Recordings Policies

Recording a university class without the express permission of the instructor and announcement to the class, or unless conducted pursuant to an Office of Student Accessibility Services (OSAS) accommodation. Recording can inhibit free discussion in

the future, and thus infringe on the academic freedom of other students as well as the instructor. ([Living our Unifying Values: The USC Student Handbook](#), page 13).

Distribution or use of notes, recordings, exams, or other intellectual property, based on university classes or lectures without the express permission of the instructor for purposes other than individual or group study. This includes but is not limited to providing materials for distribution by services publishing course materials. This restriction on unauthorized use also applies to all information, which had been distributed to students or in any way had been displayed for use in relation to the class, whether obtained in class, via email, on the internet, or via any other media. Distributing course material without the instructor's permission will be presumed to be an intentional act to facilitate or enable academic dishonesty and is strictly prohibited. ([Living our Unifying Values: The USC Student Handbook](#), page 13).

Statement on University Academic and Support Systems

Students and Disability Accommodations:

USC welcomes students with disabilities into all of the University's educational programs. [The Office of Student Accessibility Services](#) (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at osas.usc.edu. You may contact OSAS at (213) 740-0776 or via email at osasfrontdesk@usc.edu.

Student Financial Aid and Satisfactory Academic Progress:

To be eligible for certain kinds of financial aid, students are required to maintain Satisfactory Academic Progress (SAP) toward their degree objectives. Visit the [Financial Aid Office webpage](#) for [undergraduate](#)- and [graduate-level](#) SAP eligibility requirements and the appeals process.

Support Systems:

[Counseling and Mental Health](#) - (213) 740-9355 – 24/7 on call

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

[988 Suicide and Crisis Lifeline](#) - 988 for both calls and text messages – 24/7 on call

The 988 Suicide and Crisis Lifeline (formerly known as the National Suicide Prevention Lifeline) provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week, across the United States. The Lifeline consists of a national network of over 200 local crisis centers, combining custom local care and resources with national standards and best practices. The new, shorter phone number makes it easier for people to remember and access mental health crisis services (though the

previous 1 (800) 273-8255 number will continue to function indefinitely) and represents a continued commitment to those in crisis.

[Relationship and Sexual Violence Prevention Services \(RSVP\)](#) - (213) 740-9355(WELL) – 24/7 on call

Free and confidential therapy services, workshops, and training for situations related to gender- and power-based harm (including sexual assault, intimate partner violence, and stalking).

[Office for Equity, Equal Opportunity, and Title IX \(EEO-TIX\)](#) - (213) 740-5086

Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

[Reporting Incidents of Bias or Harassment](#) - (213) 740-2500

Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

[The Office of Student Accessibility Services \(OSAS\)](#) - (213) 740-0776

OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

[USC Campus Support and Intervention](#) - (213) 740-0411

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

[Diversity, Equity and Inclusion](#) - (213) 740-2101

Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

[USC Emergency](#) - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call

Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

[USC Department of Public Safety](#) - UPC: (213) 740-6000, HSC: (323) 442-1200 – 24/7 on call

Non-emergency assistance or information.

[Office of the Ombuds](#) - (213) 821-9556 (UPC) / (323-442-0382 (HSC)

A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

[Occupational Therapy Faculty Practice](#) - (323) 442-2850 or otfp@med.usc.edu

Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.