Causal Inference for Data Science
Instructor: Adam Kelleher
Syllabus and Tentative Schedule

General Information

- **Meeting time:** Thursday, 7:00p-9:30p
- **Contact**: Adam Kelleher, ak4063@columbia.edu
- **Office Hours**: TBA
- **Textbook**: Morgan and Winship, Counterfactuals and Causal Inference, 2nd Ed.
- **Grading**: Homework 40%, Mid-term 30%, Final exam 30%

Pre-requisites

- **Math:** Undergrad probability theory; Some experience with regression analysis will be useful; some knowledge of information theory will be useful, but not required. Some knowledge of bayesian networks will be useful but not required.
- **CS:** Knowledge of a programming language, preferably Python.

Homework

- Homework will be due by midnight two weeks after they are assigned. There will be assignments approximately every two weeks.
- Late assignments will be reduced as follows:
    - 0+ - 24 hours late: 25% of points deducted
    - 24 - 48 hours late: 50% of points deducted
    - More than 48 hours: no credit
- Exceptions will be made for medical emergencies or other exceptional circumstances discussed in advance.

Collaboration

- Collaboration is strongly encouraged. Everyone must write up their assignments on their own. Copying collaborators' work or copying work from other sources (textbooks, the internet) is prohibited.

Programming Assignments

- Programming assignments will be completed with Jupyter notebooks. Install and familiarize yourselves with Jupyter notebooks as soon as possible.

Tentative Schedule:

Causal Frameworks

- *Sep 6*: Context: causality in data science; Intro to Counterfactuals and Potential Outcomes
- *Sep 13*:; The Pearlian Framework; back-door conditioning HW 1
- *Sep 20*: The Pearlian framework; more on causal graphs
- *Sep 27*: Confounding; Berkson's Paradox; simpson's paradox; robin's g-formula HW 2

Effect Estimation with Conditioning

- *Oct 4*: Conditioning; matching effect estimators; HW 3
- *Oct 11*: Regression estimators of causal effects 1
- *Oct 18*: Regression 2: inverse propensity weighting; doubly robust estimators;contextual bandits; HW 4
- *Oct* 25: Mid Term
- *Nov 1*: Conditioning to reduce entropy; Conditioning to remove bias; Self-selection

Effect Estimation without Conditioning

- *Nov 8*: Instrumental variables; recommender system example; HW 5
- Nov 15: Mechanisms of action and the Front-door criterion
- *Nov 22: Holiday*
- *Nov 29*: Regression Discontinuity Design; HW 6
- *Dec 6*: Choice of Special Topics: AB testing and interventions; Multifactorial design; Intent to Treat analysis; an (observational) statistical criterion for causation; Selection Bias Correction
- *Dec 13: Study Day (?)*
- *Dec 20: Final Exam*

Tentative Homework Schedule

HW	Assigned	Due
HW1	Sep 13	Sep 27
HW2	Sep 27	Oct 11
HW3	Oct 4	Oct 18
HW4	Oct 18	Nov 1
HW5	Nov 15	Nov 29
HW6	Nov 29	Dec 6 (13?)

Disability Services
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