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

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Disability Services
Disability Services facilitates equal access for students with disabilities by coordinating accommodations and support services, cultivating a campus culture that is sensitive and responsive to the needs of students.

Students seeking accommodations or support services from Disability Services are required to register with the office. If you are interested in pursuing an evaluation for a learning disability, please visit the referrals and other campus resources page.