

# PLSC 40601

Week 1: Course orientation, potential outcomes framework.

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Spring 2023

# Overview

This course:

- Objectives.
- Course structure.
- Assignments.

Link to [syllabus](#).

# Final assignment

- Possibility of tutorial.
  - Illustrate what problem the tool is addressing, what an example use case is.
  - Still needs some amount of narrative contextualizing the problem.
  - Posted on class github.
  - Python, R, or Stata; **compiled report**.
  - Limited support with debugging.

Link to [website](#). Link to [tutorial](#).

# How to read methods papers (Murphy, 1997)

Consider:

- Who the authors are and where the article is published.
  - Econometrica? AER? Annual Review of Economics?
  - PNAS? Science? Nature?
  - JRSS B? JASA, Statistical Science?
  - SSRN, arXiv, PsyArXiv?
  - Machine learning conference proceedings?
  - Political science methods, biostatistics journal?

# How to read methods papers

Consider:

- What is the problem/gap/contribution?
- What is the background/methodological context for the paper?
  - Refer to references where it may be more clearly stated; textbooks are often clearer than original articles for understanding a new methodology.
  - Check out the bibliographic notes in a related section of [Hastie et al. \(2009\)](#), The Elements of Statistical Learning. (If you don't have this book already, download it right now.)
- (This is the role of final paper.)

# How to read methods papers

Consider:

- How would you explain this paper to someone else?
- What is a use case for the tools presented in the paper?
- (This is the role of paper presentation/discussion)

# How to read methods papers

Consider:

- How would you use the presented method on data?
  - Many of the papers have associated packages.
- When using real data, what are limitations of the assumptions required by the method?
- (Tutorial?)

# How to read methods papers

Consider:

- Annotated bibliography?



# How to read methods papers

References for notation:

- For definitions and terminology, [Hastie et al. \(2009\)](#)
- For some very machine-learning specific technology, glossary at the end of [Breiman \(2001\)](#)
- For mathematical notation, glossary of [Aronow and Miller \(2019\)](#) Foundations of Agnostic Statistics
- Other suggestions?

Potential outcomes framework.

# Statistical setup.

- Population.
- Sample, units indexed  $i = 1, \dots, N$ .
- Observed outcome,  $Y_i \in \mathbb{R}$ ;
- Treatments,  $W_i \in \{0, \dots, K\}$ ; (or  $Z_i$ , or  $D_i$ ,  $A_i, \dots$ )
  - What do we mean by treatments?
  - “No causation without manipulation.” (Holland, 1986)
- Covariates,  $X_i \in \mathbb{R}^p$ .

# Statistical setup.

- Potential outcomes framework:  $Y_i(w)$  represents the potential outcome for respondent  $i$  under treatment  $w$ .  
 $Y_i = (Y_i(0), \dots, Y_i(K))$ .
- $Y_i(1)$  is the outcome we would see only when individual  $i$  receives treatment 1.
- Alternatively, (for binary treatment,  $W_i \in \{0, 1\}$ )
  - $Y_i^1, Y_i^0$ ;
  - $Y_i^{w=1}, Y_i^{w=0}$ ;
  - $Y_{i1}, Y_{i0}$ ;
  - $Y|do(W=1), Y|do(W=0)$

## (Some) Causal estimands

What is an estimand? What makes an estimand *causal*?  
Counterfactual comparison.

- Individual treatment effect:

$$\tau_i = Y_i(1) - Y_i(0)$$

- Average treatment effect (ATE):

$$\tau = E[\tau_i]$$

- Expectation over what?  
→ The population we previously defined.

## (Some) Causal estimands

- Average treatment effect on the treated (ATT):

$$\tau_{ATT} = E[\tau_i | W_i = 1]$$

- How is this different from the ATE?
  - Why might we care about this?
- Conditional average treatment effect (CATE):

$$\tau_{CATE} = E[\tau_i | X_i = x]$$

Many others!

# References I

- Aronow, P. M. and Miller, B. T. (2019). *Foundations of agnostic statistics*. Cambridge University Press.
- Breiman, L. (2001). Statistical modeling: The two cultures (with comments and a rejoinder by the author). *Statistical science*, 16(3):199–231.
- Hastie, T., Tibshirani, R., and Friedman, J. H. (2009). *The elements of statistical learning: data mining, inference, and prediction*, volume 2. Springer.
- Holland, P. W. (1986). Statistics and causal inference. *Journal of the American Statistical Association*, 81(396):945–960.
- Murphy, J. R. (1997). How to read the statistical methods literature: a guide for students. *The American Statistician*, 51(2):155–157.