# PLSC 40601

## Week 1: Course orientation, potential outcomes framework.

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# Overview

This course:

- Objectives.
- Course structure.
- Assignments.

Link to syllabus.

# Final assignment

- 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; **replicable, 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 $i = 1, \ldots, N$.
- Observed outcome, $Y_i \in \mathbb{R}$;
- Treatments, $W_i \in \{0, \ldots, K\}$; (or $Z_i$, or $D_i$, $A_i$,...)
  - 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 $w$.
  $\mathrm{Y}_i = (Y_i(0), \ldots, Y_i(K))$.

- $Y_i(1)$ is the outcome we would see only when individual $i$ receives treatment 1.

- Alternatively, (for binary treatment, $W_i \in \{0, 1\}$)
  - $Y_i^1, Y_i^0$;
  - $Y_i^{w=1}, Y_i^{w=0}$;
  - $Y_{i1}, Y_{i0}$;
  - $Y|\mathrm{do}(W = 1), Y|\mathrm{do}(W = 0)$

# (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):

$$\tau = \mathrm{E}\left[\tau_i\right]$$

  - Expectation over what?

$\rightarrow$ The population (or sample!) we previously defined.

# (Some) Causal estimands

- Average treatment effect on the treated (ATT):

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

  - How is this different from the ATE?
  - Why might we care about this?

- Conditional average treatment effect (CATE):

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

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.