

# Syllabus

## POLSCI 699 Statistical Methods in Political Research II

Professor: Kevin Quinn  
Winter Semester 2020

**Class Room**  
7603 Haven Hall  
2:30pm – 3:50pm  
Tuesdays and Thursdays

**Office**  
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Patrick Wu  
*Email:* pywu@umich.edu

## Preliminaries

### Overview and Class Goals

The goal of this course is to provide you with enough background in probability and statistics so that you can successfully:

- evaluate basic quantitative empirical research in political science and related fields
- analyze data and *begin* to conduct your own empirical research
- take more advanced quantitative methods courses to further develop your skills.

The course focuses on the general *concepts* that underly statistical inference rather than on specific *techniques*. These concepts are introduced and taught within the context of real-world examples. The hope is that students who successfully complete the course will be able to think clearly about a wide range of substantive problems. That said, this course is a starting point, not an end point. If you plan to do empirical research, you should take several additional methodology courses.

The course is organized around two broad, intersecting themes: the dimension of the data (univariate, bivariate, multivariate) and the inferential goal (summarization, descriptive inference, predictive inference, causal inference). The “outer loop” will move from univariate to bivariate to multivariate data, while the “inner loop” will move from more simple to more difficult inferential goals.

A third theme that will be in the background throughout much of the course relates to randomness. More specifically, we will be interested in: a) where randomness enters into an analysis, b) whether the researcher is in control of the randomness, and c) what role it plays. For instance, we will see that random sampling of units from a population provides a strong basis for descriptive inferences, but this random sampling of units from a population, by itself, does not provide a strong basis for making causal inferences. We will see that another source of randomness provides a strong basis for causal inferences.

### Prerequisites

POLSCI 599, an equivalent course, or permission of the instructor, and a willingness to work hard and learn by doing.

### Logistics

Lectures will be on Tuesdays and Thursday from 2:30pm to 3:50pm in 7603 Haven Hall. Section will be held on Fridays from 11:00am to 11:50am in 7603 Haven Hall.

Jerry Yu is the head GSI for this course and Patrick Wu is the grader. Please direct questions about problem-set grades and grading to Patrick and more general questions about the course content to either Jerry or Professor Quinn.

### Computation

The primary package that we will be using in this course is R. You can download R from <http://www.r-project.org/>.

Learning to use R may be frustrating at first. Nevertheless, I encourage you to stick with it. A moderate initial investment of your time will pay large rewards later. There are several good online references for R. These can be found at the R Project website listed above. The “Introduction to R” is especially well written.

In addition, taking POLSCI 514 concurrently with this course may prove to be helpful.

### Class Requirements

Final grades will be based on class participation (10% of final grade), a series of problem sets (65% of final grade), and a take-home final exam (25% of final grade).

Problem sets will be assigned approximately every week and will generally be due one week from the time they were handed out. The assignments will be composed of analytical problems, exercises dealing with real data, and computation.

I expect all problem-set answers to be typed in L<sup>A</sup>T<sub>E</sub>X and submitted through Canvas. A L<sup>A</sup>T<sub>E</sub>X template for problem-set answers is available at; <http://jenpan.com/resources/>. All R source code used for the problem-set answers should be included in your submission. Your R code should be consistent with Google’s R Style Guide (<https://google.github.io/styleguide/Rguide.html>). The one exception to this is that I will not require you to use underscores in object names and function names (this is a nuisance for emacs users).

I encourage you to work on the problem sets with each other in groups of two or three. However, I expect you to begin working on each problem by yourself prior to working on the problems in a group. Further, I expect your write-up of the assignment to be your own work. Copying any part of another student’s answers is considered academic misconduct. The final exam will be an open book, open-note, take-home, cumulative exam. *I will not give incompletes in this course.*

### Course Website

The course website is available via the UM Canvas site.

### Office Hours and Availability

Professor Quinn will hold office hours on Wednesdays from 10:00am to 11:30am in ISR 4436. Jerry Yu will hold office hours on Fridays from 8:30am to 11:00am in 7744 Haven Hall. If these times do not work for you, you can contact both Jerry and Professor Quinn to schedule an alternative time to meet.

Patrick Wu will hold office hours by appointment.

In addition to sections and office hours, please use the *Piazza Discussion Board* when asking questions about lectures, problem sets, and other course materials. This allows all students to benefit from the discussion and to help each other understand the materials. Both students and instructors are encouraged to participate in discussions and answer any questions that are posted.

To join the POLSCI 699 Piazza site, click on “Piazza” from the modules in the Canvas course site. You will then be prompted to create your account and confirm enrollment. Once you create your account, the Piazza course page can also be accessed by logging in from <https://piazza.com> or its mobile apps. In addition, all class announcements will be made through Piazza. Canvas will still be used for hosting all class materials.

### Other Course Policies

- **Student Sexual Misconduct Policy:** Title IX prohibits sex discrimination to include sexual misconduct: harassment, domestic and dating violence, sexual assault, and stalking. If you or someone you know has been harassed or assaulted, you can receive confidential support and academic advocacy at the Sexual Assault Prevention and Awareness Center (SAPAC). SAPAC can be contacted on their 24-hour crisis line, 734-936-3333 and online at [sapac.umich.edu](http://sapac.umich.edu). Alleged violations can be reported non-confidentially to the Office for Institutional Equity (OIE) at [institutional.equity@umich.edu](mailto:institutional.equity@umich.edu). Reports to law enforcement can be made to University of Michigan Police Department at 734-763-3434.<sup>1</sup>
- **Accommodations for Students with Disabilities:** If you think you need an accommodation for a disability, please let me know at your earliest convenience. Some aspects of this course, the assignments, the in-class activities, and the way the course is usually taught may be modified to facilitate your participation and progress. As soon as you make me aware of your needs, we can work with the Services for Students with Disabilities (SSD) office to help us determine appropriate academic accommodations. SSD (734-763-3000; <http://ssd.umich.edu>) typically recommends accommodations through a Verified Individualized Services and Accommodations (VISA) form. Any information you provide is private and confidential and will be treated as such.<sup>2</sup>
- **Religious-Academic Conflicts:** While the university does not observe religious holidays, it is the policy of the University of Michigan to make every reasonable effort to allow members of the university community to observe their religious holidays without academic penalty. Absence from classes or examinations for religious reasons does not relieve students from responsibility for any part of the course work required during the period of absence. Students who expect to miss classes as a consequence of their religious observance shall be provided with a reasonable alternative opportunity to make-up missed academic work. It is the obligation of students to provide faculty with reasonable notice of the dates on which they will be absent. When the absence coincides with an exam or other assignment due date, the options to make up that missed work may be limited and will be determined by the instructor within the boundaries of the respective class.<sup>3</sup>
- **Academic Misconduct:** The University of Michigan community functions best when its members treat one another with honesty, fairness, respect, and trust. The college promotes the assumption of personal responsibility and integrity, and prohibits all forms of academic dishonesty and misconduct. All cases of academic misconduct will be referred to the Office of the Assistant Dean for Undergraduate Education. Being found responsible for academic misconduct will usually result in a grade sanction, in addition to any sanction from the college. For more information, including examples of behaviors that are considered academic misconduct and potential sanctions, please see <https://lsa.umich.edu/lsa/academics/academic-integrity.html>.<sup>4</sup>
- **Student Mental Health and Wellbeing:** The University of Michigan is committed to advancing the mental health and wellbeing of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of support, services are available. For help, contact *Counseling and Psychological Services (CAPS)* at (734) 764-8312 and <https://caps.umich.edu/> during and after hours, on weekends and holidays, or through its counselors physically located in schools on both North and Central Campus. You may also consult *University Health Service (UHS)* at (734) 764-8320 and <https://www.uhs.umich.edu/mentalhealthsvcs>, or for alcohol or drug concerns, see

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<sup>1</sup>This statement is taken from: <https://sapac.umich.edu/article/faculty-resources-sample-syllabus-language>.

<sup>2</sup>This statement is taken from: <https://ssd.umich.edu/article/syllabus-statement>.

<sup>3</sup>This statement is taken from: *Handbook for Faculty and Instructional Staff 2018*, p. 17.

<sup>4</sup>This statement is taken from: *Handbook for Faculty and Instructional Staff 2018*, p. 16.

<https://www.uhs.umich.edu/aodresources>. For a listing of other mental health resources available on and off campus, visit: <http://umich.edu/~health>.<sup>5</sup>

### **Required Books**

No books are required for this course.

In fact, there is no required reading for this class. I will make the lecture slides available on Canvas prior to the corresponding lecture. I suggest that you skim the notes prior to class and come to class prepared to actively engage with the material. After lecture I encourage you to consider checking out some of the optional readings for that class to get a deeper understanding of the material.

Another reason for making the lecture slides available to students before class is so that no one will need to furiously scribble down notes in class. Jotting down key points, questions and thoughts during lecture is good, but I strongly encourage you to resist the temptation to try write down a transcription of any given lecture.

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<sup>5</sup>This statement is taken from: *Handbook for Faculty and Instructional Staff 2018*, p. 16.

## Preliminary Schedule

The following is a preliminary schedule of course topics. It is a rough guide to what we will be covering and may well undergo some changes over the semester. There is a lot of material here and we will likely not cover it all. Someone with a very solid understanding of the first two-thirds to three-quarters of this material should have no problem tackling the remainder on their own.

# Part I: Univariate Data

## 1 Thursday, January 9: Summarizing a Univariate Sample

- univariate descriptive statistics
- univariate plots

### Optional Reading

- Aronow, Peter M. and Benjamin T. Miller. 2019. *Foundations of Agnostic Statistics*. Cambridge, UK: Cambridge University Press. pp. 44-58.
- Cleveland, William S. 1993. *Visualizing Data*. Murray Hill, NJ: Hobart Press. Chapters 1 and 2.

## 2 Tuesday, January 14: Univariate Descriptive Inference I

- Random sampling as a basis for descriptive inference
- The plug-in principle
- The sample mean as an estimator of the population mean
- The sampling variance of the sample mean
- Confidence intervals

### Optional Reading

- Aronow, Peter M. and Benjamin T. Miller. 2019. *Foundations of Agnostic Statistics*. Cambridge, UK: Cambridge University Press. pp. 91-127.
- Wasserman, Larry. 2004. *All of Statistics: A Concise Course in Statistical Inference*. New York: Springer. Chapters 6 and 7.
- Thompson, Steven K. 2002. *Sampling*. Second Edition. New York: John Wiley & Sons. Chapters 1 and 2.

### 3 Thursday, January 16: Univariate Descriptive Inference II

- Maximum likelihood estimation
- Binomial likelihood
- Gaussian likelihood

#### Optional Reading

Wasserman, Larry. 2004. *All of Statistics: A Concise Course in Statistical Inference*. New York: Springer. Chapter 9.

Casella, George and Roger L. Berger. 2002. *Statistical Inference*. Second Edition. Pacific Grove, CA: Duxbury. pp. 315-323.

### 4 Tuesday, January 21: Univariate Descriptive Inference III

- Bayesian Inference
- Binomial outcome with beta prior

#### Optional Reading

Jackman, Simon. 2009. *Bayesian Analysis for the Social Sciences*. Chichester, UK: John Wiley & Sons. Chapters 1 and 2.

Gelman, Andrew; John B. Carlin; Hal S. Stern; David B. Dunson; Aki Vehtari; and Donald B. Rubin. 2013. *Bayesian Data Analysis*. Third Edition. Boca Raton, FL: CRC Press. Chapters 1 and 2.

Wasserman, Larry. 2004. *All of Statistics: A Concise Course in Statistical Inference*. New York: Springer. pp. 175-183.

### 5 Thursday, January 23: Univariate Descriptive Inference IV

- The nonparametric bootstrap
- The parametric bootstrap

#### Optional Reading

Efron, Bradley and R.J. Tibshirani. 1993. *An Introduction to the Bootstrap*. Boca Raton, FL: Chapman & Hall / CRC. pp. 1-85.

Aronow, Peter M. and Benjamin T. Miller. 2019. *Foundations of Agnostic Statistics*. Cambridge, UK: Cambridge University Press. pp. 130-132.

Wasserman, Larry. 2004. *All of Statistics: A Concise Course in Statistical Inference*. New York: Springer. Chapter 8.

## 6 Tuesday, January 28: Univariate Descriptive Inference V

- Unequal probability sampling
- Inverse probability weighting estimators

### Optional Reading

Thompson, Steven K. 2002. *Sampling*. Second Edition. New York: John Wiley & Sons. Chapter 6.

## 7 Thursday, January 30: Testing I

- pure significance tests
- $p$ -values
- Wald test
- $t$ -test
- Likelihood ratio test

### Optional Reading

Aronow, Peter M. and Benjamin T. Miller. 2019. *Foundations of Agnostic Statistics*. Cambridge, UK: Cambridge University Press. pp. 128-130.

Wasserman, Larry. 2004. *All of Statistics: A Concise Course in Statistical Inference*. New York: Springer. pp. 149-159, 164-165, 170.

Cox, D.R. and D.V. Hinkley. 1974. *Theoretical Statistics*. Boca Raton, FL: Chapman & Hall. Chapters 3 and 4.

Casella, George and Roger L. Berger. 2002. *Statistical Inference*. Second Edition. Pacific Grove, CA: Duxbury. Chapter 8.

## 8 Tuesday, February 4: Testing II

- $p$ -hacking
- Controversies regarding null hypothesis significance testing
- Multiple testing

### Optional Reading

Wasserstein, R.L. and N.A. Lazar. 2016. "The ASA's Statement on  $p$ -Values: Context, Process, and Purpose". *The American Statistician*, 70:2, 129-133.

McShane, B.B., D. Gal, A. Gelman, C. Robert, and J.L. Tackett. 2018. "Abandon Statistical Significance". <https://arxiv.org/abs/1709.07588v2>

Benjamini, Y. and Y. Hochberg. 1995. "Controlling the false discovery rate: A practical and powerful approach to multiple testing". *J. Roy. Statist. Soc. Ser. B*, 57:1, 289-300.

Wasserman, Larry. 2004. *All of Statistics: A Concise Course in Statistical Inference*. New York: Springer. pp. 165-168.

## Part II: Bivariate Data

### 9 Thursday, February 6: Summarizing a Bivariate Sample

- Independence
- Sample covariance and correlation
- Conditional expectation
- Conditional variance
- Simple scatter-plot smoothers
- Least squares as a scatter-plot smoother

#### Optional Reading

- Aronow, Peter M. and Benjamin T. Miller. 2019. *Foundations of Agnostic Statistics*. Cambridge, UK: Cambridge University Press. pp. 59-84.
- Cleveland, William S. 1993. *Visualizing Data*. Murray Hill, NJ: Hobart Press. Chapter 3.
- Wasserman, Larry. 2004. *All of Statistics: A Concise Course in Statistical Inference*. New York: Springer. Chapter 15.
- Härdle, W. 1990. *Applied Nonparametric Regression*. Cambridge, UK: Cambridge University Press. Chapters 1 and 2.

### 10 Tuesday, February 11: Bivariate Descriptive Inference I

- OLS as a fitting method
- Properties of the OLS estimator

#### Optional Reading

- Aronow, Peter M. and Benjamin T. Miller. 2019. *Foundations of Agnostic Statistics*. Cambridge, UK: Cambridge University Press. pp. 143-156.
- Wasserman, Larry. 2004. *All of Statistics: A Concise Course in Statistical Inference*. New York: Springer. pp. 209-212, 214-215.

### 11 Thursday, February 13: Bivariate Descriptive Inference II

- Interpretation of the OLS estimator

#### Optional Reading

- Aronow, Peter M. and Benjamin T. Miller. 2019. *Foundations of Agnostic Statistics*. Cambridge, UK: Cambridge University Press. pp. 156-164.
- Angrist, J.D. and J. Pischke. 2009. *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton, NJ: Princeton University Press. Chapter 3.



## 12 Tuesday, February 18: Bivariate Descriptive Inference III

- Maximum likelihood estimation of Gaussian regression
- Properties of maximum likelihood estimators

### Optional Reading

Aronow, Peter M. and Benjamin T. Miller. 2019. *Foundations of Agnostic Statistics*. Cambridge, UK: Cambridge University Press. pp. 178-204.

Wasserman, Larry. 2004. *All of Statistics: A Concise Course in Statistical Inference*. New York: Springer. pp. 212-213.

## 13 Thursday, February 20: Bivariate Descriptive Inference IV

- Maximum likelihood estimation of binomial regression (logit & probit)
- Properties of maximum likelihood estimators

### Optional Reading

Aronow, Peter M. and Benjamin T. Miller. 2019. *Foundations of Agnostic Statistics*. Cambridge, UK: Cambridge University Press. pp. 178-204.

Wasserman, Larry. 2004. *All of Statistics: A Concise Course in Statistical Inference*. New York: Springer. pp. 223-225.

## 14 Tuesday, February 25: Bivariate Descriptive Inference V

- Local regression
- Local likelihood

### Optional Reading

Loader, C. 1999. *Local Regression and Likelihood*. New York: Springer. Chapters 1, 2, 3, and 4.

Wasserman, Larry. 2006. *All of Nonparametric Statistics*. New York: Springer. Chapter 5.

Hastie, Trevor, Robert Tibshirani, and Jerome Friedman. 2016. *The Elements of Statistical Learning: Data Mining, Inference, and Prediction*. 2nd Edition. New York: Springer. Chapter 6.

## 15 Thursday, February 27: Bivariate Descriptive Inference VI

- $t$ -tests
- Permutation tests
- Using the bootstrap with regression

**Optional Reading**

Aronow, Peter M. and Benjamin T. Miller. 2019. *Foundations of Agnostic Statistics*. Cambridge, UK: Cambridge University Press. pp. 151-156.

Wasserman, Larry. 2004. *All of Statistics: A Concise Course in Statistical Inference*. New York: Springer. pp. 161-164.

Efron, Bradley and R.J. Tibshirani. 1993. *An Introduction to the Bootstrap*. Boca Raton, FL: Chapman & Hall / CRC. Chapter 9.

**Tuesday, March 3: Spring Break (No Class)****Thursday, March 5: Spring Break (No Class)****16 Tuesday, March 10: Bivariate Predictive Inference I**

- Missing data
- Bounding approaches
- Assumptions regarding the missingness mechanism
- Multiple imputation

**Optional Reading**

Aronow, Peter M. and Benjamin T. Miller. 2019. *Foundations of Agnostic Statistics*. Cambridge, UK: Cambridge University Press. pp. 207-234.

Little, R.A. and D.B. Rubin. 2002. *Statistical Analysis with Missing Data*. Second Edition. New York: John Wiley & Sons. Chapter 1, 3, 4, and 5.

**Thursday, March 12 (CANCELED)****17 Tuesday, March 17: Bivariate Causal Inference I**

- Potential outcome notation
- Causal estimands
- The fundamental problem of causal inference
- Causal inference as a missing data problem

**Optional Reading**

Holland, Paul W. 1986. "Statistics and Causal Inference." *Journal of the American Statistical Association*. 81:396, 945-960.

Imbens, G. and D. B. Rubin. 2015. *Causal Inference for Statistics, Social, and Biomedical Sciences: An Introduction*. Cambridge, UK: Cambridge University Press. Chapter 1.

## 18 Thursday, March 19: Bivariate Causal Inference II

- Random assignment of treatment as a basis for causal inference
- The ideal randomized experiment
- Ignorable treatment assignment
- SUTVA
- Estimators for PATE, PATT, SATE, and SATT
- Standard errors and confidence intervals for these estimators

### Optional Reading

- Imbens, G. and D. B. Rubin. 2015. *Causal Inference for Statistics, Social, and Biomedical Sciences: An Introduction*. Cambridge, UK: Cambridge University Press. Chapters 3-8.
- Cox, D.R. and N. Reid. 2000. *The Theory of the Design of Experiments*. Boca Raton, FL: Chapman & Hall. Chapters 1 and 2.
- Angrist, J.D. and J. Pischke. 2009. *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton, NJ: Princeton University Press. Chapters 1 and 2.
- Holland, Paul W. 1986. "Statistics and Causal Inference." *Journal of the American Statistical Association*. 81:396, 945-960.

## 19 Tuesday, March 24: Bivariate Causal Inference III

- Manipulation checks
- Imperfect randomization
- Balance checks
- Non-compliance
- SUTVA violations
- Fisher's test of no-effect whatsoever

### Optional Reading

- Gerber, A., Arceneaux, K., Boudreau, C., Dowling, C., Hillygus, S., Palfrey, T., Biggers, D.R., and Hendry, D. 2014. "Reporting Guidelines for Experimental Research: A Report from the Experimental Research Section Standards Committee". *Journal of Experimental Political Science*, 1(1), 81-98.
- Mutz, Diana C. and Robin Pemantle. 2015. "Standard for Experimental Research: Encouraging a Better Understanding of Experimental Methods". *Journal of Experimental Political Science* 2(2): 192-215.
- Gerber, A., Arceneaux, K., Boudreau, C., Dowling, C., and Hillygus, D. 2015. "Reporting Balance Tables, Response Rates and Manipulation Checks in Experimental Research: A Reply from the Committee that Prepared the Reporting Guidelines". *Journal of Experimental Political Science*, 2(2), 216-229.
- Morgan, K.L. and D.B. Rubin. 2012. "Rerandomization to Improve Covariate Balance in Experiments". *The Annals of Statistics*. 40:2. 1263-1282.

- Montgomery, J.M., B. Nyhan, and M. Torres. 2018. “How Conditioning on Posttreatment Variables Can Ruin Your Experiment and What to Do about It”. *American Journal of Political Science*. 62: 760-775.
- Rosenbaum, P. R. 2017. “Interference Between Units in Randomized Experiments”. *Journal of the American Statistical Association*. 102: 477, 191-200.
- Imbens, G. and D. B. Rubin. 2015. *Causal Inference for Statistics, Social, and Biomedical Sciences: An Introduction*. Cambridge, UK: Cambridge University Press. Chapter 5.

## 20 Thursday, March 26: Bivariate Causal Inference IV

- Review of last three lectures

## Part III: Multivariate Data

### 21 Tuesday, March 31: Multivariate Descriptive Inference I

- curse of dimensionality
- Multiple regression

#### Optional Reading

Angrist, J.D. and J. Pischke. 2009. *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton, NJ: Princeton University Press. Chapter 3.

Hansen, B.E. 2019. *Econometrics* August 2019 revision. Chapters 1-10. (available on course Canvas site).

### 22 Thursday, April 2: Multivariate Descriptive Inference II

- $F$  tests
- Likelihood ratio tests

#### Optional Reading

Wasserman, Larry. 2004. *All of Statistics: A Concise Course in Statistical Inference*. New York: Springer. pp. 216-218.

Hansen, B.E. 2019. *Econometrics* August 2019 revision. Chapters 1-10. (available on course Canvas site).

### 23 Tuesday, April 7: Multivariate Causal Inference I

- Random treatment assignment as a basis for causal inference
- The ideal blocked experiment
- Conditionally ignorable treatment assignment
- SUTVA
- Estimators for PATE, PATT, SATE, and SATT
- Standard errors and confidence intervals for these estimators

#### Optional Reading

Aronow, Peter M. and Benjamin T. Miller. 2019. *Foundations of Agnostic Statistics*. Cambridge, UK: Cambridge University Press. pp. 235-258.

Cox, D.R. and N. Reid. 2000. *The Theory of the Design of Experiments*. Boca Raton, FL: Chapman & Hall. Chapter 3.

Imbens, G. and D. B. Rubin. 2015. *Causal Inference for Statistics, Social, and Biomedical Sciences: An Introduction*. Cambridge, UK: Cambridge University Press. Chapters 3-11.

## 24 Thursday, April 9: Multivariate Causal Inference II

- Causal inference with observational data
- Challenges of observational data analysis
- Omitted variable bias
- Post-treatment bias
- Standard identification assumptions
- No-assumption bounds

### Optional Reading

- Aronow, Peter M. and Benjamin T. Miller. 2019. *Foundations of Agnostic Statistics*. Cambridge, UK: Cambridge University Press. pp. 235-258.
- Imbens, Guido. 2004. “Nonparametric Estimation of Average Treatment Effects Under Exogeneity: A Review”. *The Review of Economics and Statistics*. 86: 1, 4-29.
- Keele, Luke and Kevin M. Quinn. 2017. “Bayesian sensitivity analysis for causal effects from  $2 \times 2$  tables in the presence of unmeasured confounding with application to presidential campaign visits”. *Annals of Applied Statistics*. 11:4, 1974-1997.
- Manski, C.F. 1990. “Nonparametric bounds on treatment effects”. *Am. Econ. Rev. Pap. Proc.* 80: 319-323.
- Imbens, G. and D. B. Rubin. 2015. *Causal Inference for Statistics, Social, and Biomedical Sciences: An Introduction*. Cambridge, UK: Cambridge University Press. Chapters 21, 22, 23.

## 25 Tuesday, April 14: Multivariate Causal Inference III

- Causal inference with regression: What to do and what not to do

### Optional Reading

- Aronow, Peter M. and Benjamin T. Miller. 2019. *Foundations of Agnostic Statistics*. Cambridge, UK: Cambridge University Press. pp. 258-262.
- Imbens, Guido. 2004. “Nonparametric Estimation of Average Treatment Effects Under Exogeneity: A Review”. *The Review of Economics and Statistics*. 86: 1, 4-29.
- Aronow, P. M. and C. Samii. 2016. “Does Regression Produce Representative Estimates of Causal Effects?” *American Journal of Political Science*. 60(1), 250-267.
- Aronow, P. M. and C. Samii. 2017. Erratum to “Does Regression Produce Representative Estimates of Causal Effects?” *American Journal of Political Science*. 60(1), 250-267. *American Journal of Political Science*, 61: 504-504.
- Glynn, A., and K. Quinn. 2010. “An Introduction to the Augmented Inverse Propensity Weighted Estimator”. *Political Analysis*, 18(1), 36-56 (just read pp. 36-38).

## 26 Thursday, April 16: Multivariate Causal Inference IV

- IPW estimators
- AIPW estimators

### Optional Reading

Aronow, Peter M. and Benjamin T. Miller. 2019. *Foundations of Agnostic Statistics*. Cambridge, UK: Cambridge University Press. pp. 264-270.

Imbens, Guido. 2004. “Nonparametric Estimation of Average Treatment Effects Under Exogeneity: A Review”. *The Review of Economics and Statistics*. 86: 1, 4-29.

Glynn, A., and K. Quinn. 2010. “An Introduction to the Augmented Inverse Propensity Weighted Estimator”. *Political Analysis*, 18(1), 36-56.

Glynn, A., and K. Quinn. 2016. Erratum for Glynn and Quinn (2010). *Political Analysis*, 24(1), 130-130.

## 27 Tuesday, April 21: Review and Q & A

- Review and Q & A