Quantitative Research Methods

Boston University
Political Science 841
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Course Description

Quantitative research methods are important tools that political scientists, sociologists, and others use to test empirical claims about the world around us. This course offers an introduction to probability, descriptive statistics, hypothesis testing, and regression analysis, the foundations upon which nearly all quantitative analysis in social science builds. We will place emphasis both on theory, i.e., the concepts, logic, and mathematics underlying statistics, and applications, using software to analyze real data and implement the techniques we have learned. We will also learn how to assess work done by other scholars that uses quantitative methods.

I do not assume that students have any prior mathematical background beyond (a) high school algebra, and (b) the material covered in the BU math boot camp. We will invoke calculus at times during lecture, but we will cover what we need to know as we go along, and homework and exams will not involve calculus. Toward the end of the course, I will introduce matrix algebra, the foundation for more advanced statistics, and some knowledge of matrix algebra will be required for the final exam, but we will learn as we go along.

As this is a required course for political science and sociology graduate students, it necessarily serves different constituencies. For all students, this course will give you a basic understanding of the tools used for empirical research in much of the social sciences, allowing you to better comprehend articles published in top journals. For those who are skeptical of quantitative research, this course will help inform your skepticism, showing explicitly the assumptions required for hypothesis testing and regression analysis, why these assumptions are often not met in practice, and what problems arise as a result. For those who find themselves inclined toward statistical analysis, this course will help teach you how to do good quantitative research rather than simply crunching numbers for numbers' sake. It also will prepare you to go on to advanced courses, such as PO 843: Maximum Likelihood Estimation; MA 684: Applied Multiple

Regression and Multivariable Methods; SI 915: Models & Methods for Causal Inference in Strategy Research (School of Management); or numerous courses offered through the summer program at ICPSR. Finally, for those who are agnostic about quantitative methods, I hope to convince you that they should be part of your research toolkit!

Software

The required computer software for the course is R, an open-source statistical analysis package that is increasingly becoming the standard for quantitative analysis in political science as well as other disciplines. In addition to being available for free (download at http://www.r-project.org/), it is powerful, flexible, and has a large user community with plenty of free advice and expertise available on the Internet. It is also the software used in PO 843 and more advanced courses at ICPSR. The Teaching Fellow will be covering R during weekly sections; the material covered here is designed to complement lectures and readings. Please download and install R on your laptops and bring them to class so you will be prepared to participate.

I will be distributing various files related to the course via Dropbox, a file sharing system. This requires you to install a free application on your laptop. On the first day of class I will explain how Dropbox will work for our purposes.

Readings

The required textbook for the course is David S. Moore, George P. McCabe, and Bruce Craig, *Introduction to the Practice of Statistics*, 7th ed. (W.H. Freeman, 2012). There is a new 8th edition out, but the 7th edition is available cheaper online, either new or used. It's the version with what looks like an impressionist painting of tall grass on the cover, not the version with a multi-colored checkboard (8th edition) or what looks like a Picasso on an orange background (6th edition). Check out Amazon.com; there are hardcover, paperback, loose-leaf, and international editions available, and each should be fine.

Most statistics textbooks cover a pretty standard set of topics, yet with different levels of mathematical sophistication. Moore, McCabe, and Craig is somewhat middle-of-the-road. Depending on your background and learning style, you might want to supplement it by also reading about the topics we are covering in a different book. Here are some options I am familiar with. There are also countless others.

> Richard J. Larsen and Morris L. Marx, *An Introduction to Mathematical Statistics and Its Applications*, 5th ed. (Prentice Hall, 2012). Much more mathematically intense.
>
> David Freedman, Robert Pisani, and Roger Purves, *Statistics*, 4th ed. (W. W. Norton, 2007). Very little math; explains almost everything in words.

Toward the end of the course, we will be using some excerpts from other textbooks for topics not covered in Moore, McCabe, and Craig; I will distribute these at the appropriate time.

In addition to the assigned readings from the textbook, for most weeks of the course I have listed a political science journal article (indicated with an asterisk) that uses one or more of the techniques being covered that week. We will try to set aside time in class to discuss these articles. The political science journal articles are all available electronically on JSTOR.

If, while we are covering topics that invoke calculus or matrix algebra, you would like to do some reading on your own to solidify your knowledge, the following might prove useful:

> Daniel Kleppner and Norman Ramsey, *Quick Calculus: A Self-Teaching Guide*, 2nd ed. (John Wiley and Sons, 1985).
>
> Gudmund R. Iversen, *Calculus* (Sage, 1996).
>
> Krishnan Namboodiri, *Matrix Algebra: An Introduction* (Sage, 1984).

And if you want a review of bits of high school algebra you might have forgotten, these books might prove useful:

> Timothy M. Hagle, *Basic Math for Social Scientists: Concepts* (Sage, 1995).
>
> Timothy M. Hagle, *Basic Math for Social Scientists: Problems and Solutions* (Sage, 1996).

Finally, the following book is a very comprehensive overview of all of the above (and is required for the BU Social Science Math Boot Camp):

> Will H. Moore and David A. Seigel, *A Mathematics Course for Political & Social Research* (Princeton, 2013).

Sections

The Teaching Fellow will teach a weekly 2-hour section, to be scheduled during the first class meeting based on students' availability. The section will involve instruction in R and review of exams, homework assignments, and theoretical material from lecture. There is no attendance or participation grade related to the section. However, this will be the only place that R, which is required for homeworks, will be taught. If you don't learn it in section, you will have to learn on your own. In prior years, students also found the review material covered in section to be very valuable.

Assignments

Problem sets (20% of the final grade), consisting of both pencil-and-paper and computer exercises, will be assigned nearly every week and will be due the following week. These are graded on a check, check-minus, check-plus basis. It is impossible to learn statistics without practice, so these problem sets are very important. Working in groups is allowed and is often the

best way to learn; however, each student must turn in their own write-up. If working in a group, make sure you understand all of the answers, because you will be on your own come exam time!

Two midterm exams (20% each) will be held in class, approximately one-third and two-thirds of the way through the course. The final exam (40%) will be held December 15, 2014, 12-2 p.m. The exams are closed-book, but you will be allowed to bring in a single page (front and back) of notes. The exams are not cumulative—you will not have the same types of problems from midterm 1 on the subsequent exams—but statistics itself is cumulative, so you cannot "forget" what you learned in the first half of the course and still do well on the final.

The week after each midterm, the homework assignment will consist of correcting your mistakes and turning in a revised version. To facilitate this, I will return exams with errors highlighted or underlined, but I will not distribute a solution sheet until after the revision are turned in. The revised exam will be graded the same as other homeworks and will not affect your midterm exam grade.

Schedule and Readings

Sept. 3, 8: Introduction to Probability

Moore, McCabe, and Craig, §4.1-4.2; §4.5.

* Christopher H. Achen, "Advice for Students Taking a First Political Science Graduate Course in Statistical Methods," *The Political Methodologist* 10, 2 (Spring 2002): 10-12.

Sept. 10, 15: Random Variables and Expectations

Moore, McCabe, and Craig, §4.3-4.4.

Sept. 17, 22: Discrete Probability Distributions

Moore, McCabe, and Craig, §3.3, §5.2 (up through p. 323; stop at "Normal approximation for counts and proportions").

* Robert Weissberg, "Collective vs. Dyadic Representation in Congress," *American Political Science Review* 72, 2 (June 1978): 535-547.

Sept. 24, 29: Continuous Probability Distributions and the Central Limit Theorem

Moore, McCabe, and Craig, §1.3, §5.1, §5.2 (from p. 323 through the end).

* Donald E. Stokes, "Party Loyalty and the Likelihood of Deviating Elections," *Journal of Politics* 24, 4 (Nov. 1962): 689-702.

Oct. 1: Review

Oct. 6: Midterm Exam

Oct. 8, 14: Confidence and Significance

Moore, McCabe, and Craig, §6.1-6.3

* Michael Coppedge, "The Dynamic Diversity of Latin American Party Systems," *Party Politics* 4, 4: 547-568.

Oct. 15, 20: Power and Error

Moore, McCabe, and Craig, §6.4-6.5

* C. F. Larry Heimann, "Understanding the Challenger Disaster: Organizational Structure and the Design of Reliable Systems," *American Political Science Review* 87, 2 (June 1993): 421-435.

Oct. 22, 27: Inferences for Means

Moore, McCabe, and Craig, §7.1-7.2

* Thad Dunning and Lauren Harrison, "Cross-Cutting Cleavages and Ethnic Voting: An Experimental Study of Cousinage in Mali," *American Political Science Review* 104, 1 (Feb. 2010): 21-39.

Oct. 29: Inferences for Tabular Data

Moore, McCabe, and Craig, §9.1-9.3

* Edward D. Mansfield and Jack Snyder, "Democratization and the Danger of War," *International Security* 20, 1 (Summer 1995): 5-38.

Nov. 3: Midterm Exam

Nov. 5, 10, 12, 17: Simple Linear Regression

Moore, McCabe, and Craig, §2.2-2.4, §10.1 (stop at "Confidence intervals for mean response," p. 557), §10.2 (stop at "Confidence intervals for the mean response…," p. 574)

John Neter, et al., *Applied Linear Regression Models* (Richard D. Irwin, Inc., 1983). Chapter 6: "Matrix approach to simple regression analysis" (skip material on weighted least squares).

* Panagopoulos, Costas. 2013. "Extrinsic Rewards, Intrinsic Motivation and Voting." *Journal of Politics* 75, 1: 266-280.

Nov. 19, 24: Multiple Regression

Eric A. Hanushek and John E. Jackson, *Statistical Methods for Social Scientists* (Academic Press, 1977). Chapter 5: "Multivariate Estimation in Matrix Form."

* John T. Gaspar and Andrew Reeves, "Make it Rain: Retrospection and the Attentive Electorate in the Context of Natural Disasters." *American Journal of Political Science* 55, 2 (April 2011): 340-355.

Dec. 1, 3: Violating Regression Assumptions

Peter Kennedy, *A Guide to Econometrics* (MIT Press, 1998). Chapters 3, 6, 7, 8, 9, 10, 11.

Dec. 8: Interaction Terms

Brambor, Thomas, William Roberts Clark, and Matt Golder. 2006. "Understanding Interaction Models: Improving Empirical Analyses." *Political Analysis* 14: 63-82.

* Christenson, Dino P., and David M. Glick. Forthcoming. "Chief Justice Roberts' Health Care Decision Disrobed: The Microfoundations of the Supreme Court's Legitimacy." *American Journal of Political Science.* http://people.bu.edu/dinopc/papers/roberts.pdf.

Dec. 10: Review

Dec. 15, 12-2 p.m.: Final exam