POLI 783: Introductory Statistics

University of North Carolina at Chapel Hill
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Instructor

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Course Information

Class: Tuesdays & Thursdays 9:30–10:45am, Hamilton 351
Lab: Thursdays 11:00–11:50am, Hamilton 351
Course Website (Sakai): https://sakai.unc.edu/portal/site/poli783f17

Course Description

Over the last half century, political scientists have come to rely increasingly on quantitative methods for their research. This trend has occurred in virtually all subfields and is ongoing, as one can see in the publication of ever more complex quantitative analysis in the top-tier journals. Given this development, statistical literacy has become indispensable for political scientists. Whether you just want to keep up with the literature in your field or want to be engaged in your own quantitative research program, a solid knowledge of statistical methods has become just as important as knowledge of the theories in your field. Learning statistics may not be what you had in mind when you decided to attend graduate school in political science, but the truth is that much of the substantive literature in the discipline will remain inaccessible without a thorough understanding of the language of statistics. This course teaches you that language.

POLI 783 is the first course in the graduate methods sequence. The main emphasis of this course is to expose you to the key concepts and procedures that lie at the heart of all statistical analysis. To this end, it will often be more abstract than future courses, which will focus more directly on applied statistical analysis. However, you should keep in mind that a thorough understanding of this material is essential for you to become a competent producer and/or consumer of applied quantitative research in political science.

Course Objectives

Provided that you do the work that is required, you can expect to learn the following skills from POLI 783:

- You will learn fundamental concepts that underlie statistical analysis.
- You will learn the logic of statistical inference and discover how this logic can be used to draw inferences about the political world.
- You will learn how to translate substantive research questions into statistical terms, so that the language and procedures of statistics can inform your own research.
- You will obtain hands-on experience in statistical programming and data management in R.
- You will be prepared for more advanced courses in statistics and data analysis.
- You will learn mathematical skills you that will help you succeed in this and other methods classes in the department.

Prerequisites

There are no prerequisites for POLI 783, except that basic knowledge of algebra is assumed. Prior course work in statistics is helpful, although it should be noted that POLI 783 goes considerably beyond the material covered in most undergraduate courses.

Knowledge of basic calculus and familiarity with mathematical notation will be necessary for POLI 783. The lab will cover all of the mathematics that you will need in this course. Below I list a couple of reference books that might be useful to review the mathematics commonly used in political science research.

Grading

Students will receive one combined final grade (H/P/L/F) for both the class and the lab.

Homework (40%)

You are expected to complete a series of homework assignments for the class during the semester. These homework assignments will require you to solve analytical statistical problems, generally from the Devore and Berk textbook. You are expected to submit each class homework assignment by 9:30 am on the day it is due. Late submission of these assignments will result in a grade reduction.

There will also be homework assignments for the lab over the course of the semester. These homework assignments will focus on mathematical concepts and statistical programming in R.

Exams: Midterm (20%) and Final (40%)

Two closed-book, in-class exams will be given during the semester. A midterm exam will take place in class on Tuesday, October 17, while a cumulative final exam will take place on Tuesday, December 12, in Hamilton 351 at 8:00am (as scheduled by the university). The exams will only cover the material from the statistics coursework, not the lab. However, the exam will require you to use the math skills learned in the lab.

Collaboration and UNC Honor Code

You can learn a great deal from your classmates, and I encourage you to discuss the course materials, including the homework assignments. However, there is a fine line between accepting help and having someone else do the work for you, or between giving help and finishing someone else's work. For your own benefit you should avoid crossing this line. Plagiarism is a UNC Honor Code violation and will be prosecuted accordingly.

Course Materials

The following textbook is required for POLI 783. You may purchase a hard copy of the book or use an electronic copy available through the UNC library.

- Devore, Jay L., and Kenneth N. Berk. 2012. *Modern Mathematical Statistics with Applications*. 2nd Edition. Springer.
  http://link.springer.com.libproxy.lib.unc.edu/10.1007/978-1-4614-0391-3

If you are interested in an additional resources on math for political science:

- Jonathan Kropko. 2016. *Mathematics for Social Scientists*. Sage Publications.
- Will H. Moore & David A. Siegel. 2013. *A Mathematics Course for Political and Social Research*. Princeton University Press.

Course Philosophy

POLI 783 forms a foundation for all of your future quantitative methods courses in the PhD program. My primary goal as the instructor of this course is to make sure that every first-year student gains a solid understanding of key concepts in statistical methods. I will aim to pace the course accordingly. If this requires us to slow down and spend extra time on some topics, that is not a problem. I would rather you gain a firm grasp of key, central concepts than a shallow conception of a broad range of topics.

Below I provide a list of topics to cover in this course, but not a specific schedule. We may cover some topics in less than one class period; other topics will likely require multiple days. We may not be able to get to the last set of topics on the list. Don't worry about this. We will focus on the most critical concepts first. You will learn about the topics that we don't get to in future courses.

Words of Advice

For some of you, this may be your first course in statistics. I recognize this and have designed the course with this in mind. My main piece of advice is to do all that you can to keep up. Much of the material covered in this course is cumulative, so it can be difficult if you fall behind. Make sure that you keep up with the reading and the homework problems. Don't be afraid to ask questions in class. If you need more explanation about something, you can be sure someone else in the class is thinking the same thing. If you need additional help, don't hesitate to come to see me or Dan in our office hours.

On the other hand, for some of you, parts of the course may seem relatively easy, especially if you've already taken a course in statistics. I would advise you not to be lulled in a sense of complacency, or you may quickly find yourself falling behind once we hit more advanced topics. In my experience, there is always something to learn about even the most basic statistical concepts, and a firm understanding of statistical methods generally requires you to revisit these concepts multiple times during your career as a graduate student and beyond.

Course Organization

Unit 1: Descriptive Statistics (Ch. 1)

- Populations and samples
- Measures of location, measures of variability

Unit 2: Probability (Ch. 2)

- Probability axioms and theorems
- Conditional probability, Bayes' Theorem, independence

Unit 3: Discrete Random Variables (Ch. 3.1–3.4, 3.7)

- Probability mass functions, cumulative distribution functions
- Expected values, variance
- Moments and moment generating functions
- Bernoulli, binomial, and Poisson distributions

Unit 4: Continuous Random Variables (Ch. 4.1–4.3)

- Probability density functions, cumulative distribution functions
- Expected values, variance
- Uniform and normal distributions

Unit 5: Joint Probability Distributions (Ch. 5.1–5.3)

- Joint and marginal distributions, independence
- Expected values, covariance and correlation
- Conditional distributions

Unit 6: Sampling Distributions (Ch. 6)

- Statistics, sampling distributions
- Central limit theorem, law of large numbers
- Normal family (Chi-squared, t, and F distributions)

Unit 7: Estimation (Ch. 7.1, 8.1–8.4)

- Point estimators
- Properties of estimators (Mean-squared error, bias, efficiency, consistency)
- Confidence intervals

Unit 8: Hypothesis Testing (Ch. 9.1–9.4)

- Hypothesis tests, types of error, power
- Tests about the population mean and proportion

Unit 9: Inferences Based on Two Samples (Ch. 10.1–10.5)

- Difference-in-means test and confidence intervals
- Difference-in-proportions test and confidence intervals
- F-test for equality of variances

Unit 10: Preview of Future Courses (if time)

- Least squares regression, correlation (Ch. 12)
- Likelihood functions, maximum likelihood estimation (Ch. 7.2–7.4)
- Bayesian statistics (Ch. 14.4)

Lab Topics

The lab will cover material that complements and enriches the content covered in the course lectures. Lab sessions early in the semester will review all of the mathematics that will be needed in the course. The lab will also provide an introduction to the R statistical programming package, which you will use in future courses in the methods sequence. Examples of topics that will be covered in the lab include:

- Overview of basic math topics
- Differential and integral calculus
- Programming and data management in R
- Matrix algebra

Important Dates

No Class:

- Thursday, October 12 (University Day)
- Thursday, October 19 (Fall Break)
- Thursday, November 23 (Thanksgiving)

Exams

- Midterm exam: Tuesday, October 17 (in class)
- Final exam: Tuesday, December 12 at 8:00am in Hamilton 351