University of Michigan Political Science Math Camp - Summer 2018

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Schedule: Aug. 20-24 and Aug. 27-29, 10:00AM-12:00PM and 2:00-4:00PM
Location: Haven Hall 7603

Math Camp Overview

The goal of this course is to provide a review of some of the essential math that you will see in much of social science research, and to prepare you for taking the first courses in the formal theory and statistics sequences (PolSci 598 and PolSci 599). While this course is not for credit, there will be practice problems and a few tests to help you solidify your understanding of the concepts we cover. Mathematics is best learned through a combination of instruction and practice, and during this short course our hope is to integrate both.

Practice Problems

Practice problems will be assigned twice daily: once after the morning session – which you should try to work through before the afternoon session – and once after the afternoon lecture. They will be designed such that they shouldn't take longer than 1-1.5 hours; if you find this is not the case you should let me know! You are encouraged to work together on these problem sets, but you are also encouraged to try them on your own before meeting as a group. They will not be graded, but solutions will be posted, which you should read carefully to ensure you can identify and understand any mistakes made. Additionally, we may work through some of the problems in class. I will be available briefly after each lecture to discuss any questions.

Tests

There will be a diagnostic quiz to start off the course, just to get a sense of where everyone is. There will also be tests which will cover content from days 1-4 and days 5-9 respectively. These will be graded so that you can get some feedback, but the grades will not be used for anything beyond providing you with (hopefully useful!) information.

Suggested Textbooks

- Simon and Blume - Mathematics for Economists:
  Course lectures will be at approximately this level, and this is a great reference text for a lot of the math you can expect to use in your career. This will also be one of the reference textbooks for PolSci 598.
- DeGroot and Schervish - Probability and Statistics:
  An introduction to mathematical statistics/probability theory that is both rigorous and accessible.

– Moore and Siegel - A Mathematics Course for Political and Social Researchers:
This text is a great intuitive introduction to a lot of the math you'll need, with political science examples. It's pitched at a somewhat lower level than the lectures will be, although this would be a great bridge to get up to the level of the lectures.

Additional Resources

These resources will cover material at a variety of levels and can serve as an introduction/refresher for important topics.

– A Mathematics Course for Political and Social Researchers Video Lectures Designed to accompany the textbook *A Mathematics Course for Political and Social Researchers* by Moore and Siegel, David Siegel has a video course which follows content from the book and may be a very useful resource.

– Mooculus - Calculus 1 Massive Open Online Course This is a fairly thorough online calculus course that will cover almost all of the calculus you will need to know for the methods sequence. You can access the course (for free) through the link above and watch the videos on YouTube. If you attempt to do the full course, you should skip week 7 (trigonometric functions).

Course Schedule

- Day 1: Fundamentals & Logic
  - Diagnostic assessment
  - Terminology and set notation
  - Functions, correspondence, graphing (functions and inequalities), increasing and decreasing functions, domain and range, surjective, injective, bijective, and inverse functions. Power rules and exponentials. Factoring of polynomials. Summation notation.
  - Basic rules of formal logic.
  - Simon and Blume Ch. 2.
- Day 2: Proof Strategies & Calculus I
  - Proof strategies: direct and proofs by construction, proofs by contra (contradiction, contrapositive, counterexample), induction.
  - Change over time, secant and tangent lines, notation, limits and derivatives.
  - Product rule, quotient rule
  - Simon and Blume Ch. 3.
- Day 3: Differentiation (including some partial differentiation). Chain rule.
  - Product rule and quotient rule review.
  - Chain rule, derivatives of functions (Polynomials and powers, exponentials, logarithms, other functions).

  - Discussion of partial derivatives.
  - Simon and Blume Ch. 4-5.

- Day 4: Integrals, Integration by Parts, and Fundamental Theorem of Calculus (FTOC). Test 1.
  - Definite integrals as sums, indefinite integrals, antiderivatives, rules of integration (polynomials and powers, exponentials, logarithms, other functions). If time permits, integration by substitution and integration by parts.
  - Simon and Blume Ch. 4-5. Appendix 4.

- Day 5: Introduction to probability theory. Basic combinatorics.
  - Sample space, events, probability axioms, conditional probability. Factorials, combinations, permutations.
  - Simon and Blume Appendix 1, DeGroot and Schervish Ch. 1-2.

- Day 6: More probability theory/mathematical statistics.
  - Random variables, distributions. Expectation operator, moments (including variance and rules for variance), etc.
  - DeGroot and Schervish Ch. 3-5.

- Day 7: Introduction to vectors, with elements of real analysis. Introduction to linear algebra.
  - Points and functions in n-space, distance between vectors, epsilon balls, open/closed sets, boundedness, compactness. More on vectors.
  - DeGroot and Schervish Ch.7. Simon and Blume Ch. 10, 12.5.

- Day 8: More linear algebra. Test 2.
  - Dot products, orthogonality, linear combinations. Properties of matrix multiplication, transposes, etc.
  - Time permitting: discussion of determinants, matrix rank, matrix inverses (2x2), Cramer's rule, using linear algebra to solve systems, etc. End with application to linear regression.
  - Simon and Blume Ch. 7-9