University of Michigan Political Science Math Camp - Summer 2015

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Schedule: Aug. 25-28, 9:15-11AM and 1:30-3:30PM. Aug. 31-Sept. 4, 10AM-12PM and 3-4:30PM
Location: Haven Hall 7603
Course website: CTools.

Math Camp Overview

After months of the dreariness that is warmth, free time, and sunshine, math camp has finally arrived! 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 (PS598 and PS599). 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 lecture, which you should try to work through before the afternoon lecture, 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 us 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. We 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 on August 28 and September 4, 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 PS598.

  – 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. There is also a video course by David Siegel (one of the authors of the book), linked to here, which follows content from the book and may be a very useful resource for some of you.

Course Schedule

- Day 1 (Jean) - August 25: Diagnostic quiz. Math fundamentals: terminology and set notation, intervals, functions (increasing, decreasing, domain, range), factoring.

    – Functions, correspondence, graphing (functions and inequalities), increasing and decreasing functions, domain and range, surjective, injective and bijective functions. Brief discussion of inverse functions. Power rules and exponentials. Factoring of polynomials.
    – Simon and Blume Ch. 2.

- Day 2 (Jean) - August 26: Change over time, tangent lines, introduction to differentiation.

    – Change over time, secant and tangent lines, notation, limits and derivatives.
    – Simon and Blume Ch. 3.

- Day 3 (Jean) - August 27: Differentiation (including some partial differentiation). Product, quotient, chain rules.

    – Chain rule, product rule, quotient rule, derivatives of functions (Polynomials and powers, exponentials, logarithms, other functions). Discussion of partial derivatives.
    – Simon and Blume Ch. 4-5.

- Day 4 (Jean) - August 28: Integrals: definite and indefinite integrals, rules of integration. Integration by parts. 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.
- Simon and Blume Ch. 4-5. Appendix 4.

- Day 5 (Jean & Jason) - August 31: Introduction to set theory and probability theory.

  - Sample space, events, algebra of sets (unions and intersections), probability axioms, conditional probability.
  - Simon and Blume Appendix 1, DeGroot and Schervish Ch. 1-2.

- Day 6 (Jason) - September 1: 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 (Jason) - September 2: Introduction to estimation. Introduction to vectors, with elements of real analysis.

  - What is an estimator? Introduction to maximum likelihood estimation. Points and functions in n-space, distance between vectors, epsilon balls, open/closed sets, boundedness, compactness.
  - DeGroot and Schervish Ch.7. Simon and Blume Ch. 10, 12.5.

- Day 8 (Jason) - September 3: Introduction to linear algebra.

  - Dot products, orthogonality, linear combinations. Properties of matrix multiplication, transposes, etc.
  - Simon and Blume Ch. 7-9

- Day 9 (Jason) - September 4: More linear algebra. Test 2.

  - 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