Math Prep Summer 2018

Syllabus for POLI Ph.D. Students

Yuki Atsusaka
Department of Political Science
Rice University

Office: 206 Herzstein Hall
Office Hours: by appointment
Email: atsusaka@rice.edu

Course Objectives

This course is designed to provide incoming Ph.D. students a broad review of basic mathematical topics whose understanding is required for the successful completion of the first-year method sequence (POLI 504 & 505) and beyond in the Dept. of Political Science. Beyond helping students build their quantitative toolkits, learning and reviewing mathematical concepts and operations will be helpful for them to organize their thoughts and build their own theories and hypotheses. The main goal of this course is to provide an opportunity for students to familiarize themselves with mathematical language and manipulation through repeated problem solving practices.

Schedules

We will meet in Herzstein 126 for the following dates and times. We have **nine days** of math prep. (We do not have a class on April 15th due to the Orientation for All Incoming Graduate Students.)

- August 6th to August 10th (10AM-11:30AM)
- August 13th to August 14th (2:30PM-4:00PM)
  [the Orientation for International Students is during 8:15AM-2PM for both dates]
- August 16th to August 17th (10AM-11:30AM)
  the Orientation for RVA/RGA residents may happen during the two dates, while it is not announced as of May 8th. If it overlaps with our schedule, rescheduled time will be announced

Course Materials

In this course, we primarily use Will H. Moore and David A. Siegel (2013) *A Mathematics Course for Political and Social Research*, Princeton: Princeton University Press for our class material. In addition, our assignments include a set of video lectures by David A. Siegel, which are available at

(https://www.youtube.com/channel/UCrA2SLUKnV6yjdgIfDwFeGg/playlists).

Course Expectation

Students are expected to read the assigned sections from the textbook and watch the corresponding video lectures before the beginning of each class. The details of the assignments are listed below. For each class, students should submit their homework "problem sets" answers by the **start of the next class** on Canvas after covering corresponding materials (e.g., HW for Day 1 is by 10AM of Day 2). Although this course is not graded, homework answers will be graded and returned one day after their due dates. *(All assignment should be submitted as a pdf file on Canvas. You can submit the pictures of your hand-writing answers after converting them into pdf files, for example by scanning or by a relevant app such as CamScanner, or you can write your answers via LaTeX (and compile them into a pdf file) if you are already familiar with and prefer it.)*

In each class, we will (i) review previous homeworks, (ii) go over the covered materials, (iii) solve some practice problems together, (iv) and discuss questions that students have. If you have any question or concept that you want to clarify in each class, it is more than welcome and please email it to me ideally by 5pm of the day before each class.

Finally, this course is designed for incoming students with all level of mathematical background. If you think that you are already familiar with basic topics, I encourage you to read more advanced chapters in the book, which are not included in the assignments, and further expand your knowledge. If you think that you do not have a strong or any mathematical background, there is nothing to worry about and you can build it from this course. It is highly recommended, however, for those who feel that way to go over the book and solve homework problems *at least three times*. It should be emphasized that this is not a competition and working together on the homework problem sets is more than fine as long as your write-up is done by yourself.

Special Needs

If you have a disability and need accommodations in this class, please contact me in advance, preferably before or during the first day of class. Students with disabilities also need to contact Rice Disability Support Services (Phone: +1-713-348-5841; email: adarice@rice.edu) in the Allen Center, Room 111.

Syllabus Change Policy

The contents of this syllabus may be changed by the instructor. The instructor will notify students in advance, if any changes are made.

Course Outline and Assignment

Day 1: Introduction to Probability

- Topics: basic probability theory; combinations and permutations; joint, conditional, and marginal probabilities; Bayes' rule
- Readings: M&S (Moore and Siegel) 9.1-9.2, 10.3.2.
- Video lecture: Lecture 7, module 1-5 (+ relevant problems in problem session); Lecture 8, module 2 (10:16 $\sim$).
- Problem sets: (M&S 9.4): 1(b), 1(d), 4(b), 4(d), 5, 7, 11, 13(c), and 15. $\leftarrow$ **Homework**

Day 2: Algebra and Introduction to Functions

- Topics: mathematical symbols and notation; summation and product operators; factoring; solving equations; definition of a function; identity, inverse, monotonic functions, etc.
- Readings: M&S Chapter 1, 2.2, and 3.1.
- Video lecture: Lecture 1, module 4-6 and 10 (including 10b); Lecture 2, module 1-2.
- Problem sets: 5(b), 5(d), 5(f), and 7 of M&S 1.8; 4, 6, 16, 22, 26, and 28 of M&S 2.4; 1 and 4 of M&S 3.4.

Day 3: Examples of Functions, Limits, Sequences and Series, and More on Sets

- Topics: properties of linear and nonlinear functions (i.e. exponential, logarithm, polynomial, etc.), sequences and series, limits and continuity, and various types of sets
- Readings: M&S 3.2 and Chapter 4.
- Video lecture: Lecture 2, module 3-10.
- Problem sets: (M&S 3.4): 8, 13[1], 14[2], 15, and 17.

Day 4: Introduction to Calculus and the Derivative

- Topics: definitions of calculus and the derivative; a brief introduction to partial derivatives

[1] f you have any difficulty running a Java program, you can visit https://www.desmos.com/calculator instead.

[2] The address of the website has changed to http://zonalandeducation.com/mmts/functionInstitute/polynomialFunctions/graphs/polynomialFunctionGraphs.html.

- Readings: M&S Chapter 5.
- Video lecture: Lecture 3.
- Problem sets: (M&S 5.5): 2(a), 2(i), 3(a), 3(b), 4(a), 4(c), 5(d), and 5(f).

Day 5: The Rules of Differentiation

- Topics: Computing derivatives; chain rule; derivatives of functions (polynomials, exponentials, and logarithms)
- Readings: M&S Chapter 6.
- Video lecture: Lecture 4.
- Problem sets: (M&S 6.4): the 6th, 8th, 12th, 18th, and 24th of problem 1, 2(b), 2(e), 2(k), and 2(m).

Day 6: The Integral

- Topics: the definition of the integral; definite and indefinite integral; integrals of functions
- Readings: M&S 7.1-7.3.5.
- Video lecture: Lecture 5, module 1-6 (+ relevant problems in problem session).
- Problem sets: (M&S 7.6): 3(i), 3(k), 3(o), 4(k), 4(o), 5, 6(a), 6(b), 6(c), and 6(j).

Day 7: Extrema in One Dimension

- Topics: maxima and minima; first and second derivative tests; concavity and convexity
- Readings: M&S Chapter 8.
- Video lecture: Lecture 6.
- Problem sets: (M&S 8.5): 1(b), 1(d), 1(g), 1(i)[3], and 2 (assuming that $a > 0$).

Day 8: Introduction to Vectors and Matrices

- Topics: scalars and vectors; matrix algebra; matrix inverse; properties of vectors and matrices
- Readings: M&S 12.1-12.4.
- Video lecture: Lecture 10, module 1-8.

[3]Check the Errata from http://people.duke.edu/∼das76/Research/Errata.pdf

- Problem sets: (M&S 12.6): 1(c), 1(f), 1(j), 3(b), 3(d), 4(e), 4(g), 4(k), 5(b), 5(d), and 6(a).

Day 9: Application of Matrix Algebra and Concepts in Linear Algebra

- Topics: Application of Matrix Algebra and Concepts in Linear Algebra
- Readings: M&S 12.5, 13.1, 15.2.2 (the gradient vector part), and 15.2.4.
- Video lecture: Lecture 10, module 9-problem session; Lecture 11, module 1-2; Lecture 14, module 1 and 4.
- Problem sets: 8, 9, 10, 11, and 12 of M&S 12.6; 1(a) and 1(b) of M&S 13.4.