

Illinois Political Science Math Camp 2020

Political Science Graduate Student Association
August 10–14, 2020, in David Kinley Hall (DKH) 404

Course Description

The Political Science Graduate Student Association hosts a week-long Math Camp to review important topics in mathematics, probability, and the basics of programming in R to help you succeed in graduate methods courses. The schedule has two components: (i) morning lecture and review sessions on mathematical topics like calculus, linear algebra, and probability; and (ii) afternoon sessions on the basics of programming in R. The morning sessions on Day 1–Day 4 mainly focus on mathematics and probability with a combination of lecture and problem-solving. Students are expected to do daily homework on a voluntary basis. Afternoon sessions are software sessions that focus on basic programming skills in R. Day 5 is mainly dedicated for students to learn skills on producing reproducible reports and participate in a small group project to demonstrate what they have learned in Math Camp.

Evaluation & Policies

Homework

Each day, you will be given short homework assignments that review material covered in the morning lecture. You are expected to solve some problems each day on a voluntary basis. Solutions will be provided.

Small Group Project

In the final day of Math Camp, there will be time for you to team up with other students to complete a small group project. The due date of the group project is August 16 at 11:59PM. While there are no grades for Math Camp, we encourage you to take homework problems and the small group project seriously to benefit as much as possible from the course material.

Attendance and Participation

Attendance is voluntary, but highly recommended. Students are strongly encouraged to participate in class and ask questions. For those who are familiar with the materials covered in the class, please take this as review time and use it as an opportunity to help your colleagues learn. Please ask a lot of questions, and ask them often. Math Camp also offers incoming first-years an opportunity to spend time with your cohort to bond, meet other graduate students, and be exposed to our department culture.

Strongly Encouraged: Complete DataCamp & Swirl Boot Camps Before Arriving

In order to get the most out of Math Camp, it is strongly encouraged that you complete a preliminary coding boot camp with DataCamp and Swirl. For DataCamp, we recommend you register and complete Introduction to R & Intermediate R with [DataCamp](#)—don't worry, registration is free. The expected time to complete both sessions in DataCamp is roughly ten hours, although this can be shorter or longer depending on your programming experience.

After completing DataCamp, we strongly encourage you to complete [Swirl](#). Swirl provides

exercises and feedback from within your R session to help you learn in a structured, interactive way. On average, it should take most people roughly 15 hours to complete all of the Swirl sessions, however, this can be shorter or longer depending on your background with programming.

Course Website

You can access the course site via Github on [this page](#). You can find the lecture slides, R codes, final projects, classwork, and solutions there.

Resources

The following is a list of resources that you can use over the summer to help you succeed in Math Camp and grad school. None are required, but reviewing at least some of these will help you immensely once you get to campus. Calculus, linear algebra, and probability theory will pop-up in quantitative methods and game theory courses.

If you have never had exposure to calculus before, don't worry, we will cover it in Math Camp. That said, Math Camp is a short and intensive program, and it could be helpful if you reviewed the basics of univariate calculus (limits, derivatives, integrals) over the summer using these books and web resources. Books 3–5 give an overview of the mathematics used in political science and economics.

Books

1. Kleppner, Daniel and Norman Ramsey. 1985. Quick Calculus: A Self-Teaching Guide, 2nd Edition. John Wiley and Sons.

A popular, accessible book for self-teaching differential and integral calculus.

2. Morgan, Frank. 2001 Calculus Lite. Natick, MA: K Peters.

Another popular book for self-studying. Good as a refresher.

3. Moore, Will and David Siegel. A Mathematics Course for Political and Social Researchers. Princeton Uni. Press.

Written by two political scientists, this is an intuitive introduction to a lot of the math you will need with political science examples. Highly recommended. David Siegel also has a video course that go along with the book, which could be a good resource.

For David Siegel's video lectures and other related materials, please see [David Siegel's online materials](#).

4. Gill, Jeff. 2006. Essential Mathematics for Political and Social Research (Analytical Methods for Social Research). Cambridge.

This covers most of the topics that will be presented in the Math Camp. This is a book about building fundamentals in preparation for more advanced methods texts. Highly recommended.

5. Simon, Carl and Lawrance Blume. 1994. Mathematics for Economists. Norton and Co.

This is a good reference book with more rigorous/advanced treatment of the topics compared to the other books listed here. This is a good book to have if you are interested in formal theory.

Online Resources for R and more

It is important that you can take some time to get familiar with R, one of the programming languages you will predominantly use in our program. We highly recommend that you install [R](#) beforehand. You are also encouraged to install and get familiar with [R Studio](#), a more user-friendly software to use R output.

You can also find many courses on programming, data science, calculus, probability, and a variety of other courses on [Coursera](#) (Calculus from OSU and R from JHU courses are popular). For advanced learners, feel free to check out [Kaggle](#). There are also many other open platforms offering online courses on a variety of topics, such as [MIT OpenCourseWare](#) and [Khan Academy](#).

There are also other Political Science Math Camps with free content: Duke offers free [YouTube videos](#), [practice problems](#), and [solutions](#). [Harvard](#) also has helpful resources.

Class Schedule

Morning Session A:	9AM–10:30AM
Break:	9:40AM–9:50AM
Morning Session B:	10:30AM–12PM
Break:	11:10AM–11:20AM
Lunch:	12PM–1PM
Afternoon Session C:	1PM–3PM
Break:	1:50PM–2PM
Afternoon Session D:	3PM–5PM
Break:	3:50PM–4:00PM

08/10 Monday

Morning Session A: Sets & Intervals, Functions (Sanghoon Kim)

Morning Session B: Introduction to Linear Algebra I (James Steur)

Lunch: GSA Mentoring Session

Afternoon Session C: Introduction to R (Kristin Bail & Jinwon Lee)

Afternoon Session D: Review Sets & Intervals, Functions, Linear Algebra, & Introduction to R (James Steur)

08/11 Tuesday

Morning Session A: Introduction to Linear Algebra II (James Steur)

Morning Session B: Limits & Derivatives (Tolgahan Dilgin)

Lunch: What is GSA?

Afternoon Session C: Integrals (Miles Williams)

Afternoon Session D: Playing with Data I: Data Manipulation & Logical Statements (Justin Pierce & Jinwon Lee)

08/12 Wednesday

Morning Session A: Review Introduction to Linear Algebra II, Derivatives, & Integrals (James Steur)

Morning Session B: Probability I: The Basics (Lucie Lu)

Lunch: Mentoring Session with Faculty

Afternoon Session C: Probability II: Distributions (Jae Cho)

Afternoon Session D: Distributions in R (Miles Williams & Justin Pierce)

08/13 Thursday

Morning Session A: Review Probability and Distributions in R (James Steur)

Morning Session B: Mathematical Notation (Lucie Lu)

Lunch: FREE TIME

Afternoon Session C: Hypothesis Testing (Josh Holmes)

Afternoon Session D: Regression: OLS (Stephen Mullins)

08/14 Friday

Morning Session A: Review mathematical notation, hypothesis testing, and regression (James Steur)

Morning Session B: Playing with Data II: Visualization (Sanghoon Kim & Josh Holmes)

Lunch: FREE TIME

Afternoon Session C: Project Time I (James Steur & Yiqiang Wang)

Afternoon Session D: Project Time II & Professionalization (James Steur & Yiqiang Wang)

8/18 Tuesday

Small group project due. Please send your group project to James Steur (steuer2@illinois.edu) by 11:59PM.

FAQ About Methods at Illinois

1. I haven't done math in a long time/I have no experience in programming, and I'm worried: can I succeed in the methods sequence?

The short answer is yes, and do not worry! Graduate students in our department come from diverse backgrounds. Some students enter the program and haven't done any math since they graduated high school, and they make it through the methods sequence. With the help of your cohort, the methods TA, and faculty members all of us successfully finish our methods sequence. That said, people with less of a math and programming background should expect to invest a good deal of their time into their methods courses, especially during the first year of graduate school.

2. How can I prepare for the methods sequence before arriving at Illinois?

Once the semester begins, it can be challenging for students to learn both programming and statistics at the same time. As a result, we strongly recommend you complete the Datacamp and Swirl boot camps before starting graduate school. These online resources help you learn R: the primary programming language you'll be using in most of the methods sequence. In Quant I and Quant II, for example, you'll be asked to finish your assignment using R almost every week, and the boot camps help prepare you for future methods classes. Completing the tutorials and exercises can give you more confidence in programming before starting graduate school. If you finish both boot camps before Math Camp, you can get a head start by reading the math books we've suggested, or find another boot camp on your own to further build your skills.

3. I have a lot of math/programming experience: will I be challenged?

Although it depends on your background, most people find the methods sequence challenging. The Political Science Graduate Student Association hosts Math Camp as a primer for those without a background in math/programming, and it serves as a review for those with more of a math/programming background to help prepare incoming cohorts for quantitative methods.

Importantly, the methods sequence and Math Camp assume virtually no background in quantitative methods. If you have a strong background in mathematics or programming (e.g. a STEM-focused undergraduate study), the basic mathematics serve more as a review of concepts you're probably familiar with already. Not to worry, however: once you are in the methods courses themselves there is plenty of mathematical depth that you are unlikely to have encountered.

Similarly, if you have previous experience with data management and basic statistical analysis in R, the material in Math Camp may not cover new content, but it will be an opportunity to continue practicing. Once you are in the methods courses, you will have the chance to work on a variety of interesting problems. If you know a different programming language besides R, then you should have a straightforward and engaging experience adapting to the syntax and data structures employed in R.

Ultimately, even if you know a lot of math and programming, Math Camp and our Methods Sequence emphasize applying these techniques to social science and critiquing them effectively.

4. What resources are available to help me succeed in the methods sequence?

The best resource to help you succeed are your professors. You should speak with the professors in your subfield about research ideas and what methods you might need to use for a paper. If you're struggling in a methods class or want to learn more about a specific topic, you should reach out to that professor. They are generally happy to help you learn, and they will guide you to the best resources given your particular interests and skills.

There is also a graduate student appointed to serve as a teaching assistant for the methods sequence. This student generally attends methods classes and holds regular office hours. They are another great resource if you need help or have questions.

Beyond professors and the graduate teaching assistant, there are a variety of online resources that can be helpful when starting out with methods. Here are a handful that can help you learn basic statistics and programming:

- 1- Learning R.
 - a. DataCamp (<https://www.datacamp.com/>)
 - i. Offers several interactive tutorials where you can practice and learn for free
 - b. <https://www.r-bloggers.com/>
 - c. *Cookbook for R*, by Paul Teetor and James Long (<https://rc2e.com/>) or any of its companion manuals
 - d. *Discovering Statistics Using R* by Andy Field, Jeremy Miles, and Zoë Field.
- 2- Statistical methods:
 - a. <https://www.statisticsonewrong.com/>
 - b. <https://www.khanacademy.org/math/statistics-probability>
 - c. <https://www.coursera.org/search?query=statistics&>

5. How many methods classes do I need to complete at Illinois?

According to our [Graduate Handbook](#), “The department requires that PhD students complete a minimum of five graduate-level units (20 semester hours) distributed across the areas of statistics, formal theory, and qualitative methods, as appropriate for their specialization.”

Two of these courses (8 semester hours) must be a sequence in statistical methods. Generally, students take PS530 (Quantitative Political Analysis I) and PS531 (Quantitative Political Analysis II) to fulfill this requirement. Most students also decide to take PS532 (Quantitative Political Analysis III) to help them fulfill their methods requirement. Students are also required to take PS 522 (Research Design).

You should know that if you want an outside course to apply toward the departmental requirements for graduation, all courses outside of the Political Science department need to be approved by the current methods subfield committee chair. This person will need to review

syllabi and will determine on a case-by-case basis whether a course will satisfy the methods requirements for your degree. You should try to email the current methods subfield committee chair the syllabus before the semester starts to get approval.

6. What math topics and programming languages are typically covered in the methods sequence?

The faculty members who teach our methods sequence are Brian Gaines, Jake Bowers, and Wendy Cho. Generally, people have Brian for Quant I, Jake for Quant II, and Wendy for Quant III. However, the instructors sometimes switch between the different methods sequence classes, so it is hard to say definitively what topics you'll cover. Generally, students by the end of the methods sequence get exposure to data description, bootstrapping, hypothesis testing, regression, causal inference, and permutation testing—although there is much more you'll be exposed to! Jake has included some of his [syllabi](#) on his website if you'd like to look at them. Ultimately, by the end of the methods sequence, you'll have exposure to a wide variety of quantitative topics in political science.

The programming language primarily covered in our department is R. If Wendy is teaching spatial econometrics during PS532, you'll also get some exposure to QGIS and GeoDa.

7. Why is it important for me to learn methods?

What comprises “effective” data analysis? How can researchers resolve problems with missing or limited data? How can researchers ensure they select the correct target of study for their empirical analysis? How can researchers ensure that results are statistically sound and reproducible? As a researcher, these are the types of questions you'll grapple with in your own work. By developing an understanding of methods, you will have an easier time answering these complex questions you'll encounter.

Importantly, these types of questions cluster around a foundational concern in empirical research: are we asking the right questions, and are we *asking them in the right way so as to produce meaningful, informative results*? As a social scientist, you frequently deal with complicated, elusive concepts and measures. An understanding of methods equips you to deal with these challenges more readily, and provide a strong foundation from which to ponder (and solve!) difficult problems as you come across them in your own research. Likewise, it will give you the tools to assess the strengths and weaknesses of your own work and your peers—enabling you to contribute to their growth as scholars, and them to yours. This mutual process of learning, rooted in a common framework of understanding the questions that we seek to answer, enables us to engage in a collaborative process about our work.

Finally, the discipline's methodological toolbox continues to grow with the advent of data science and the availability of more varied data sources. Scholars in the discipline are expressing concerns about *how* researchers apply these methods and work on developing novel ways to address these concerns. As you learn methods, you'll learn how to balance this variety of considerations that constitute the modern landscape of social science and think about your own work more critically.

8. You've talked a lot about quantitative methods, but what about qualitative methods in the department?

There is one qualitative methods class our department offers: The Comparative Method (PS523). In this course, students learn about topics like interviews, process tracing, field research, mixed methods, and other aspects of qualitative research. That said, this is the only qualitative course our department offers since we primarily focus on quantitative methods. If you are interested in qualitative training beyond PS523, you may need to search for additional resources outside the department. One potential option is taking summer courses through Syracuse University's Institute for Qualitative and Multi-Method Research (IQMR).

9. Should I take courses in other departments, like statistics, for my methods training?

This will depend on your individual research interests and the availability of methods training in the department. Generally, the methods you learn in the department will be those you see most in political science, and our department offers excellent training both through the official methods sequence and in additional courses (including [ITV classes](#)).

That said, many students take courses outside of the department for their methods training. This is typically done for one of two reasons. First, the methods you need for your research interests aren't available or aren't covered in-depth by classes in the department. In these cases, you might want to take courses in other departments to better learn a method you're planning to use in your dissertation. Second, you may want to add more rigorous statistics training or learn more advanced methods to suit the needs of a specific career in something like data science.

Thankfully, great methods classes are available throughout the University, no matter what your reason is for wanting to learn more. The Political Science Graduate Student Association maintains a repository of courses that students have taken outside of the department, so you can see what other students have studied and determine if a course is for you at this link: <https://publish.illinois.edu/poliscigsa/resources/outside-courses/>. Many students are happy to chat with you about a specific course they've taken if you reach out to them.

More specifically, many students take graduate-level courses in statistics, like STATS 420, to refine their understanding of topics covered in the methods sequence. Other students take quantitative or mixed methods courses from the Sociology department, and Educational Psychology regularly offer methods classes on linear regression, categorical data, theory of measurement, and many other useful topics. If you plan on using econometrics or time series, you might want to take specialized methods courses in the Business School or Department of Economics.

If you are really interested in learning statistical methods, the Department of Statistics offers a Master of Science in Applied Statistics that is designed for graduate students pursuing doctoral degrees in other fields. To learn more, visit <https://stat.illinois.edu/academics/graduate-programs/degree-programs/ms-statistics-applied>.