

Math Workshop for New Graduate Students: A Refresher and a Crash Course

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1 Course Description

Mathematical literacy is essential to make the most out of graduate education in social sciences. Generally, the students are assumed to already have this level of literacy, or they are expected to build it by themselves on their own. This approach tends to have very varied results.

This refresher / crash course workshop has two goals: First is to help new students familiarize themselves with mathematical expressions they will regularly encounter. For many students, particularly those with no undergraduate training in mathematics, unfamiliarity can quickly devolve into math-phobia. If nothing else, this workshop aims to prevent this phobia and make you comfortable enough with quantitative social science to be able to consume published work.

Second, the workshop aims you provide the background to do well in methods courses offered in Josef Korbel. Furthermore, it will provide students strong enough mathematical foundations to be able to continue their quantitative methodological training on their own.

2 Course Format

The workshop is expected to meet 10 days, for two hour sessions over 2 weeks. Since math can only be learnt by doing the primary goal is to use this time together to go over the challenging material and solve some problem sets, rather than lecturing. There will of course be some lecturing.

There are many, many resources for mathematics, some of which are specially aimed at graduate students in social sciences. I have assembled the readings for this workshops from those aimed at social scientists, particularly

in political science . In addition to readings, there will be problem sets for each section. I will share the recommended readings and problem sets with the participants, once the workshop starts.

3 Schedule (Tentative)

3.1 Intoduction

3.1.1 Why do we need Math?

We start with a simple (self)assessment and discuss how and why math is useful and necessary for social sciences. We look at some examples where mathematical approach to social sciences has helped make progress. Since the use of statistics are now almost ubiquitous, I have chosen two formal modeling papers as examples.

Page, Scott E. "Path Dependence." *Quarterly Journal of Political Science* 1, no. 1 (January 26, 2006): 87–115.

This is a great example of how math can be used to clarify concepts and bring rigor and coherency to our thinking. Scott Page uses some relatively basic math to clarify and categorize what "Path Dependency" can mean in different contexts.

Fearon, James D. "Rationalist Explanations for War." *International Organization* 49, no. 3 (1995): 379–414.

One of the most cited and assigned papers in IR. A simple game-theoric model that helped generate a whole research program.

3.2 Algebra & Calculus

3.2.1 Algebra, Sets, Functions and Relations

An introduction and refresher of basic building blocks: algebra, sets, functions an relations. Recommended Reading: Moore and Siegel, Chapter 1

Although the whole book is great, their introductory chapter is particularly easy to get into and get upto speed with material from high school you might have forgotten.

3.3 Calculus

The goal of this section is to familiarize ourselves with limits, derivatives and integrals. They will prove essential when we are concerned with behavior of functions, such as when we are examining rates of change and probability distributions.

Recommended Reading: Hagle, Chapter 1-5

This is a brief and concise introduction to linear calculus that is more than robust enough for our purposes.

3.3.1 Derivatives

3.3.2 Integral

3.4 Linear Algebra

For our purposes, some familiarity with matrices and vector notation will be sufficient. We will need to familiarize ourselves with fundamentals of linear algebra to understand applied statistical work using linear regression and ordinary least squares (OLS) estimation.

Recommended Reading: Namboodiri, Chapter 1-3

Similar to Hagle, although other resources such as Moore and Siegel cover this topic, this shorter introduction is enough for our purposes.

3.4.1 Vectors and Matrices: Introduction

3.4.2 Matrix operations and Systems of Equations

3.5 Probability

Probability is central to social sciences. Not only it is the foundation of statistical analysis, but it is also a very useful for formulating explicit arguments about the nature of uncertainty.

Recommended Reading: Moore and Siegel, Chapter 9-10 : Fox, Chapter 4

Probability is fundamental so we want to spend more time on this topic. Moore

and Siegel chapters are comprehensive enough and easy to follow. Fox chapter will help us bring it all together to put into application in statistical analysis.

3.5.1 Introduction to Probability

3.5.2 Discrete & Continuous Distributions

3.5.3 Putting it to work: Foundations of Statistical Analysis

3.6 Wrap Up and Looking Forward

Wrapping up the workshop and looking at the ways to further build your repertoire on your own, whether in formal modeling or statistical techniques.