

# Mathematics for Political and Social Scientists

Given by Pedro Martín Cadenas

Dates: 26 – 30 September 2022

Time: 10:00-12:00

Refectory room, Badia Fiesolana

Register [online](#)

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The objective of this 10-hour workshop is to provide a refresher into basic algebra and calculus, specifically for those with no or little background in mathematics and statistics. Please note that this workshop aims to help a fairly small group of 1st-year researchers with little previous background, rather than those who already took statistics or quantitative methods courses in their grad/undergraduate. Slides and materials will be provided to anyone interested.

Knowledge of algebra and calculus is increasingly crucial in quantitatively-oriented political and social science, allowing researchers to understand better, manipulate and develop statistical methods and formal theory. This knowledge will also help researchers to keep the pace of first term quantitative methods courses. Next to providing a refresher into basic algebra and calculus, the workshop discusses examples of their use in political and social science practice.

The workshop will be divided into 4+1 blocks for each of the five workshop days. The first block will refresh basic mathematical notions related to arithmetic, notation, and calculus. The second block aims to familiarize students with standard equations present in actual social science research and introduce derivatives and extrema. The third block introduces students to basic notions of probability, random variables, and most common probability distributions. The fourth block focuses on vectors and matrices, their basic properties, and their utility in social science research. Finally, the last block summarizes the previous blocks and adapts to students' questions/concerns. Most of the materials and structure of the workshop are taken from Moore and Siegel (2013).

Students are required to do short proposed exercises within the class, without homework requirements. The workshop has two main objectives: first, to familiarize students with basic notions of arithmetics, calculus, probability, and algebra; second, to help students self-evaluate their quantitative skills, raising awareness and familiarity with accessible and helpful materials.

## 1st Session - Arithmetic, calculus and notation

- Short introduction. Why maths in social sciences.
- Variables, constants, concepts.
- Sets. Ordered (datasets) and unordered; difference, complement, intersection, union; Venn diagrams and scope conditions; relations ( $<$ ,  $>$ ,  $=$ )
- Operators. Table, introduce to most important operators (and less common)
- Arithmetics review
- Level of measurement. Nominal, ordinal, interval, ratio
- Ratios, proportions, percentages
- Exercises with sets, arithmetic operations.
- Intro to functions and equations. Utility. Linear, exponential, logarithmic functions with social science examples.

**There are no readings for the first session**

## 2nd Session - Derivates and Extrema

- Derivatives. Explanation, definition, systematization and shortcuts. Why are they so important.
- Extrema. Local and global extrema. Critical and inflection points. Concavity and convexity.
- Maximization. Utility example, Minimum Square Error example.
- Multivariate functions and partial derivatives.
- Short, intuitive, introduction to integrals.
- Exercises. Calculate derivatives, maximum and minimums, partial derivatives.

### Recommended reading

- Moore, W. H., & Siegel, D. A. (2013). A mathematics course for political and social research. Princeton University Press. Pgs. 88-91.

## 3rd Session - Probability and Random Variables

- Events: random, simple and compounds
- Probability spaces, sample space
- independence and exclusiveness
- Joint, union and conditional probabilities

Notions related to random variables:

- Notions of random variables and distribution, realization and support
- Population and sample distributions
- Joint and marginal distributions
- Probability mass function and probability density function
  - location (mean and median), scale (standard deviation) and dispersion (variance) parameter
  - Expectation
- A focus on the normal distribution

### **Suggested reading**

- Blyth, M. (2006). Great Punctuations: Prediction, Randomness, and the Evolution of Comparative Political Science. *American Political Science Review*, 100(4), 493-498. [doi:10.1017/S0003055406062344](https://doi.org/10.1017/S0003055406062344)

## **4th Session - Vectors and Matrices**

- Why matrices and vectors matter in social sciences ?
  - practical example : theory of measurement, OLS, network theory
- Basic definition of scalar, vector and matrices : length and dimension
- Special matrices
- Operations with matrices and rules

**There are no readings for the fourth session**

## **5th Session - Bonus**

The last session will be mainly used as a wrap up session. It is the opportunity to take times to answer students' questions and develop further certain notions of interest in the audience.

**There are no readings for the fifth session**