

Mathematics for Political and Social Scientists

(SPS Preparatory Course)

Lecturer: Tuna Abay

E-mail: tuna.abay@eui.eu

Dates: 25 – 29 September 2022

Time: 10:00-12:00

Sala del Capitolo, Badia Fiesolana

Contact: Monika.Rzemieniecka@eui.eu

The objective of this ten-hour workshop is to provide a refresher/introduction to basic algebra, calculus, linear algebra, and statistics, specifically for those with little background in mathematics and statistics. Those with a solid quantitative background are also strongly recommended to follow this course as a refresher course. The main goal is to familiarize students with quantitative methods by giving intuitions and examples from social science papers.

This course will also provide a solid basis for the upcoming first-term quantitative methods courses. The workshop will be divided into five blocks for each of the five workshop days and cover the following topics in each session:

Outline

1st Session: Algebra and Functions

1. Introduction and Motivation: Why is mathematics helpful in Social Sciences? Examples of models and methodologies from Papers.
2. Algebra Refresher: Real Numbers, Integers, Fractions, Fractional Powers, inequalities, Equations, Quadratic Equations, Linear Equations in Two Unknowns, Sums.
3. Functions: Graph of functions, Linear, quadratic, polynomial, Power, and Logarithmic functions with examples, and functions of many variables.

2nd Session: Calculus

1. Limits and Differentiation: intuition, rules, and examples
2. Unconstrained Optimization: Second-order differentiation, Convexity, and Concavity, Global maximum, and Local extreme points.
3. Multivariable Calculus
4. Integration
5. Calculus in Use: Examples from Political Science and Economics
6. Bonus: (If time allows) Approximations: Taylor Rule

3rd Session Part 1: Optimization

1. Constrained Optimization: Lagrange Method

3rd Session Part 2 and 4th Session: Probability and Statistics

1. Basic probability theory: Event, Sample Space, Probability axioms, Joint, marginal, and conditional probabilities, Bayes Rule.
2. Random variables. Probability density and cumulative distribution functions with examples. Continuous Random Variables.
3. Expectation, Mean, Median, Variance, Standard deviation, covariance, correlation.
4. Use of Statistics in Political and Social Sciences: Examples from Papers

5th Session: Linear Algebra

1. Definition and Intuition of Scalars, Vectors, and Matrices
2. Basic Matrix Operations
3. Special Topics: Determinants, Ranks, System of Linear Equations, Diagonalization, Eigenvectors, and Eigenvalues (If time allows, otherwise a simple introduction)
4. Use of Linear Algebra in Social Sciences with examples
5. Intersection with Multivariate calculus, optimization, statistics, data structures, and programming (If time allows)
6. Basic Visual Intuition of each concept in 2D space (If time allows).

Reference Books:

- Sydsæter, Knut, and Peter J. Hammond. Essential mathematics for economic analysis. Pearson Education, 2008.
- Moore, W. H., & Siegel, D. A. (2013). A mathematics course for political and social research. Princeton University Press
- Blitzstein, Joseph K., and Jessica Hwang. *Introduction to probability*. Crc Press, 2019.