

PROGRAM-SPECIFIC REQUIREMENTS

QUANTITATIVE SOCIAL SCIENCES

Program Head: Prof. Tiago Peixoto
Contact Information: peixotot@ceu.edu
Office: Quellenstraße 51 / A305

Degree offered: BA in Quantitative Social Sciences

Duration of the program: 3 Academic Years

Structure of the Academic Year: 3 terms: Fall, Winter, and Spring

Duration of the Fall Term: 12 weeks

Duration of the Winter Term: 12 weeks

Duration of the Spring Term: 11 weeks (teaching period is 6 weeks)¹

Amount of credits required per Academic Year: 30 US Credits / 60 ECTS

Overall amount of required credits: 90 US Credits / 180 ECTS

Program structure

First year: In the first year, students take introductory courses in the following modules: Mathematics I, Programming and Data Analysis, and Social Sciences. In addition, they take a course in academic writing. All courses are mandatory.

Second year: In their second year, students continue with mandatory courses in the modules Mathematics II, Data Science, and Social Sciences. In the winter term they have to choose **two specialization tracks** from the following set: 1. Sociology, 2. Economics, 3. Environmental Sciences, 4. Political Science, and 5. Data Science. The choice of specialization tracks will determine which courses are mandatory in the rest of the program (see “Specialization tracks” below.)

Third year: In the third year, students continue further in their specialization tracks: they take all the core courses of their specialization tracks and choose further mandatory elective courses from any of the tracks, in addition to free elective courses. Furthermore, they take a series of seminars on Quantitative Social Sciences intended to consolidate the different perspectives on the topic. Based on this they write a thesis project by the end of third year.

Specialization tracks

Specialization tracks allow students to pursue a particular field in the quantitative social sciences in more depth. Students must choose **two** of five tracks: 1. Sociology, 2. Economics, 3. Environmental Sciences, 4. Political Science, and 5. Data Science. Each track has a set of core and mandatory elective courses (see table below). Students must take 8 ECTS of core courses of the chosen track, and an additional total of 12 ECTS freely chosen from all tracks. This will allow students to choose their own path, according to their preference, background and abilities, and acquire more substantial expertise in the chosen areas.

Third year thesis

The aim of this module is to give students the opportunity to pursue a question, topic or subject in significant detail, within the chosen specialization tracks. Students are expected to formulate their own

¹Assignments maybe be due within two weeks of the end of teaching time.

project. Students will have the opportunity to present their work to their colleagues and to gain feedback on it. They will also receive guidance on how to write a thesis. The thesis should be between 5000 to 7000 words.

By completing the thesis, students will have learned how to develop a sustained and detailed line of argument, or conduct a piece of research; they will have learned how to consult relevant literature and make use of available software tools; they will have learned how to prepare a long piece of systematic academic work; and they will have learned how to present their work in a seminar to their fellow students.

Program modules

Mathematics

The aim of this module is to provide the students with the fundamental mathematical background that will be necessary for most of the remaining courses. This includes an introduction to linear algebra, calculus and statistics. This will continue with more advanced mathematical background, including multivariate calculus, advanced topics in linear algebra and optimization.

After completing this module, students will be familiar with university-level mathematical concepts, will have acquired more advanced mathematical intuition and experience, and will be able to apply the new skills to formulate and solve mathematical problems. Students will know how to approach more advanced mathematical problems, and have the foundations to comprehend the advanced computational methods covered in the Data Science module.

Programming and Data Analysis

This module will introduce students to computation and data analysis, starting from the elementary concepts of programming to more advanced algorithms and data structures, covering also fundamentals of data analysis and data visualization. This module also includes a course on “Introduction to Quantitative Social Sciences” in the fall of the first year, which aims to illustrate at an early stage how quantitative analysis is used in the social sciences. Upon completion, students will be able to write computer programs in Python, understand and analyze algorithm efficiency and employ basic data structures. They will also be able to use the Python environment to manipulate scientific data, extract from them meaningful conclusions and perform visualizations.

Social Sciences

The purpose of this module is to provide a broad introduction to the various fields of social sciences, covering basic themes in Sociology, Economics, Political Science and Environmental science. These courses serve as a foundation for the specialization track module, where students choose two main fields to follow. In particular, the course “Quantitative Approaches to Social Sciences” is meant to emphasize the quantitative aspects in each field of specialization, and inform the student’s choice which should be made in year 2. Students will be able to position themselves in the overall context of the various social sciences, will acquire knowledge of the fundamental concepts and basic theories in each field, and have a grasp of the possibilities and main approaches of quantitative analysis in each of them.

Data Science

This module introduces more advanced topics of Data Science, including an introduction to machine learning methods, as well as data mining and management. It also includes an introduction to the mathematical modeling of complex systems. This aims to equip the students with a robust background in modern computational data analysis methodology. This module also includes a substantial hands-on element, with two project-based courses. In the winter term the students are required to take a “Data Science Review Project” course, where they have to reproduce a published research on a specific dataset, and in the Spring term they must complete a “Data Science Advanced Project,” where they must apply their skills on a new problem.

After completing the module students will be able to extract, manipulate and analyse large amounts of structured data stemming from social systems, and derive from them model-based conclusions.

Quantitative Social Sciences Seminar

This module is composed of a series of seminars delivered in the fall and winter terms, covering the different fields of quantitative social science and data science, with the objective of exposing the students to current research and field applications in academia and industry, as well as outstanding challenges. Students will be able to bridge the gap between the classroom material and applications to the real world, and in this way find motivating material for their projects and thesis throughout the program.

Third year optional courses

Students take a number of courses either from other parts of the QSS syllabus, or from any other CEU program. The aim of this module is to allow students to broaden their education beyond the main subjects of their study. Having completed this module, students will have learned about some areas of knowledge outside the main areas of their degree program.

Yearly curriculum plan

Year 1				
Module	Fall term	Winter term	Spring term	ECTS
Mathematics I	Introduction to Mathematics (6)	Introduction to Multivariate Calculus and Linear Algebra (6) Introduction to Statistics (6)		18
Programming and data analysis	Introduction to Programming in Python (6) Introduction to Quantitative Social Sciences (4)	Algorithms and Data Structures (4) Fundamental of Data Analysis (4)		18
Social sciences	Introduction to Environmental Sciences (4)	Principles of Sociology (4) Quantitative Approaches to Social Sciences (4)	Introduction to Political Economy (4) Ethics of Science (4)	20
Academic writing	Academic Writing (4)			4
ECTS	24	28	8	60

Year 2				
Module	Fall term	Winter term	Spring term	ECTS
Social sciences	Principles of Microeconomics (8) Ethics of Big Data (4)			12
Mathematics II	Advanced Multivariate Calculus, Linear Algebra, and Statistics (4)	Introduction to Optimization (4)		8
Data science	Introduction to Machine Learning and Data Mining (4) Introduction to Complex Systems (4)	Data Management (4) Data Science Review Project (8)	Data Science Advanced Project (12)	32
Specialization tracks		(Mandatory electives) (8)		8
ECTS	24	24	12	60

Year 3				
Module	Fall term	Winter term	Spring term	ECTS
Specialization tracks	(Mandatory electives) (12)	(Mandatory electives) (12)		24
Free electives	(Free electives) (8)	(Free electives) (4)		12
Seminars	QSS Seminar I (4)	QSS Seminar II (4)		8
Thesis		Thesis Preparation (4)	Thesis Preparation (12)	16
ECTS	24	24	12	60

Specialization tracks				
Sociology	Economics	Environmental sciences	Political science	Data science
Core courses				
Gender Inequality through numbers (4)	Econometrics for QSS (8)	Measuring progress (4)	Introduction to Comparative Politics: History, Topics and Methods (4)	Introduction to Network Science (4)
Key Issues in Sociological Theory (4)		Climate Change (4)	Rational Choice Politics (4)	Advanced Machine Learning (4)
Introduction to Social Networks (4)		Geospatial Data Visualization (4)		Data Visualization (BA) (4)
Mandatory electives				
Robots, Artificial Intelligence, and Genes of the Human (4)	Principles of Macroeconomics (8)	Environmental Modelling (4)	Multimethod Research Design (4)	Advanced topics in Applied Statistics (4)
Inequality in the Age of Globalization (4)	Banking and Finance (4)	Energy Economics (4)	Welfare States in the Current Era: Origins, Issues and Challenges (4)	Digital tools for the Social Sciences and Humanities (4)
Labor Economics (4)	Economic Development (4)	Advanced Topics in Global Environmental Governance (8)	Frontiers of Political Research: Topics, Trends, Techniques (4)	Advanced Algorithms and Data Structures (4)
Social Problems (4)	History of Economic Thought (4)	Ecological Economics (8)	Varieties of Capitalism (4)	Introduction to Differential Equations (4)
Labor Economics (4)	Health Economics (4)	Sustainable Energy (4)	Domestic Politics in the Global Economy (4)	Data Security and GDPR (4)
	International Trade (4)		Democracy, Autocracy and Economics Development (4)	
	Economic History (4)		Political Economy: Rational Choice and Collective Action (4)	
	International Finance (4)			
	Game Theory (4)			