UNIVERSITÀ DEGLI STUDI DI CAGLIARI

HR EXCELLENCE IN RESEARCH

Dipartimento di Scienze Economiche ed Aziendali
Direttore: Prof. Patrizio Monfardini
Dottorato in Scienze Economiche e Aziendali
Doctoral Program in Economics and Business
Coordinatrice: Prof.ssa Francesca Cabiddu

Artificial Intelligence and Mathematics

The Souls of Mathematics: from Pythagoras to Artificial Intelligence

Course leader: Prof. Beatrice Venturi

Other instructors: Prof. Vincenzo Vespri

Aims of the course

This interdisciplinary seminar fosters a collaborative and engaging environment where students can learn, exchange ideas, and explore innovative research directions in economics and finance.

Key objectives include:

- Understanding how mathematical thinking underpins modern economics, finance, technology, and decision-making processes.
- Engaging with an instructor who unites culture, science, and innovation through accessible storytelling.
- *A better understanding of economics and finance:* connecting the historical evolution of mathematics—from Pythagoras to modern artificial intelligence—with students' academic research and future career paths.

This seminar is an intellectual journey through the foundational ideas that shape our world, with relevance to economics, business, policy, innovation, and competence.

Learning outcomes and competences

By the end of the seminar, students will be able to:

- Understand the historical and philosophical development of mathematical ideas and their societal impact.

- Recognize how mathematical reasoning contributes to today's technological, economic, finance and ethical challenges.
- Contextualize data-driven technologies such as AI within broader intellectual and cultural traditions.
- Develop interdisciplinary thinking, bridging insights from mathematics, finance, economics, history, and innovation studies.

Students will come to appreciate mathematics not merely as abstract theory but as a powerful, creative tool for understanding and shaping the real world. This knowledge will support their ability to analyse economic and financial models applied to real-world challenge

Pre-requisites

Elementary mathematics, statistics and financial calculus.
The seminar is open to all PhD students in Economics and Business and is designed to be inclusive and stimulating, even for participants without a formal background in mathematics

Course contents and syllabus

The seminar is structured in one **thematic module** that combining short lectures, discussions, and suggested readings:

1. **Mathematics instruments in economics and finance meets Artificial Intelligence** – Economics, Financial markets, Big data, ethics, and the future of human decision-making

Organization of the course

- Each module consists of a **2-hour interactive lecture and discussion**, including a presentation by the instructor followed by Q&A and group dialogue.
- Optional readings and resources will be provided for further study and deeper engagement.

Assessment method

At the end of the PhD seminar, each student is required to submit a written paper or report that reflects on the seminar topics. The content and focus of the elaboration will be defined through a specific assignment provided by the seminar lead instructor.

Reading list

1. Mathematics, Economics & AI

- *Ivor Grattan-Guinness*, The Economics of the Historian of Mathematics, 2004
- *Ivar Ekeland*, The Best of All Possible Worlds, 2006
- *Philip Mirowski*, More Heat than Light, 1989

2. Classical & Modern Financial Mathematics

- *Steven Shreve*, Stochastic Calculus for Finance (Vol. I & II), Springer
- *Robert Merton*, Continuous-Time Finance, 1990
- *John Hull*, Options, Futures, and Other Derivatives, Pearson
- *Paul Wilmott*, Paul Wilmott Introduces Quantitative Finance, Wiley

3. Game Theory & Mathematical Economics

- *Von Neumann & Morgenstern*, Theory of Games and Economic Behavior, 1944
- *Arrow & Debreu*, Existence of an Equilibrium for a Competitive Economy, 1954
- *Ariel Rubinstein*, Modeling Bounded Rationality, MIT Press

4. Mathematics of Cryptocurrencies & Blockchain

- *Narayanan et al.*, Bitcoin and Cryptocurrency Technologies, Princeton UP
- *Bonneau et al.*, SoK: Research Perspectives and Challenges for Bitcoin, IEEE, 2015
- *Andreas Antonopoulos*, Mastering Bitcoin, O'Reilly
- *Tim Roughgarden*, Cryptocurrency and Blockchain: An Introduction, Columbia University

Critical Perspectives

- *David Golumbia*, The Politics of Bitcoin, Univ. of Minnesota Press

5. Historical & Interdisciplinary Insights

- *E. Roy Weintraub*, How Economics Became a Mathematical Science, 2002
- *Roger Backhouse*, The Ordinary Business of Life, Princeton UP

6. **Recommended Articles & Essays**

- *Silvio Micali*, Cryptography and Game Theory, MIT
- *Mathematics and the Modern Economy*, *Notices of the AMS*
- *How the Black-Scholes Model Changed the World*, *Financial Time*

Timetable and Room Booking

Date: July 8, 2025 **Time**: 12:00 – 14:00

Please consult the Teams calendar for real-time updates.