Syllabus

Course Description

Course Title	Fundamentals of Game Theory
Course Code	71083
Course Title Additional	
Scientific-Disciplinary Sector	INFO-01/A
Language	English
Degree Course	PhD Programme in Computer Science
Other Degree Courses (Loaned)	
Lecturers	dr. Alessandro Torcinovich, Alessandro.Torcinovich@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/49855
Teaching Assistant	
Semester	Second semester
Course Year/s	1
CP	1
Teaching Hours	10
Lab Hours	0
Individual Study Hours	25
Planned Office Hours	
Contents Summary	Game theory is the study of strategic interaction, that is, how individuals or institutions make decisions when outcomes depend not only on their own actions but also on the actions of others. From analyzing competitive markets and political negotiations to modeling evolutionary behavior and powering modern AI systems, game theory has become a cornerstone of understanding rational decision-making in complex environments. This course offers an introduction to the foundational principles of non-cooperative game theory, focusing on how rational agents make strategic decisions. Students will explore key concepts such

	as players, strategies, payoffs and equilibria, delving into classic models like the Prisoner's Dilemma, Coordination Game, Cournot competition, and others. The course also covers advanced topics including evolutionary game theory and applications of GT to machine learning, discussing also implementative details.
Course Topics	- Concept of Non-Cooperative Game, Player, Strategy, Payoff - Common Knowledge - Prisoner's Dilemma - Dominance - Maximin Criterion - Nash Equilibria - Cournot Game, Location Game - Mixed Equilibria - Rock, Paper, and Scissors - Evolutionary Stability - Game Theory and Machine Learning: Dominant Sets & Graph Transduction Games. Strategic Thinking Capabilities in LLMs
Keywords	Non-Cooperative Game Theory Evolutionary Game Theory Machine Learning
Recommended Prerequisites	Basics of optimization theory (e.g., derivatives, gradient, etc.)
Propaedeutic Courses	
Teaching Format	Frontal lectures, exercises.
Mandatory Attendance	Not compulsory. Non-attending students must contact the lecturer at the start of the course to agree on the modalities of the independent study.
Specific Educational Objectives and Learning Outcomes	- Understanding the concept of game - Being able to formalize a multi-objective problem as a game - Implementing and applying simple algorithms to find equilibria of games
Specific Educational Objectives and Learning Outcomes (additional info.)	Knowledge and understanding: • D1.1 - Knowledge of the key concepts and technologies of game theory disciplines • D1.2 - Understanding of the skills, tools and techniques required for an effective use of game theory • D1.11 - Knowledge of the main algorithms for classic game theory and evolutionary game theory Applying knowledge and understanding:

	• D2.2 - Ability to address and solve a problem using scientific methods • D2.4 - Ability to develop programmes and use tools for the analysis of game theoretic problems Making judgments • D3.2 - Ability to autonomously select the documentation (in the form of books, web, magazines, etc.) needed to keep up to date in a given sector Communication skills • D4.1 - Ability to use English at an advanced level with particular reference to disciplinary terminology. Learning skills • D5.3 - Ability to deal with problems in a systematic and creative way and to appropriate problem solving techniques.
Assessment	Attending Students: Oral examination - the student is required to prepare a presentation about one or more works related to the topics covered during the course. Optionally, the student can convert an algorithm from the Gambit library to PyTorch, to enable GPU acceleration. Non attending Students: All of the above + oral exam with verification questions on the topics covered during the course.
Evaluation Criteria	Attending & Non-attending students: - Clarity in the exposition. - Clear understanding of the topics. - (Optional) Implementation of algorithms, if any.
Required Readings	Professor's notes.
Supplementary Readings	Fujiwara-Greeves, *Non-Cooperative Game Theory*, Springer 2025
Further Information	
Sustainable Development Goals (SDGs)	Quality education