COURSE DETAIL

COMPLEX SYSTEMS & NETWORK SCIENCE
Country Italy
Host Institution University of Bologna
Program(s) University of Bologna
UCEAP Course Level Upper Division
UCEAP Subject Area(s) Computer Science
UCEAP Course Number 185
UCEAP Course Suffix
UCEAP Official Title COMPLEX SYSTEMS & NETWORK SCIENCE
UCEAP Transcript Title COMPLX SYTMS&NETWRK
UCEAP Quarter Units 6.00
UCEAP Semester Units 4.00

Course Description

This is a graduate level course that is part of the Laurea Magistrale program. The course is intended for advanced level students only. Enrollment is by consent of the instructor. The course focuses on basic notions of complexity and network sciences and the identification, formulation, modelling, and analysis of new problems that arise in modern computing systems. The course requires basic notions of computer system architecture, computer networks, operating systems, and probability theory as a prerequisite. Modern information systems and services often rely on large numbers of independent interacting components to provide their functions. Under certain conditions, the behavior that results from these interactions can be unexpected and surprising. Complexity Science is an interdisciplinary field for studying global behaviors resulting from many simple local interactions in an effort to characterize and control them. Networks allow us to formalize the structure of interactions. They play a central role in the transmission of information, transportation of goods, spread of diseases, diffusion of innovation, formation of opinions and adoption of new technologies. Network Science is an interdisciplinary field for studying the interconnectedness of modern life by exploring fundamental properties that govern the structure and dynamic evolution of networks. The course discusses topics including: Complex systems: definitions, methodologies; Dynamical systems, Nonlinear dynamics; Chaos, Bifurcations and Feigenbaum constant, Predictability, Randomness and Chaos; Models of complex systems, Cellular automata, Wolfram's classification, Game of life; Autonomous agents, Flocking, Schooling, Synchronization, Formation creation; Cooperation and Competition, Game theory basics, Nash equilibrium; Game theory: Prisoner's Dilemma, Coordination games, Mixed strategy games; Adaptation, Evolution, Genetic algorithms, Evolutionary games; Network Science: Definitions and examples; Graph theory, Basic concepts and definitions; Diameter, Path length, Clustering, Centrality metrics; Structure of real networks, Degree distribution, Power-laws, Popularity; Models of network formation; The Erdos-Renyi random model; Clustered models; Models of network growth, Preferential attachment; Small-world networks, Network navigation; Peer-to-peer systems and overlay networks; Structured overlays, DHTs, Key-based routing, Chord;

Distributed network formation: Newscast, Cyclon, T-Man; Processes on networks: Aggregation; Rational dynamics: Cooperation in selfish environments, Homophily, Segregation; Diffusion, Percolation, Tipping points, Peer-effects, Cascades.

Language(s) of Instruction
English

Host Institution Course Number
81943

Host Institution Course Title
COMPLEX SYSTEMS & NETWORK SCIENCE (LM)

Host Institution Course Details
https://www.unibo.it/en/teaching/course-unit-catalogue/course-unit/2021/461740

Host Institution Campus
BOLOGNA

Host Institution Faculty
COMPUTER SCIENCE

Host Institution Degree
LM in Computer Science (Artificial Intelligence)

Host Institution Department
COMPUTER SCIENCE

Course Last Reviewed
2021-2022

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