INTRODUCTION TO GAME THEORY AND MECHANISM DESIGN

PROF. SWAPRAVA NATH
Department of Computer Science and Engineering
IIT Bombay

INTENDED AUDIENCE: Pre-final and final year undergraduates, early graduate students

PREREQUISITES : Familiarity with formal mathematical reasoning, probability theory, calculus,basics of computational complexity, and (soft constraint) familiarity with computer programming.

INDUSTRY SUPPORT : Management wing of any company that is interested in mathematical handling of strategic planning will have interest in this course.

COURSE OUTLINE:
This course is an introduction to game theory and mechanism design. The goal is to equip students with a general purpose tool to analyze strategic behavior in multi-agent interaction. Though primarily a topic of economic flavor, it has significant applications in the decision process of a multi-agent environment like sponsored advertisements, crowdsourcing, social media, internet-based trade, and several settings of social choice and welfare. This course is a backend of such applications and discusses the mathematical details of analyzing and designing strategic interactions.

The evaluation criteria has been updated from the video. The final criteria is mentioned below on this enrollment page

ABOUT INSTRUCTOR:
Prof.Swaprava is an Assistant Professor at the Department of Computer Science and Engineering, IIT Bombay. Before this, he was a faculty member at the Dept. of CSE, IIT Kanpur. Even earlier, he held postdoctoral positions at Carnegie Mellon University and Indian Statistical Institute, New Delhi, and finished his PhD from the Dept. of CSA, IISc Bangalore. His research interest lies at the intersection of economics and computation, which has several applications in social and industrial paradigms (for details, please see his CompEcon group page: https://www.cse.iitb.ac.in/~swaprava/group.html and his research page: https://www.cse.iitb.ac.in/~swaprava/research.html). His work has been published in top AI and multiagent systems conferences, e.g., AAAI, IJCAI, AAMAS, WINE, and also in economics and management venues, e.g., Games and Econ Behavior, Economics Letters, Management Science. Apart from academic positions, Swaprava also has experience in the industry. He has worked at Xerox Research Centre Europe and Cisco Systems India. He has been recipients of Fulbright-Nehru postdoctoral grant, Tata Consultancy Services PhD Fellowship, and the Honorable Mention Award of Yahoo! Key Scientific Challenges Program

COURSE PLAN:

Week 1: Introduction, the game of chess, proof of chess theorem, normal form games
Week 2: Dominance, Nash equilibrium, Maxmin strategies, elimination of dominated strategies, preservation of pure Nash equilibrium (PSNE), matrix games, relation between maxmin and PSNE in matrix games
Week 3: Mixed strategies, mixed strategy Nash equilibrium (MSNE), finding MSNE, MSNE characterization theorem, algorithm to find MSNE
Week 4: Correlated equilibrium (CE), computing CE, extensive form games, subgame perfection, limitations of subgame perfect Nash equilibrium
Week 5: Imperfect information extensive form games (IIEFG), strategies in IIEFGs, equivalence of strategies in IIEFGs, perfect recall
Week 6: Equilibrium in IIEFG, game theory in practice: P2P file sharing, Bayesian games, strategy and utility in Bayesian games, equilibrium in Bayesian games
Week 7: Introduction to mechanism design, revelation principle, introduction and proof of Arrow's impossibility result, introduction to social choice setup
Week 8: Introduction and proof of Gibbard-Satterthwaite theorem, domain restriction, median voter theorem
Week 9: Task sharing domain, uniform rule, mechanism design with transfers, examples of quasi-linear preferences, Pareto optimality and Groves payments
Week 10: Introduction to VCG mechanism, VCG in Combinatorial allocations, applications to Internet advertising, slot allocation and payments in position auctions, pros and cons of VCG mechanism
Week 11: Affine maximizers, single object allocation, Myerson's lemma, optimal mechanism design
Week 12: Single and multi-agent optimal mechanism design, examples of optimal mechanisms