Strategic Multi-agent Artificial Intelligence

Week 1: June 23-27, 2025

Prof. Swaprava Nath Department of Computer Science & Engineering



Prof. Swaprava is an Associate 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. 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 Behaviour, Economics Letters, Management Science. Apart from academic positions, Prof. 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 Honourable Mention Award of Yahoo! Key Scientific Challenges Program. For more information about his work, please see the links below.

https://www.cse.iitb.ac.in/~swaprava/group.html

https://www.cse.iitb.ac.in/~swaprava/research.html

Course Outline:

Date	Morning Session	Afternoon Session	Brief overview of the topics to be covered
June 23 Monday	10:00-11:30 (lecture)	14:00-15:30 (lecture)	AI and competitive games: Part 1: Sequential move games, games with partial information, games with no information, subgame and subgame perfection,
	11:45-12:45 (tutorial)	15:45-16:45 (tutorial)	Part 2: Speedup techniques for solving sequential two player zero-sum games: depth-limited search, pruning. Examples in real-life. Simultaneous move two player zero- sum games, idea of an equilibrium.
June 24	10:00-11:30 (lecture)	14:00-15:30 (lecture)	Game theory and practice: Part 1: General games with any finite number of players and utilities, normal form game representation, equilibria concepts: dominant strategy equilibrium, pure and mixed Nash equilibrium. Algorithm to find MSNE.
	11:45-12:45 (tutorial)	15:45-16:45 (tutorial)	Part 2: <i>Peer-to-peer sharing: desired terminology, file-sharing game, new protocol (BitTorrent). BitTorrent optimistic unchoking algorithm, attacks on BitTorrent, BitThief, Strategic piece revealer.</i>
June 25	10:00-11:30 (lecture)	14:00-15:30 (lecture)	AI in democracy and stable matching: Part 1: Inverse game theory: mechanism design. Voting rules: plurality, Borda, single transferable vote, Condorcet consistency, Copeland voting rule. Manipulability of voting rules, Gibbard-Satterthwaite impossibility.
	(tutorial)	(tutorial)	Part 2: <i>Stable matching problem, the Gale-Shapley deferred acceptance algorithm, properties of DA: efficient computability, perfect matching, pairwise stability.</i>
June 26	10:00-11:30 (lecture) 11:45-12:45	14:00-15:30 (lecture) 15:45-16:45	Auctions and Internet economics: Part 1: Examples of allocation problems. Valuation and payment functions. Quasi-linear utility function. Examples of allocation rules: Constant rule, dictatorial rule, utilitarian rule, affine maximizer rule, egalitarian rule. Examples of payment rules: No deficit, no subsidy, budget balanced. Domain strategy incentive compatibility in quasi-linear setting. What is the expression for the VCG? Computing the outcome and VCG payment.
	(tutorial)	(tutorial)	Part 2: The essence of Internet advertising. Click through rate and a foundation for the next module. An allocation is efficient if the allocation is by rank by the expected revenue mechanism. Calculation of total expected payment.
June 27	10:00-11:30 (lecture)	14:00-15:30 (lecture)	Cake cutting and inheritance division: Part 1: Allocation of a single divisible good, cake model: heterogeneous, divisible, non-identical preferred good, agent model: additive valuation, divisibility,
	11:45-12:45 (tutorial)	15:45-16:45 (tutorial)	normalization, fairness notions: proportionality, envy- freeness, Robertson-Webb query model for complexity,

2025 INTERNATIONAL SUMMER SCHOOL

Date	Morning Session	Afternoon Session	Brief overview of the topics to be covered
			mechanisms: I-cut-youchoose (2 players), Dubins- Spanier algorithm (n players), Even-Paz algorithm (n players, recursive).
			Part 2: Cake cutting envy-freeness question: Selfridge- Conway algorithm for EF allocation of a cake between three agents. Fair allocation of indivisible goods, envy- freeness upto one good, round-robin algorithm for additive valuations. Pareto optimality of an allocation.

Venue:

LC 101(1st Floor)

Lecture Hall Complex, L1 Building, Opposite KReSIT Building, Between Physics & MEMS Department.