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Game Theory and Mechanism Design with its applications in telecommunications and distributed systems

Presented by

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Extended abstract

1. the technical subject,
2. its importance, and
3. its relevance and benefits to IEEE ICT 2019 attendees

Game theory is the mathematical modelling of strategic interaction among rational (and irrational) agents. Beyond what we call 'games' in common language, such as chess, soccer, etc., it includes the modeling of conflict among nations, political campaigns, competition among firms, and trading behavior in stock markets. There has been a remarkable increase in the usage of game theory and mechanism designs for computer science applications in the past two decades.

In engineering fields, game theory and mechanism design are used as a way to solve optimization problems in systems where participants act independently, and their decisions change the whole system. This tutorial aims to provide a basic understanding of various game theoretic concepts (non-cooperative games, cooperative games, mechanism design concepts, advanced game theory topics such as evolutionary games) and its applications in different solution architecture domains. After this tutorial, the attendees should be able to model several real situations using game-theory and design solutions (mechanisms, algorithms, protocols etc.) that are robust even in presence of "self-centered" entities.

Non-cooperative games are essentially used for handling conflicting situations. It involves static and dynamic games of both complete and incomplete information, repeated games, Bayesian games and Evolutionary games. Evolutionary games, for example, itself has been used for solving various issues in computer networks, wireless networks cloud, edge and fog computing. There are also strategies which can be applied to enforce cooperation among self-interested agents such as rewards, punishments and more.

Cooperative games on the other had are of two major types – Bargaining games and Coalition games. They are used to model situations where decisions have to be taken where resource sharing is extremely important such as resource sharing, profit sharing, multimedia streaming etc in telecommunications networks.

Another class of games are mechanism design principles which essentially means designing a mechanism for solving certain problems. A great example for mechanism design auctions.

They can be used for solving issues such as resource selection and price distribution. This shows how important it is to understand the concepts behind the game theory and types of games so that we can apply the right type of game for handing the right issues in our respective domain.
The aim of this tutorial is to introduce the participants, to the novel concepts of game theory with special emphasis on its applications in current day engineering domains of relevance to IEEE ICT 2019 attendees including communications, wireless networks, computer networks, multimedia networks, cloud, grid, edge and fog computing systems. In the above-mentioned areas, (which are of high importance to IEEE ICT 2019), game theory has been specifically used for various research issues involving handling conflicting situations, for enforcing cooperation and making optimal decisions in dynamic situations.

Examples of its application in networks and communications include research issues such as resource allocation, price sharing, job scheduling, resource management, applications based on edge/fog computing, deployment, security and much more. In networking, it has also been used widely for various issues including routing, congestion, wireless networks, IoT based network systems, network security, and blockchain. Traffic management in mobile cloud systems, resource sharing, broker models and energy efficient optimization are also of interesting issues where game theory potentially helps.

Outline

Section	**Sub-section**	**Application Areas in IEEE ICT 2019 domains**
Noncooperative Games	Static and Dynamic games, Repeated Games	Network congestion control, Cloud Security, Resource allocation in Cloud centric IoT, Mobile edge computing predictive offloading, Security
	Congestion and potential games	Network congestion control, Routing, Computation offloading in Edge
	Bayesian Games	Multi-access edge computing
	Evolutionary Games	Service selection, Resource management, Price selection, Deployment, Security, Computational offloading, QoS handling
Cooperative Games	Bargaining Games	Resource allocation, Bargaining and power in networks
	Coalitional Games	Network federation, Mobile edge computing predictive offloading, Resource cooperation in mobile cloud
Mechanism Design Principles	Auctions	Pricing strategies, Resource allocation
	Other Mechanisms	Mechanism Design for Resource Procurement in Grid Computing
Advanced Topics	Stackelberg Games	Resource Management in Fog, Resource management and pricing Cloud/Fog/Blockchains, Edge Caching
	Bayesian Coalitional Games	Content Distribution in Internet of Vehicles, QoS Management in Mobile Cloud

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Potential attendee profile.

Anyone who is keen on the research issues such as resource management, resource allocation, resource sharing, pricing strategies, conflict handling, computation offloading, resource utilization, broker models, QoS management, security issues, network congestion etc in the broad areas of networks, communications and cloud/edge/fog computing would find this session extremely useful to model various issues in their domain of interest.

Biography of the instructor (100-200 words).

Dr. Ganesh Neelakanta Iyer currently serves as an Associate Professor in the Department of Computer Science & Engineering, School of Engineering, Amrita Vishwa Vidyapeetham, Coimbatore. He has received his PhD degree from National University of Singapore in 2012. He brings in a decade of industry experience in various companies including Sasken Communication Technologies, NXP semiconductors and most recently at Progress software. He has handled several roles in the software industry including QA Architect, Technical Support Manager, Engineering development and Technology Evangelist.
He has strong inclination towards Game Theory. He applies game theory for handling conflicts, enforcing cooperation and for multi-agent systems. His technical knowledge and experience are in various areas including Cloud/Edge/Fog Computing Paradigms, Computer Networks, Software Engineering practices (Agile) and Quality Analysis, Economic models (Game Theoretic principles) and current day practices on cloud-based enterprise architectures, Internet of Things
(IoT) based systems, Machine Learning and technology for traditional Indian dance popularization. His mathematical interests include game theory, graph theory, optimization principles etc. Dr. Iyer has delivered several practical workshops and talks on various cuttingedge technology topics in many academic and industry events in several countries including USA, Europe, Australia and Asia.

Previous lecture and Tutorial experience of the Tutorial speaker

1. “Game Theory for Computer Science", Invited talk at Tennessee State University, Nashville, USA, June 2015 – This was a day session to introduce game theory principles and its applications in various computer science and engineering domain including computer networks, distributed systems, multimedia systems, wireless networks, multi-agent systems etc. to the research scholars and faculty at the university
2. Invited tutorial on "Game Theory and Engineering Applications" for IEEE INDICON December 2018 - The aim of this tutorial was to introduce attendees of the conference to the novel concepts of game theory with special emphasis on its applications in current

day inter-disciplinary engineering domains including distributed computing systems, cyber physical systems, communication networks, social media analytics, security mechanisms, electrical smart grids, Internet marketing strategies, wireless networks etc. Key participants were attendees of the conference as well as research scholars and faculty from the host institution

3. In addition, Dr. Iyer has delivered several practical workshops, tutorials and talks on various cutting-edge technology topics in many academic and industry events in several countries including USA, Europe, Australia and Asia