GT-2010-0157: Game Theory for Wireless Communications

Tutor

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Course Description

In this course, the competitive interaction of radio devices dynamically accessing the spectrum in self-configuring networks is studied using tools from game theory. Here, problems such as radio resource management and quality of service (QoS) provisioning are modeled as non-cooperative games. The first part of the course is oriented to present fundamental concepts such as that of a game (static and dynamic), types of games (zero-sum games, potential games, supermodular games, etc.), the idea of equilibrium (Nash, Debreu), equilibrium selection techniques and concepts for solving games (Stackelberg solution, Satisfaction Solution, etc.). The second part of the course tackles the application of these concepts to the analysis of mainly two scenarios: decentralized parallel multiple access channels (MAC) and decentralized parallel interference channels (IC). Here, metrics such as transmission rate and energy efficiency are thoroughly studied. The final part of the course tackles learning aspects in games. Here, we assume that transmitters are unable to obtain global information of the network (other transmitters) and thus, they must achieve equilibrium literally blindly. For doing so, we present fundamental tools of reinforcement learning and trial and error learning.

Content

- **First Part: Fundamentals Of Game Theory** (8 Hours).
  - Static and Dynamic Games
  - Pure and Mixed Strategies
  - The Concept of Equilibrium: Nash Equilibrium, Debreu's Equilibrium, Aumann's equilibrium, etc.
  - Existence, Uniqueness and determination of the Equilibrium.
  - Relevant types of games in wireless communications: Zero-sum games, repeated games, potential games, supermodular games, etc.
  - Atomic and Non-Atomic Games.
- **Second Part: Game Theory in the Analysis and Design of Wireless Networks** (4 Hours).
  - Spectral Efficiency of Decentralized Multicarrier Systems.
  - Energy Efficiency of Decentralized Multicarrier Systems.
  - Techniques for Achieving Equilibria in Self-configuring Networks: Best-Response Dynamics, fictitious play, etc.
  - Main constraints on using GT in wireless communications (Discussion).
- **Final Part: Learning Theory in Wireless Networks** (4 Hours).
  - Reinforcement Learning.
  - Regret Learning.
  - A Bayesian Approach to Learning in Games.
  - Open Problems. (Discussion).
- **Practical Part:** (4 Hours).
  In this part the students (gathered in working groups) will use the tools learnt in course to study equilibrium network configurations in several scenarios.

Requirements Probability theory, optimization theory, and fundamentals of wireless communications.

Language The course can be taught in Spanish, English(recommended) or French. Slides and support are provided in English.

Short Biography of the Tutor Samir M. Perlaza was born in Cali, Colombia. He received his BSc degree in Electronics and Telecommunications Engineering from Universidad del Cauca, Colombia in 2005. He obtained the Msc degree in Mobile Communications Systems at École Nationale Supérieure des Télécommunications (ENST Paris) and Institute Eurecom in 2007. From 2006 to 2008, his research activity in radio resource allocation in ad-hoc networks at Institut Eurecom was supported by the Alβan programme, the European Union Programme of High Level Scholarships for Latin America. Currently, he is pursuing his Ph.D degree at ENST Paris sponsored by Orange Labs (France Telecom R+D). His work is developped in close cooperation with the Laboratoire des Signaux et Systèmes (LSS - CNRS), the Universite Paris Sud XI and the Alcatel Lucent Chair on Flexible Radio at Supelec. His current research interests include information theory, random matrix theory and game theory applied to wireless communications. He is the recipient of the Crowncom2009 best student paper award.

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