Ankur A. Kulkarni
Systems & Control
ankur@sc.iitb.ac.in

SC 631 Games and Information

Autumn 2013

Course Description

Examples are rife of systems with multiple decision making entities but asymmetry of information. In economics, one frequently finds situations where an agent lacks complete information about something he is concerned with, or where one agent has more information about that thing than another agent. In biology, individual cells routinely differ in the information available to them and yet have to coordinate their actions. In communication, the central quest is to signal accurately to the receiver something that the sender can observe but which the receiver has no way of directly observing – a classic case of a common purpose for two agents (sender and receiver), but asymmetric information. In all of these systems, there are *agents* (or controllers, players, etc), which are stations where a decision is computed; each agent has a *utility function* that specifies the *payoff the agent receives from its decisions*; there is the *state of the world* which is random; there are *observation channels* that differ from agent to agent, and there are *decisions* that agents make based on these observations to maximize their payoffs.

This course is intended to expose students to the following key issue: agents are faced with a random environment that not every agent knows everything about it. Furthermore, through its decisions, an agent can influence what the other agents know. The basic questions then are: given what one knows and the rewards one is seeking, what is the optimal thing to do? And if a system is to be designed to achieve best overall rewards for all, who should know what?

The study of the capabilities and limitations of such systems lies at the intersection of the theory of games, theory of information and theory of control. Apart from the simplest questions, most questions in this area remain unsolved. This is a course in game theory that emphasizes the role of information in games. It will illuminate the consequences of randomness, imperfection and asymmetry of information in games. The objective of the course is to teach students the models, results and challenges in this area and make them aware of the generality of the questions it deals with. The course will develop all the background necessary – starting from the basics of game theory – to realize this theme. A significant part of the course is about noncooperative games and the latter part will address cooperative games with asymmetric information.

Course Content

- Basics of static games: Normal form of games. Zero-sum and non-zero sum games, concept of Nash equilibrium.
- Information: Extensive form of games and information sets. Imperfect, incomplete, and asymmetric information. Stackelberg equilibrium. Bayesian Nash equilibrium. Aumann's common knowledge.
- General formulation of dynamic games: sub-game perfectness, open-loop, closed-loop and feedback Nash equilibria, informational properties of Nash equilibria, informational nonuniqueness.
- Asymmtric information: Moral hazard. Importance of common knowledge.
- Dynamic stochastic team problems: introduction, information structures (static and dynamic) person-by-person optimality, Witsenhausen problem, signalling, connections to economics, information theory.

References

- T. Başar and G. Olsder, *Dynamic Noncooperative Game Theory*, SIAM, 1999.
- Fudenberg and Tirole, *Game Theory*, Ane Books, 2010 (**Indian ed**).
- E. Rasmusen. *Games and Information: An Introduction to Game Theory.* Wiley-Blackwell, 2006.
- M. J. Osborne and A. Rubinstein. *Course in Game Theory.* MIT Press, 1994 (**online**).
- S. Yuksel and T. Başar, *Stochastic Networked Control Systems - Stabilization and Optimization under Information Constraints.* Birkhäuser, 2013.

Formalities

- **Prerequisites:** A course in optimization, such as SC 607, AE 310, EE 659, IE 501, IE 601 or consent of instructor.
- **Credits:** 6. For slot and room information, please check `http://asc.iitb.ac.in`