CSC304: Algorithmic Game Theory and Mechanism Design
Fall 2016

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Lecture 1

Course Organization:

1. **Sources**: Lots of sources including textbooks, my posted lecture notes (beware typos), lecture notes from other Universities, and papers. Very active field. Usually taught at the graduate level but becoming more and more accessible for undergraduates. To a large extent I will be following a new unpublished text "Game Theory Alive" by Anna Karlin and Yuval Peres. An online version is available (and being updated based on feedback:w) at Anna Karlin's home page.
2. **Lectures and Tutorials**: M,W,F at 3; usually lectures on M,W with tutorials as needed and held "usually" on Fridays. **This week there will be three lectures and no tutorial.**
3. **Grading**: See course information sheet.
4. **Office hours**: TBA But mainly, when I am in, my door is open and I welcome questions (unless I am preoccupied). So feel free to drop by and/or email me to schedule a time. My office is SF 2303B and my email is bor@cs.toronto.edu. The course web page is www.cs.toronto.edu/~bor/304f16

What is appropriate background?

- The official prerequisites specify some background in probability and this is perhaps the most relevant background. The Karlin and Peres text indicate that linear algebra is also a prerequisite.
- A course like our undergraduate Algorithm Design, Analysis and Complexity (CSC 373) is equally relevant. Any of the popular undergraduate texts (for example, Kleinberg and Tardos; Cormen, Leiserson, Rivest and Stein; DasGupta, Papadimitriou and Vazirani) would be good references for CSC373 background. We should have made CSC373 a co-requisite.
- In addition some knowledge of graph theory would also be useful.

BUT any CS/ECE/Math 3rd or 4th year undergraduate student should find the course accessible and useful.

Comments and disclaimers on the course

- This is the first time this course is being taught. Some of this material was presented in CSC200 but this course will be more focused and aimed more at CS (and related fields) students.
- As this is the first time, the pace and precise set of topics will evolve. The topics listed in the information sheet is a draft of what we intend to do.
- Game theory, mechanism design, and social choice are well established and fundamental topics in Economics (and related disciplines). Relatively recently (approximately 1999 for CS theory, beginning with the seminal paper by Nisan and Ronen), computer scientists have become involved in this topic and the course title reflects the new perspectives being provided by algorithmic considerations. CS theory based conferences (e.g. SODA, EC, etc.) refer to the area as algorithmic game theory (AGT) but the area is also an active part of more AI based conferences (e.g. AAMAS, AAAI, etc.) and sometimes referred to as multi-agent systems).

Two (at least) game theory communities

From our perspective, the two main communites with active research in game theory

1. Economics with its traditional emphasis on rationality and equilibria as an explaination of how agents (also often called players) should behave, and characterizations of *optimal* behavior when it exists.
2. Computer Science with its traditional emphasis on compuational and informational constraints, approximation, and learning.

But because of the pervasive influence of game theory in many fields, game theory is an important topic for behavioral psychology, sociology, operations research/management science, and political science.

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Following Kate Larson's University of Waterloo slides:

Game theory

Game theory is a field that analyzes (in a mathematatcally precise way) **interactions** amongst a set of two or more **rational** agents who behave **strategically**. (Note: an agent can be an algorithm!)

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- Strategic: Agents try to take into account how their actions will influence the game.
- Rational: Agents choose actions so as to maximize their **utility**. In some cases (e.g. if the agent is a government body), the agent's utility may be (at least in principle) to maximize the overall **social welfare and/or fairness** of the outcome.

Why computer science and the computational lens

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These computational and information constraints are now critical due to the emergence of very large scale online social and economic systems. In many case, traditional economic solutions may not be feasible due to such constraints. For example, how to allocate wireless spectrum or online advertisements.

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The increasing application of algorithmic thinking in game theory and economics is part of what has been called *the computational lens* whereby every social, biological, mathematical and physical science is becoming more and more computationally oriented.

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The agents in game theory and mechanism design traditionally have cardinal (e.g. monetary values) utilities wheres in **social choice theory** (e.g. voting, peer evaluation), agents usually have preferences. With that possible distinction in mind, we can view social choice theory as part of game theory/mechanism design.

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Here is one question you may have asked or be thinking: What kind of games are we talking about?