CS 580: List of Uncovered Topics and Research Problems

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Since Algorithmic Game Theory is a very vast field, there are quite a few topics that we will not be able to cover in the class. Here are some of them. I think these are good topics for survey project as well, however please do not feel constrained by them and choose any topic of your liking. The only requirement is that it should be related to AGT.

- Fair cake-cutting
- Pros and cons of Bitcoin under strategic agents
- Security games (starting point is work of Prof. Milind Tambe and his group's at USC)
- Matching markets (like uber, lyft, taskrabbit, etc)
- Reward/review/badges mechanisms, and their applications (yelp, quora, amazon review, stack overflow are some examples) These are mechanisms without money, where participating agents do not even gain any physical object
- Extensive-form games (like Chess) and/or repeated (like games within an organization) games
- Multi-player succinct games, and computation of Nash and correlated equilibria
- Learning dynamics in games, *i.e.,* best response, no regret, etc.
- Learning in markets through revealed preferences
- Strategic behavior in markets – (Fisher) market games
- Pros and cons of auctions used in practice
- Multi-item auction (probably with single bidder)
- Auctions with interdependent valuations
- Games and Evolution, Evolutionary stable strategies. (Probably one of the first use of game theory was to understand evolution of competing species)
- Simple Stochastic Games (SSG): computation and applications
- Non-linear congestion games
- Nash bargaining game, its core, and applications
- Behavioral game theory – prospect theory/quantal response (some what explains rationale behind success of lotteries)
- Combinatorial games like Nim, Hex, etc.
- (complexity) Total function classes (TFNP). This includes PPAD, PPA, PLS, CLS, etc.

Research Projects

I understand that it may not always be possible to finish what one aims for within a specific time window while doing research, especially in case of theoretical research. Therefore, if you choose to do a research project, I expect a sincere attempt. At the end if no results are obtained, then it is okay to report/present literature survey and failed attempts.

Ideally I want you to come up with a problem for research project. Here are some theoretical problems to get you started (as far as I understand these are not easy problems, but can lead to publication).

- Efficient algorithm for CEEI with chores.
- Efficient algorithm to compute EF1+PO allocation with additive valuations.
- Existence of EFX allocation with four or more agents and additive valuations.
- Existence of EFX allocation of chores with three (or more) agents and additive valuations.
- Non-existence of EFX allocations under general valuations.
- Efficient algorithm for computing 4/5-MMS with additive valuations
- Stable 3-D matching: existence and computation.
- Beating $\frac{1}{e}$ – PoA of a truthful mechanisms for Fisher market game.
- Some problem from security games, like theoretical guarantees of quantal response, or game with multiple attackers.
- Incentive compatibility analysis of Bitcoin.
- Good mechanisms for Uber like systems – Matching with highly dynamic supply and demand. Drivers and riders both are strategic.
- Complexity of computing correlated equilibria in polymatrix coordination games.
- Complexity of computing correlated equilibria in extensive form games.
- Analysis of games under "prospect theory" model.
- Fair rent division with piecewise-linear utilities is in CLS (see paper by Arunachaleswaran, Barman, and Rathi from SODA'18).
- Understand relations between problems in CLS, *i.e.,* SSG, PLCP, contraction map, net-coordination games, and congestion games.
- Black-box separation between complexity classes PLS and PPAD.
- Is factoring in PLS or PPAD? A simpler (non-randomized) reduction to show factoring is in PPA.

Important: Grading for the projects will be based on sincerity with which the project was executed, and quality of the report and presentation.