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Simplicity & Complexity in Economics
T/Th 9 :00-10:15, ECON 2071
Fall 2019

SYLLABUS

updated Sep 4 2019

A. Course Overview

Technology has enabled the emergence of economic systems of formerly inconceivable complexity. Nevertheless, some technology-related economic problems are so complex that either supercomputers cannot solve them in a reasonable time, or they are too complex for humans to comprehend. Thus, modern economic designs must still be simple enough for humans to understand, and must address computationally complex problems in an efficient fashion. This topics course explores simplicity and complexity in economics, primarily via theoretical models. We will focus on recent advances. Key topics include (but are not limited to) resource allocation in complex environments, communication complexity and information aggregation in markets, dynamic matching theory, influence maximization in networks, and the design of simple (user-friendly) mechanisms. Some applications include paired kidney exchange, auctions for electricity and for radio spectrum, ride-sharing platforms, and the diffusion of information.

This class will not attempt to be comprehensive. Instead, the goal is to study six topics deeply, starting from the fundamentals and building rapidly to the research frontier. Topics will be largely self-contained, and we will teach in a way that assumes mathematical proficiency but little prior knowledge.

Notes: This course is open to high level undergrads with approval from instructor.

B. Office Hours

We encourage you to make office hours appointments with us to discuss paper ideas. To do so, please send one of us an email describing what you'd like to discuss (e.g., a paragraph- or page-long description of the project idea) and some blocks of time that are convenient and we can set up an appointment.

C. Course Website and Readings

We will use the course website (on Canvas) to distribute information and materials relevant to the class.

D. Assignments

D1. Final Paper

The main assignment for this course is to write a final paper.

You are required to write a one-page proposal (of potentially multiple ideas) by **October 13**. The final project presentations are in the last two sessions of the class (15 to 20-minute presentations, depending on the number of projects), and the final paper is due at **December 5.**

You can also co-author your projects and work in pairs. For groups of more than two people the expectations will be adjusted accordingly.

How to read the following section of the syllabus:

- Papers marked with (**) are essential reading. If you are not familiar with the material, you should read these thoroughly before the class.
- Papers marked with (*) are the main topic of the class. We will discuss these at length. Before the class, you should read to understand the broad outline and main results, though not necessarily the details of the proofs.
- Papers marked with no sign are *optional reading.* They are natural next steps if you are particularly interested in this topic.

F. Class Schedule and Readings

The schedule is tentative, and we will add (mostly optional) readings.

Section I: Ascending Auctions are Greedy Algorithms

Sept 3, 5

- The VCG mechanism and the Green-Laffont-Holmstrom Theorem
- Complex constraints, greedy algorithms, and knapsack auctions

** Milgrom, Paul (2004). *Putting Auction Theory to Work.* Chapter 2, pages 45-73
* Lehmann, Daniel, Liadan Ita Oćallaghan, and Yoav Shoham. *Truth revelation in approximately efficient combinatorial auctions.* Journal of the ACM (JACM) 49, no. 5 (2002): 577-602.
* Milgrom, Paul, and Ilya Segal. *Clock auctions and radio spectrum reallocation*. forthcoming at the Journal of Political Economy.

Sept 10, 12, 17

- One-for-one substitution and matroid auctions
- Auctions and stable matching as tatonnement

**Bikhchandani, Sushil, Sven De Vries, James Schummer, and Rakesh V. Vohra. "An ascending vickrey auction for selling bases of a matroid." Operations research 59, no. 2 (2011): 400-413.
** Gale, David, and Lloyd S. Shapley. *College admissions and the stability of marriage.* The American Mathematical Monthly 69.1 (1962): 9-15.
* Milgrom, Paul (2017). *Discovering Prices,* Chapter 2, pages 63-102 and 120-131
Arrow, Kenneth J., and Leonid Hurwicz. *On the stability of the competitive equilibrium, I.* Econometrica (1958): 522-552.

Kelso Jr, Alexander S., and Vincent P. Crawford. *Job matching, coalition formation, and gross substitutes.* Econometrica (1982): 1483-1504.
Hatfield, John William, and Paul R. Milgrom. *Matching with contracts.* American Economic Review 95, no. 4 (2005): 913-935.

Section II: Simple Mechanisms

Sep 19, 24, 26

- Obviously strategy-proof mechanisms
- Simplicity for agents with imperfect forward planning
- Mechanisms that rely only on first-order beliefs

* Li, S. (2017). *Obviously strategy-proof mechanisms.* American Economic Review, *107*(11), 3257-87.
* Pycia, M., & Troyan, P. (2018). *A Theory of Simplicity in Games and Mechanism Design*. Working paper.
* Borgers, Tilman, and Jiangtao Li. *Strategically simple mechanisms*. (2018).
Kagel, John H., Ronald M. Harstad, and Dan Levin. *Information impact and allocation rules in auctions with affiliated private values: A laboratory study*. Econometrica (1987): 1275-1304.
Hassidim, Avinatan, Assaf Romm, and Ran I. Shorrer. *Strategic behavior in a strategy-proof environment.* In Proceedings of the 2016 ACM Conference on Economics and Computation, pp. 763-764. ACM, 2016.
Rees-Jones, Alex. *Suboptimal behavior in strategy-proof mechanisms: Evidence from the residency match*. Games and Economic Behavior 108 (2018): 317-330.

Section III: Revenue Maximization and Complexity

Oct 1

- Optimal auctions
- Auctions versus negotiations

** Krishna, Vijay. Auction theory. Academic press, 2009. *Chapter 5*.
* Bulow, Jeremy, and Paul Klemperer. *Auctions versus Negotiations.* American Economic Review 86.1 (1996): 180-194.

Oct 3

- Multi-dimensional optimal auctions **(Guest lecture: Costis Daskalakis)**

***** Daskalakis, Constantinos, Alan Deckelbaum, and Christos Tzamos. *Strong Duality for a Multiple-Good Monopolist.* Econometrica 85.3 (2017): 735-767.
* Kleiner, Andreas, and Alejandro Manelli. *Strong Duality in Monopoly Pricing.* Econometrica 87.4 (2019): 1391-1396.

Oct 8

- Simple and approximately optimal mechanisms (**Guest lecture: Nicole Immorlica**)

*Babaioff, Moshe, Nicole Immorlica, Brendan Lucier, and S. Matthew Weinberg. "A simple and approximately optimal mechanism for an additive buyer." In 2014 IEEE 55th Annual Symposium on Foundations of Computer Science, pp. 21-30. IEEE, 2014.

Oct 10

- Sample complexity and optimal auctions **(Guest lecture: Yannai Gonczarowski)**

*Yannai A. Gonczarowski , and S. Matthew Weinberg. "The sample complexity of up-to-ε multi-dimensional revenue maximization." In Proceedings of the Proceedings of the 59th Annual IEEE Symposium on Foundations of Computer Science (FOCS 2018), pp. 416–426, 2018.

Oct 15

- Credible auctions

* Akbarpour, Mohammad, and Shengwu Li. *Credible mechanisms.* (2019).

Intermission

Oct 17

Early-stage research discussion

Section IV: Dynamic Matching

Oct 22, 24

- Dynamic matching on stochastic networks
- Dynamic matching with heterogeneous agents
- Dynamic matching: Toolkit

**Akbarpour, Mohammad, Shengwu Li, and Shayan Oveis Gharan. *Thickness and information in dynamic matching markets.* Journal of Political Economy (Forthcoming).
* Ashlagi, Itai, Maximilien Burq, Patrick Jaillet, and Vahideh Manshadi. *On matching and thickness in heterogeneous dynamic markets.* Operations Research (Forthcoming).
* Liu, Tracy, Zhixi Wan, and Chenyu Yang. *The efficiency of a dynamic decentralized two-sided matching market.* Available at SSRN 3339394 (2019).
Ashlagi, Itai, Afshin Nikzad, and Philipp Strack. *Matching in dynamic imbalanced markets.* Available at SSRN 3251632 (2018).

Section V: Influence on Networks

Oct 29

- Influence maximization: Optimum

** Kempe, David, Jon Kleinberg, and Éva Tardos. *Maximizing the spread of influence through a social network.* Proceedings of the ninth ACM SIGKDD international conference on Knowledge discovery and data mining. ACM, 2003.
* Banerjee, Abhijit, Arun G. Chandrasekhar, Esther Duflo, and Matthew O. Jackson. *The diffusion of microfinance.* Science 341, no. 6144 (2013): 1236498.

Oct 31

- **Guest lecture: *Ben Golub***

* Galeotti, Andrea, Benjamin Golub, and Sanjeev Goyal. *Targeting interventions in networks*. arXiv preprint arXiv:1710.06026 (2017).

Nov 5

- Greedy and random seeding

* Akbarpour, Mohammad, Suraj Malladi, and Amin Saberi. *Just a few seeds more: value of network information for diffusion.* Available at SSRN 3062830 (2018).

Intermission

Nov 7

- **Guest lecture: *Paul Milgrom***

Section VI: Communication Complexity

Nov 12

- Communication complexity and competitive equilibrium

** Hayek, Friedrich August. "The use of knowledge in society." *The American economic review* 35, no. 4 (1945): 519-530.
** Nisan, Noam, and Ilya Segal. "The communication requirements of efficient allocations and supporting prices." *Journal of Economic Theory* 129, no. 1 (2006): 192-224.

Nov 14

- Chain stability (**Guest lecture: Scott Kominers**)

* Hatfield, John William, Scott Duke Kominers, Alexandru Nichifor, Michael Ostrovsky, and Alexander Westkamp. *Chain stability in trading networks*. In Proceedings of the 2018 ACM Conference on Economics and Computation, pp. 617-618. ACM, 2018.

Nov 19

- Communication complexity of stable matching **(Guest lecture: Yannai Gonczarowski)**

* Gonczarowski, Yannai A., Noam Nisan, Rafail Ostrovsky, and Will Rosenbaum. *A stable marriage requires communication.* Games and Economic Behavior (2019).

Student Presentations

Nov 21, 26

Dec 3 – no class