

COMP_SCI 497: Theory+X

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Week 1

A Grand Challenge for Computer Science and Economics

Theoretical Computer Science:

understand computer systems

- mostly prescriptive.
- quantitative focus.
- handles complexity, information

Economic Theory

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Theory+X: Combine TCS and TE perspectives to confront big questions.

Topics at a Glance

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Weekly Topics:

Jan 14	Redistribution [Taxation]	Feb 11	Fairness & Bias
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Jan 28	[Online] Commitment	Feb 25	Econometrics of Learning
Feb 4	Adaptive Data Analysis	Mar 3:	Brain [Computation]

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Some topics not covered: cryptocurrency, fake news, authenticity among deepfakes, cumulative advantage in academia, money in politics, money in journalism, signaling and ML, future of work, academic processes, ...

Coursework:

- ① lead discussion of weekly topic. [details below]
- ② survey paper on topic area.
- ③ research proposal on topic area (with preliminary results).
- ④ final presentation [week 10]

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Topic Signup: online survey. [Abebe, Cole, Gkatzelis, Hartline SODA 2020]

Week 2: Redistribution [Taxation]

Presenters: Yiding Feng & Yingkai Li

Summary:

- symmetric concave utility; asymmetric production cost.
- no redistribution \Rightarrow high total wealth, low total utility.
- redistribution distorts incentives \Rightarrow low total wealth, low total utility
- are there simple near optimal policies?

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Papers:

- T. Piketty, E. Saez, **Optimal labor income taxation**. In Handbook of public economics 2013.
- Z. Abrams, **Revenue maximization when bidders have budgets**. SODA 2006.

Week 3: Privacy

Summary:

- differential privacy has broad impact across computer science, statistics, society.
- [many applications: adaptive data analysis, fairness, etc.]
- how did this field start?
- what's the role of game theory?

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Papers:

- I. Dinur, K. Nissim, K. **Revealing information while preserving privacy**. PODS 2003. **PODS Test-of-Time Award 2013**.
- C. Dwork, F. McSherry, K. Nissim, A. Smith, **Calibrating noise to sensitivity in private data analysis**. TCC 2006. **TCC Test of Time Award 2016**. **Godel Prize 2017**.
- R. Gradwohl, and R. Smorodinsky. **Privacy, Patience, and Protection**. SSRN 2019.

Summary:

- principal and agent interact repeatedly.
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- is there a role for privacy? or anonymity?

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Papers:

- N. Immorlica, B. Lucier, E. Pountourakis, S. Taggart, **Repeated sales with multiple strategic buyers**. EC 2017.
- L. Doval, V. Skreta, **Mechanism design with limited commitment**. ArXiv 2018.
- L. Doval, V. Skreta, **Optimal mechanism for the sale of a durable good**. SSRN 2019.
- P. Tang, Y. Zeng, **The price of prior dependence in auctions**. EC 2018.

Week 5: Adaptive Data Analysis

Summary:

- scientific discovery is a process.
- false discovery can result from adaptive data analysis.
- restrict or modify process to prevent false discovery.
- what is role of incentives?

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Papers:

- C. Jung, K. Ligett, S. Neel, A. Roth, S. Sharifi-Malvajerdi, M. Shenefeld, **A New Analysis of Differential Privacy's Generalization Guarantees.** ArXiv 2019.
- B.E. Woodworth, V. Feldman, S. Rosset, N. Srebro, N. **The everlasting database: statistical validity at a fair price.** NeurIPS 2018.

Summary:

- algorithms have bias if data has bias.
- various definitions of fairness.
- what are the right definitions?
- what is role of incentives? endogenous features?

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Papers:

- C. Dwork, M. Hardt, T. Pitassi, O. Reingold, R. Zemel, **Fairness through awareness**. ITCS 2012.
- S. Corbett-Davies, S. Goel, **The measure and mismeasure of fairness: A critical review of fair machine learning**. ArXiv 2018.
H. Heidari, M. Loi, K.P. Gummadi, A. Krause, **A Moral Framework for Understanding Fair ML through Economic Models of Equality of Opportunity**. FAT* 2019.

Summary:

- algorithmic comparison of sexual vs. asexual reproduction.
- asexual: maximizes fitness; sexual: maximizes robustness.

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Papers:

- A. Livnat, C. Papadimitriou, **Sex as an Algorithm: The Theory of Evolution Under the Lens of Computation.** CACM 2016.
- A. Livnat, C. Papadimitriou, J. Dushoff, M.W. Feldman, **A mixability theory for the role of sex in evolution.** PNAS 2008.
- E. Chastain, A. Livnat, C. Papadimitriou, U. Vazirani, **Algorithms, games and evolution.** PNAS 2014.

Summary:

- inference and counterfactual estimation for “no regret” agents

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Papers:

- D. Nekipelov, V. Syrgkanis, E. Tardos, **Econometrics for learning agents**. EC 2015. **Best Paper**.
- D. Hoy, D. Nekipelov, V. Syrgkanis, **Efficiency Guarantees from Data**. ArXiv 2015.
- A. Alaei, A. Badanidiyuru, M. Mahdian, S. Yazdanbod, **Response Prediction for Low-Regret Agents**. WINE 2019.

Week 9: Brain [Computation]

Summary:

- computational perspective on neuroscience.
- why is the brain good at what it does?

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Papers:

- W. Maass, C. Papadimitriou, S. Vempala, R. Legenstein, R. **Brain computation: a computer science perspective.** Computing and Software Science, 2019.
- L. Valiant, **Memorization and association on a realistic neural model.** Neural computation 2005.
- C. Papadimitriou, S. Vempala, **Random projection in the brain and computation with assemblies of neurons.** ITCS 2019.
- S. Vempala, C. Papadimitriou, D. Mitropolsky, M. Collins, W. Maass, **Brain computation by assemblies of neurons.** BioRxiv 2019.

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