Incentives in Computer Science

Your professor and TA

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TODAY: 3:30-4pm

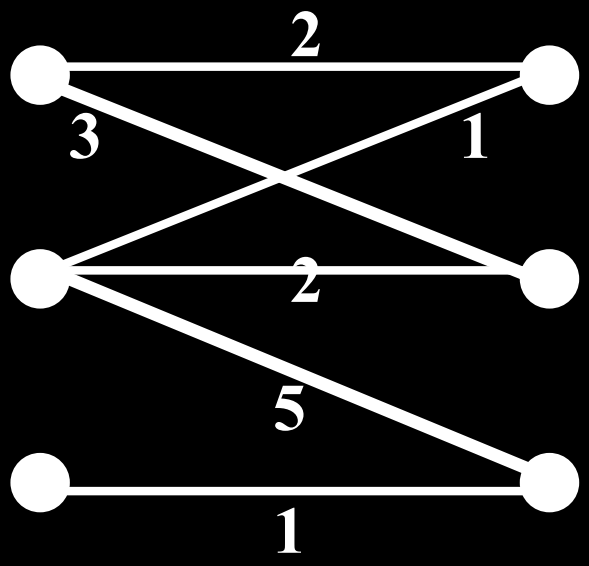
An Example

Classical Optimization Problem:

Maximum Weighted Matching

Input: Weighted Bipartite Graph

Output: Matching that maximizes the sum of matched edge weights.



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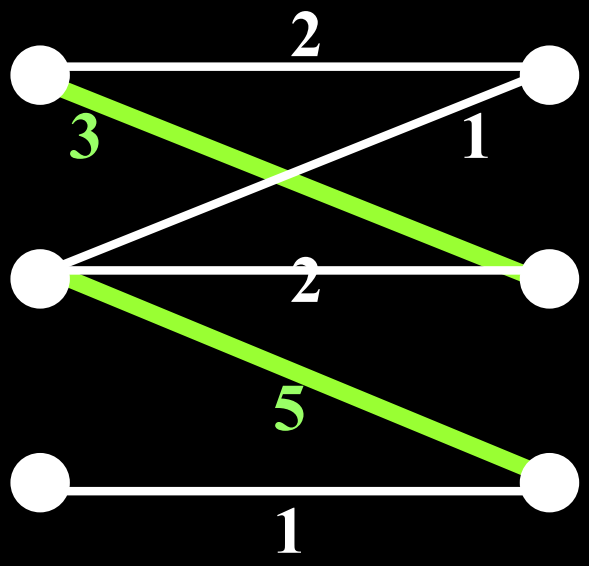
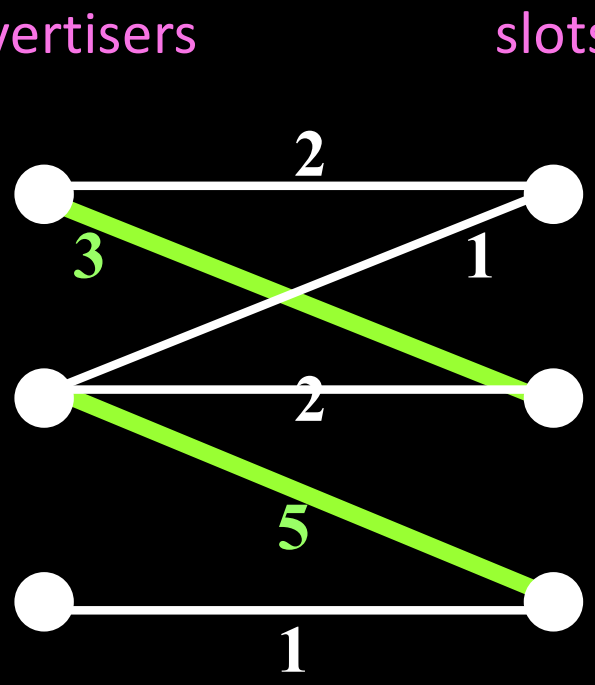


Example Application

Selling advertising slots

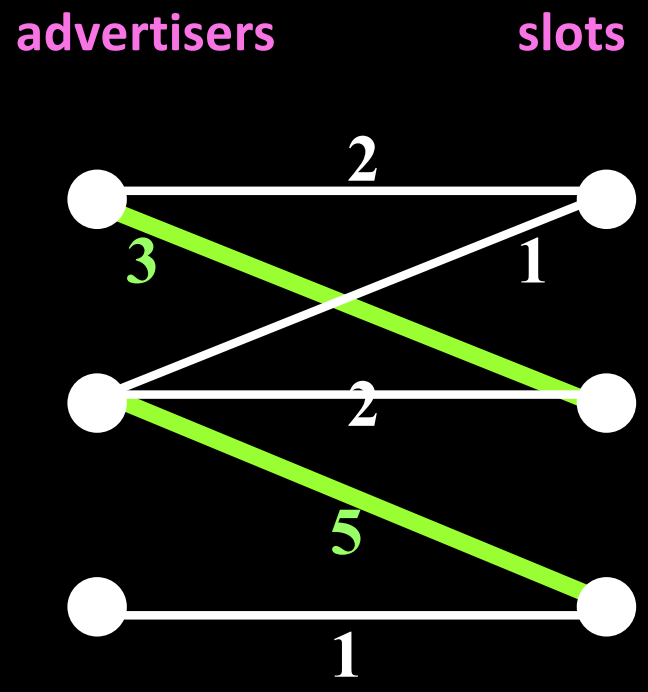
- A search engine has advertising slots for sale
- Advertisers are willing to pay different amounts to have their ad shown in a particular slot



Optimal Search Engine Revenue = maximum weighted matching

Private Values

- **Algorithm must solicit values**
- **Advertisers may lie to get a better deal**



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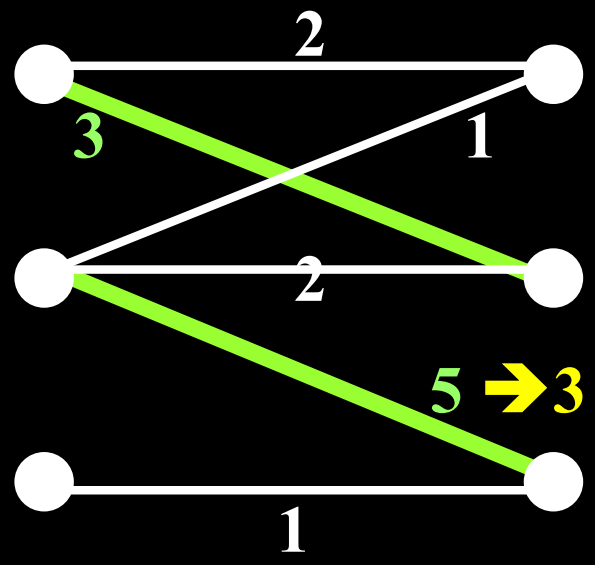

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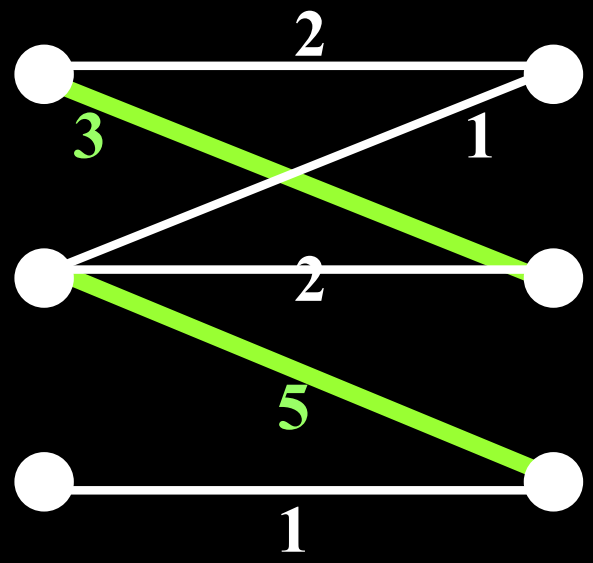

What if all advertisers speculate?

Big Picture

Many problems where input is private data of agents who will act selfishly to promote best interests

- Resource allocation
- Routing and congestion control
- Electronic commerce

Fundamental Question:
How do we optimize in a strategic world?

Use ideas from game theory and economics.

Game Theory

Game Theory studies the interaction between competing or cooperating individuals.

Key notion: **equilibrium**

Algorithmic Game Theory

Newish field at interface between theoretical computer science and game theory. Motivated by

- new applications in ecommerce, network applications, large scale resource allocation problems, myriad of nontraditional, computer-run auctions, etc.
- addresses fundamental problems about auctions, networks and human behavior using the tools of game theory, economics and algorithm design and analysis.

Companies/systems that can be studied from this perspective

- eBay, Amazon
- Google, Yahoo!, Microsoft
- Facebook
- Twitter
- Uber, Lyft
- airBnb
- Quora
- Farecast
- Wikipedia
- …

Problems that can be studied from this perspective

- Auction design and analysis
- Reputation systems
- Recommendation systems
- Crowdsourcing
- Resource allocation problems
- Routing and congestion control
- Creating incentives in social and financial systems
- Prediction markets
- …

Themes

- Designing systems for strategic participants with good performance.
- Games that arise in the wild: when is selfish behavior benign?
- How do strategic players reach an equilibrium? Or do they?

- Goal: to expose you to a different way to think.

Tentative list of topics

- Matching and allocation problems
- Intro to game theory, Nash equilibrium, etc.
- Markets, market-clearing prices, first welfare theorem
- Auctions (ads, spectrum)
- Price of anarchy
- Incentives in cryptocurrencies
- Online learning in markets
- Scoring rules and prediction markets
- Voting

Note…

This is a theoretical class.

EXPECTED BACKGROUND

- "mathematical maturity"
- Basics of probability, some background in algorithm design and analysis.
- I do not expect you to know any game theory or economics.

The nuts and bolts

Course website

http://www.cs.washington.edu/cse490z

Grading

100% homework (mix of theoretical and programming)

Participation

- Please do it!!!!!!!
- Use the chat feature to either write a question or in the chat box, type “hand” and I will call on you soon thereafter.

Let’s go around the “room” and Introduce ourselves

This week's lectures

- Covers some of the major results that resulted in the awarding of the 2012 Nobel Prize in economics to Lloyd Shapley and Al Roth

- *"The Prize concerns a central economic problem: how to match different agents as well as possible. For example, students have to be matched with schools, and donors of human organs with patients in need of a transplant. How can such matching be accomplished as efficiently as possible? What methods are beneficial to what groups? The prize rewards two scholars who answered these questions on a journey from abstract theory on stable allocations to practical design of market institutions."*

A basic definition

Mechanism

An algorithm whose inputs come from agents with a strategic interest in the output. Each agent's input is their own private information.

Takes as input the reported preferences/data for a set of agents and produces as output an outcome, decision or action.

Today: mechanisms without money