Networks and Markets

Lecture 1: Introduction

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Plan for today

- Content overview
- Syllabus/Course structure
- Questions
- Time permitting, move on to first content lecture
- Hopefully end a few minutes early for specific questions

Please interrupt with questions at anytime

(but raise your hand)

Who are we?

Instructor: Nikhil Garg

Asst Professor, Cornell Tech, ORIE

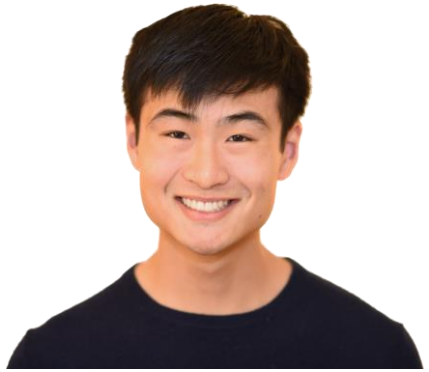
Research on the application of algorithms, data science, and mechanism design to the study of democracy, markets, & societal systems

Past experiences/collabs: Uber, Upwork, other marketplaces, campaign data science

TAs:

Kenny Peng

PhD Student, CS



Content overview

What *is* this class about?

Incentives and *networks* in computing

Many modern applications of algorithms and data science involve building systems that interact with people, who have their own incentives, and who have connections with other people.

How do we analyze and design algorithms in the presence of these incentives and connections? How do we *know* that these algorithms can handle these things?

Methods: *Theoretical (*mathematical) and *Conceptual* (paper reading)

What is this class *not* about

Programming based → **Many other courses**

Applied Data Science [I teach in the Fall]

Introduction to probability/optimization

→ **Other ORIE courses**

Organization

Game theory introduction

Matching Markets and Online Platforms

Networks introduction

Recommendation Systems

Social Choice, Democracy, and Crowdsourcing

Some concepts we'll discuss

- Price of anarchy: Selfishness can make everything worse
- Matching markets: how centralization sometimes fixes "everything"
- Winner's curse: Why winning means you overpaid
- Friendship paradox: why your friends have more friends than you do
- Network effects: why more is better
- Wisdom of the crowds: bunch of people who don't know anything, together know things
- Market unraveling: why markets can fail due to competition
- Braess paradox: why removing a road can speed up traffic
- Rent division: how should you and a roommate decide who pays what
- Participatory budgeting: how do we make complicated decisions?

Incentives and Connections between people

These ideas are behind many important systems

- How are NYC school students matched to schools?
- How are medical students matched to residencies?
- How do you get a kidney if your donor isn't a match for you?
- How are ads sold on the internet?
- How do internet data packages get routed around in decentralized fashion?
- How should you game TikTok/Twitter/etc so you get good recommendations? (And make sure your content is shown to others?)
- How do you design algorithms in online platforms?
  - Uber/Airbnb/Amazon/ChatGPT plugins/social media/etc

Let’s play a game

https://shorturl.at/fzDS1

Strategy

- What should you play if everyone else is picking a number uniform at random?
  - Everyone else has mean 50 → you should pick **33.333** (50 * 2/3)
- If you think everyone else does that math, then pick…
  - 33.333 * 2/3 = 22.2222
- Keep going…→ Optimal strategy is to play 0!
- Ok, let’s play again -- https://shorturl.at/fzDS1
- What happened?

Syllabus

https://networksmarketscornelltech.github.io/Spring2024/syllabus/

Assignments + Grading

Homework: **45%**.

4-5 homeworks. Each HW is an equal part of the homework grade. Lowest score replaced by paper presentation/review grade.

Primarily theoretical and conceptual

Paper presentation and review: 25%.

In class assignments/quizzes: 20%.

~weekly in class assignments quizzes. Lowest 1-2 scores dropped.

Participation: 10%.

Note the late day policy in the syllabus

Paper presentation and review

- You'll (in groups) present a paper and write a paper review
  - Detailed instructions (on course website): https://docs.google.com/document/d/1XVYrOeXj3RAoJAl0wLpP1Wel2HjuOXTtQKg2F_AeCNM

- Will also be a *discussant* and *peer reviewer* to another team's presentation

Attendance and Participation

- **Don’t come to class sick or if you suspect you’re sick**
- **Otherwise, please attend**
- No remote participation
- Likely won’t be posting videos online
- **We’ll have in-class assignments approximately every week**
  - Will drop lowest 2 grades
- Attendance + Participation is an important component of the class

Course communication

EdStem Discussion: First resource for any question

Office hours: You are strongly encouraged to come to office hours for any reason.

Email: Only for private questions and concerns. Technical questions will not be answered over email – please use Ed Discussion.

Important links + resources

- Course website: https://networksmarketscornelltech.github.io/Spring2024/
- Canvas
- Ed Discussion – Primary communication tool
- Gradescope – Place to turn in all assignments

Announcements

- My office hours – Mondays at 4:15 (right after class)
- TA office hours preference form will be sent out
- TA office hours start next week
- Homework 1 will be posted soon
- Form teams (of 4) for paper presentation
- Look at preferred readings/etc on course website

Questions?

How to fairly decide who gets what

- Paper presentations will be over 7-8 days this semester
- Each of you have *preferences* over when you want to present
  - Maybe you want to get it over with, and present early
  - Maybe you want to procrastinate, and present later
- How do we decide who gets what?

Let’s think through a couple of mechanisms

Attempt 1: Random selection

Each team gets a completely random presentation day

Pro 1: “Fair” – each team has an = chance of each day

Pro 2: “Strategy-proof” – You can’t “game” the system

Con 1: Preferences are completely ignored!

- Possible that someone who wants a late day gets an early day, and vice versa

Attempt 2: Each team reveals favorite day

Each team i tells me their single most preferred day s_i

Mechanism: “Serial dictatorship with a single preference”

- I randomize the teams in some order “lottery number”
- When it is your team’s turn, I look at your s_i
  - If that day has an empty spot, I give it to you
  - Otherwise, I skip your turn
- At end, I randomly assign the remaining spots to the skipped teams

Attempt 2 analysis

Pro: Takes into account preferences!

Pro: Fair-ish! Each team has equal chance at high lottery number

Strategy proof? Let’s think

Attempt 3: Each team reveals full preference list

Each team i tells me gives me *full ranking* over their preferences

Mechanism: “Serial dictatorship with full preference lists”

- I randomize the teams in some order “lottery number”
- When it is your team’s turn, I go down your list in order
- I give you the highest ranked day that still has room

Attempt 3 analysis

Pro: Takes into account preferences!

Pro: Fair-ish! Each team has equal chance at high lottery number

Strategy proof? Let’s think…