

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

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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:

- Ulysse Hennebelle

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- Mikhail Fadin

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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/in practice* (research 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**

Topics

- Game theory introduction
- Networks introduction
- Matching Markets and Online Platforms
- Recommendation Systems
- Social Choice, Democracy, and Crowdsourcing
- Applications in modern AI

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
- Preference elicitation + aggregation: how do you collect preferences and then make decisions?
- 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
- How do we align modern AI agents to multiple people's preferences?

Let's play a game

<https://networkmarketscornelltech.github.io/Spring2026/1to100/>

Strategy – let's discuss

- 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://networkmarketscornelltech.github.io/Spring2026/1to100/>
- What happened?

Syllabus

<https://networkmarketscornelltech.github.io/Spring2026/syllabus/>

Assignments + Grading

Homework: 50%.

- 5 homeworks. Each HW is an equal part of the homework grade.
- Lowest score replaced by quiz average

In class assignments/quizzes: 25%.

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

Paper annotations and review: 15%.

Participation and Attendance: 10%.

- You have five total late days for homeworks (24 hours each).

Paper annotations and review

- We'll be reading and discussing research papers throughout the semester.
- You'll complete structured annotations for each paper.
- You'll write a longer review memo for one paper

Attendance and Participation

- **Don't come to class sick; otherwise, please attend.**
- **Live remote attendance is not an option.**
- Lectures generally won't be recorded or posted.

- We'll have in-class assignments/quizzes about once a week (lowest 2 dropped). No electronics allowed during quizzes. Paper notes allowed
- Participation includes attendance (in-class sign-ins) + surveys/engagement.

Course communication

- Ed 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 (include “[networksmarkets]” in subject).
 - Technical questions will not be answered over email — please use Ed Discussion.

Important links + resources

- [Course website](#)
- [Canvas](#)
- [Ed Discussion](#) – Primary communication tool
- [Gradescope](#) – Place to turn in assignments

Announcements

- Instructor office hours – Wednesdays 4:20–5:00pm (Bloomberg 454)
- TA office hours: TBD (watch Ed Discussion)
- Homework 1 will be posted soon
- Please review course readings/resources on the course website

Questions?

How to fairly decide who gets what

- Paper annotations + memo choice will be over 5–8 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
 - You have preferences over the paper you want to read in detail
- How do we decide who gets what?

Let's think through a couple of mechanisms

Attempt 1: Random selection

Each person gets a completely paper day

Pro 1: “Fair” – each person 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 person i tells me their single most preferred day s_i

Mechanism: “Serial dictatorship with a single preference”

- I randomize people in some order “lottery number”
- When it is your 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 people

Attempt 2 analysis

Pro: Takes into account preferences!

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

Strategy proof? Let's think

Attempt 3: Each person reveals full preference list

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

Mechanism: “Serial dictatorship with full preference lists”

- I randomize people in some order “lottery number”
- When it is your 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 person has equal chance at high lottery number

Strategy proof? Let's think...

