

Networks II: Market Design

Lecture 1: Introduction

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Welcome to Networks II: Market Design!

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Outline for today:

- What: Course overview
 - Overview: The big picture
 - What exactly? Course topics
- How: Course information
 - Logistics
 - Credit components
 - Course policies
- Who: Introductions

Networks (II): Market Design

- Networks: What comes to mind?
 - Most generally: **Interconnected entities**
 - Examples... and not-examples!
 - Entities: People, data, machines, things,
 - Nature of connection: Structural (the “standard” meaning), strategic, statistical, ...!
- Markets: What comes to mind?
 - A broader view: *Institutions for exchange*
- Design: Not just analyze or predict outcomes, but influence what might happen!

Our focus: Design in networked economies

- *'Economies'*: Very broadly defined
 - Any system with exchange amongst economic agents
- Economic agents: Agents who make choices or decisions
- Exchange: Of any kind (goods, services, ...) with or without currency
 - Currency: Money, *and* other things of value (virtual currency, attention, ...)

Why (is this our focus)?

- Networked economies are everywhere!
 - Exposure: Thinking about one helps think about others
- **Conceptual: Reasoning about questions**
- Techniques: Reasoning about answers
 - Logical reasoning (recognizable as such, ... or not :))
 - And other things ...

What we'll do:

- *Models*: Formal models for networked economies
- *Analysis*: Analyze to make predictions about behavior
- *Design*: Design systems to induce 'desirable' outcomes
- Centered around real-world economies: Kidney exchange, college admissions, online marketplaces (EBay, Amazon) . . .

- Goal: *Recognize* networked economies; analyze; design
 - Remember, networked **for us** means connected in *behavior*!
- Theory; mathematical modeling; real-world applications
 - Understand modeling choices: Abstracting real-world settings
 - Learn relevant theory and techniques
 - Real-world applications: Apply to designing real systems
 - How do models match, and how do they deviate?

Course structure and learning

- Lectures:
 - Recaps; outlines; summaries
 - Interaction; active learning
- Readings: Supplemental material; class preparation
- Understanding the theory: Homeworks, in-class clicker questions
- Developing your curiosity:
 - Short explorations: “Blog-post” style assignments
 - Developing a curiosity, in depth: Project
- Regular feedback and participation: You!

- Allocation: Who gets what?
 - Matching markets with *non-transferable utilities*
 - Theory: Properties of, algorithms for, 'good' allocations in one-sided and two-sided markets
 - Real-world design: Kidney exchange, college admissions
- Information: Who knows what?
 - Information and networked behavior: Who comes to market, and how do they behave, given information structure?
 - Theory: Information asymmetry in markets, repeated prisoners' dilemma, ...
 - Real-world design: Ratings; reputations (eBay; Amazon; ...)

Networked economies: Three aspects

- Modeling: How do you identify and abstractly *model* a real-world setting as an instance of networked economic behavior?
- Analysis: What are the general principles that apply to this instance?
- Design: Can we use our model and analysis to *design* for desirable outcomes?

Topics in more detail: Matching markets

- Why matching markets without money?
 - They matter: School choice, organ donation, college admissions
 - Bring up new conceptual questions!
- One-sided matching markets without money
 - Binary preferences: Perfect matchings; Hall's theorem
 - Rank-order preferences
 - Pareto efficiency, strategy-proofness
 - No 'initial endowments': Serial dictatorship
 - Initial endowments: Core allocations; Gale's Top Trading Cycles (TTC) Algorithm
 - Market design: Kidney exchange

Outline: Matching markets

- Markets with two-sided preferences
 - The marriage model
 - Stable matchings: Algorithm, properties
 - Many-to-one matching models
 - Incentives and preference reporting
- Market design: College admissions
 - The NRMP hospital-intern match

Outline: Information and networked behavior

- Allocation in markets with non-transferable utilities: Who gets what
 - Market participants, preferences given and known
- Who comes to market, and how do they behave?
 - Information structure in market determines participants, prices, preferences, ! . . .
- Information and networked behavior
 - Information asymmetry and inefficiency in markets
 - Adverse selection: Inefficiency; credible disclosure, signaling
 - Moral hazard: A prisoner's dilemma model; repeated games

Outline: Information and networked behavior

- Alleviating information asymmetry: Reputations
- Quality uncertainty on the Web
 - Online ratings and reputation systems
 - Attacks on reputation systems
- Market design:
 - An empirical study and redesign of the eBay reputation system

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- Instructor (*i.e.*, me): Arpita Ghosh
(Associate Professor, Information Science)
- Networks II online:
 - **Course webpage:** <https://courses.cit.cornell.edu/info4220/>
 - CMS: All assignments, submissions
 - Course Piazza page:
 - Will be activated next week: Wait for CMS message with sign-up link!
 - **Guidelines for use: In a few slides**
- Office hours:
 - Will start week of February 4
 - Times TBA: Check **course webpage**

- **Homework assignments:** 40%
- **Midterm:** 35%
- **Project:** 25%
- **Graded clicker questions:** $\sim 0\%$
 - May be used for final grade, for extreme borderline cases, at discretion of instructor
 - Vital learning tool: Use seriously!

- Homework assignments: Timeline and policies
 - Roughly 1 assignment every 2 weeks; 5-7 in total
 - All assignments matter: No dropped assignments
 - Posted and due by *electronic upload* on CMS, typically Thursdays by noon (unless otherwise specified)
 - **Late policy:** 20% penalty within 24 hours after deadline; no credit thereafter
 - *No exceptions, other than university-approved reasons*
 - Grades based on CMS submission only: No exceptions
 - Regrade requests, if necessary: Requests submitted *in writing* to grad TAs

Credit components: Details (contd.)

- Midterm: **In-class, Thursday April 18**
 - Save the date: No alternative exam!
- Project:
 - Groups of 4
 - Report; presentation slides due: **Thursday May 2 10AM**
 - Details later in term
- Clickers:
 - **Register** your clickers at:
<http://atcsupport.cit.cornell.edu/pollsrcv/>
 - **Start bringing clickers to every class starting second week**

- Announcements: Lectures (in detail), CMS
- Email: *Not good!*
 - I am unable to respond to email due to a chronic medical condition. Asking questions **in-class or in office hours** is the best way to communicate with me.
- **Piazza**: Discussions, questions
 - All questions related to course material
 - **Not** for logistics, grading, course policy, ...
- Email address, for (Piazza-inappropriate) individual issues *only*, reaching instructor and graduate TAs:
INFO4220-GradTAs-L@cornell.edu
 - Most people shouldn't need to use this
 - Note: Do not email instructor/TAs individually (unless otherwise instructed)

- Use of electronic devices:
 - No cellphone use
 - Laptop use for note-taking only
- Academic integrity: **Honor code**
 - Maximum penalty for violations
- Disruptive behavior: In-class, or online
 - Simple: Please don't.
 - Incentives must work: “Anti-class-participation” points, anywhere up to 20 points off final score (‘taxing externalities’)

- No textbook for the class:
 - No single book covers course topics
- Readings (by topic) will be posted on CMS
 - Different level of detail
 - Do not substitute lectures
- Lecture slides:
 - Will be posted on CMS on day of class
 - Slides provide scaffolding: **Not** complete transcript of class

- Networks (INFO2040)
- Familiarity with logical reasoning (at the level of CS 2800 or equivalent)
 - Converses and contrapositives: If $A \Rightarrow B$ is known true,
 - $\text{Not } B \Rightarrow \text{Not } A$ is certainly true
 - $\text{Not } A \Rightarrow \text{Not } B$ may or may not be!
- Familiarity with basic probability and statistics

- I haven't taken Networks. Can I still take Networks II?
- I don't have the second/third prerequisite. Can I still take this class?
- Three related questions:
 - ① Will it be too fast for me?
 - ② Will it be too slow for me?
 - ③ *Must* I come to class?

What to expect: What's similar, and what's different

- Content:
 - Similar in style: Mathematical models for real-world phenomena
 - Depth versus breadth: More involved reasoning
- Logistically:
 - Similar grading structure, policies
 - Project instead of final

Informal overview, summary: What you'll need to do

- 5-7 homework assignments: Problem sets plus one or two explorations
- Midterm
- Project:
 - Group formation and topic
 - Intermediate report
 - Full report and flash presentations
 - Poster session

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Research interest: Formal (mathematical) analysis of social systems

- What that means:
 - Past, distant and recent:
 - User-generated content, crowdsourcing: Incentives for quality and participation
 - Personal data: Models, mechanisms and markets for privacy
 - Online advertising: Auctions, markets, information, . . .
 - Peer-to-peer lending: Auction design; market clearing
 - . . .
 - Current research focus: Incorporating 'real' behavior into mathematical analysis and design. . . or mathematical analysis and design into the study of behavior!

Introductions: You!



- Matching markets: Starting out!
 - Matching markets with versus without money
 - One-sided matching markets
 - The simplest preference model: Binary preferences
 - Ideal allocations: Perfect matchings
 - Finding perfect matchings: A proof of Hall's theorem