Econ 407 - Market Design
Washington University in St. Louis
Spring 2020

Instructor: SangMok Lee
Email: sangmoklee@wustl.edu
Classroom & time: Tuesday/Thursday 11:30am – 12:50pm, Seigle 304
Office hours: Tuesday 1-3pm (Seigle 339)
Assistant To Instructor: Laura Hurtado-Moreno (laurah@wustl.edu)
Laura’s office hours: Mon 1-2pm and Tue 9-10 am (Seigle 376)

1. Overview
The objective of this course is to study how to design mechanisms to allocate scarce resources such as medical residencies, dormitories, public housing, kidneys, ad sections, etc. We will consider various applications, which include the National Resident Matching Program, the Kidney Exchange for transplants, and sponsored search auction (e.g., Google, Facebook, etc.) For each topic, we start with a class of similar applications and develop a theoretical model that helps us identify a “good” institution. An important goal is to introduce students to the field of Economics that connects Economic theory to very practical applications.

2. Main Topics: Matching and Auction
Two-sided matching studies how to pair two kinds of participants: e.g., medical school graduates and residency programs, students and public schools in large cities, college students and dormitory rooms, donated kidneys and transplant patients, etc. Participants in these markets have preferences over potential partners. How to find a “good” matching that takes into account the preferences? The task is more challenging (and interesting) when it is repugnant or illegal to use prices to clear supply and demand. We will study various algorithms that are implemented in practice, discuss their pros and cons, and identify some desirable ones.

Auctions are everywhere: from art auctions to Amazon HQ2. Suppose you sell a used car. We can either sell by an ascending-price auction (English Auction) or a descending-price auction (Dutch Auction). Which one is likely to generate a higher revenue? Consider internet auctions. You google “hybrid car” and will see advertisements say, e.g., Toyota ad first, followed by GM, Ford, Honda, etc. What’s a “good” way for Google to sell ad spots and determine prices? We will study how different types of auctions work in theory and perform in practice. More complex problems sell multiple units of a single good, or even auction multiple related goods. The examples include the Federal Communications Commission (FCC) spectrum auction. The objectives are either generating revenue or improving social welfare. We study how to design an optimal auction if any exists.
3. Prerequisites

We apply advanced microeconomic theory to solve very practical problems. As such, students are expected to be well-trained in Microeconomic Theory, Game Theory, and Optimization. The official prerequisites for this class are Intermediate Microeconomics (Econ 4011), Calculus (either Econ 493 or Math 233). Keep in mind that these are "minimum" prerequisites. Some knowledge of Game Theory (Econ 467) and Optimization (Econ 4111), although not required, will be very useful.

4. Textbooks:

Lecture notes/slides will be self-contained. No textbook is required. If you really want to have a textbook, I suggest

The next book is written for a casual reader:
- Who Gets What and Why: The New Economics of Matchmaking and Market Design, by Alvin Roth

Two graduate textbooks will be used for references only:
- Two-Sided Matching: A Study in Game-Theoretic Modeling and Analysis. 1990, by Alvin Roth and Marilda Sotomayor.

5. Grading

Four Homework Assignments: 15% each (Due Dates: Feb 6, Feb 27, Mar 26, and April 16)
Two exams: 20% each (March 5, April 23, in class)

The first two assignments and the first exam cover matching. The rest covers auction. Each assignment will be uploaded to Canvas about a week before the due.

6. Course policies

- A request for a re-grade of a problem set or an exam must be submitted to me in writing within 1 week after the graded assignment/exam has been returned. I will reevaluate your complete homework set or exam.
- If you miss the first exam, then the second exam will be worth 40% of your semester grade. If you miss the second exam, a make-up exam will be arranged during the summer break. If you miss an exam, a university-approved excuse must be provided and it must be provided at, or before, the scheduled time of the exam.
- The assignments will be given one week before the due dates and will be due at the start of the lecture on the day they are due. You can submit in class, or any time before the class. Late assignments will not be accepted.
- You are encouraged to work with others when completing the homework assignments, but you must submit solutions individually. The exams are to be your own work. As
such, evidence to the contrary will result, initially, in a failing grade on the exam, and immediate academic disciplinary action. If you ever feel that these standards of academic integrity are not being met, please notify me, or an undergraduate advisor, immediately. If you are uncertain about the policy on academic integrity at Washington University, refer to http://studentconduct.wustl.edu/academic-integrity/policies-and-procedures/.

- Students with testing accommodations must submit their “VISA” to me by 5 pm on the last Friday in Jan. Sending the VISA as an email attachment is acceptable.
- If you are taking this course P/F or CR/NCR, you must receive a C or better to receive a ‘P’ or ‘CR.’

7. Tentative Course Schedule

Each topic will take about 2 or 3 classes.

0.) Introduction to Market Design: Overview of the topics, Math overview.

- GH-Chapter 1
- Math Review: Logic (A lecture note by John Nachbar)

1.) Introduction to Matching Theory: The “marriage market” and one-to-one matching, stable matches, Gale-Shapley Deferred Acceptance algorithm, Optimal matches for men and women, incentives.

- GH-Chapter 9
  [This is the first paper on matching. A math paper that doesn’t have a single equation!]

2.) The National Resident Matching Program: Stable matchings and orderly markets, the NRMP for medical residency and fellowship programs.

- GH: Chapter 10
This paper describes the redesign of the matching algorithm in 1998. Challenging to read, so it’s okay to skim.

3.) Market Unravelling: the problem of market unraveling, matching markets for law clerks, college admissions.
   - GH doesn’t cover this topic.

4.) House Allocation and Kidney Exchange: The house allocation problem, efficient outcomes and the core, serial dictatorship, the top trading cycles algorithm and variations, kidney exchanges.
   - GH: Chapters 11, 12, and 16.
   - Short article on National Science Foundation Website: “Kidney Exchange: A Life-Saving Application of Matching Theory,” [Google: “Kidney Exchange NSF”]

5.) Public School Choice: School choice, the Boston algorithm and its incentive problems, deferred acceptance and top trading cycles as alternatives, problem of ties, Boston & NYC School Districts.
   - GH: Chapter 13-14.

[Midterm Exam About Here]

6.) From Matching to Auction: The assignment model (matching with prices), competitive equilibria and efficiency, ascending auctions, assignment auctions, connection with auction and the deferred acceptance algorithm, Course Bidding at Wharton MBA
   - GH doesn’t cover this topic.
- Eric Budish and Judd Kessler: “Bringing Real Market Participants' Real Preferences into the Lab: An Experiment that Changed the Course Allocation Mechanism at Wharton,” working paper, 2016.
  [Google: Financial Times Article “Technology brings choice to MBA students”]

7.) **Traditional Auction Theory:** the private value model of auctions, ascending auctions, first and second price sealed bid auctions, the revenue equivalence theorem
   - GH: Chapter 2 and 3
   - [Easy. Many of the practical economic concerns in designing a large-scale auction.]

8.) **Simple Auction in Practice (E-bay):** from theory to practice with an E-bay auction example.
   - GH: Chapter 3.

9.) **Sponsored Search Auctions:** VCG auction, Google’s advertising auction, bidding incentives and equilibria, other ways to run the auction, Facebook’s Vickrey auction.
   - GH: Chapter 4-5.
   [Challenging. Lecture slides simplify the setup]

10.) **Search Auction with Daily Budget:** Online Matching (A different kind of matching problem). Dynamic Matching. Greedy, Patient, and Batching Algorithms.
   - GH doesn’t cover this topic.

11.) **Common-value Auctions:** the common value model of auctions, the winner’s curse, examples, and applications, when do price aggregate information, application to oil lease auctions.
   - GH: Chapter 6 covers a bit.
   [Off-shore oil leases]
  [Accessible. Experimental and empirical evidence on the winner’s curse. Behavioral economics]

10.) Multi-Unit Auctions: US Treasury Auctions, Sequential auctions, uniform price auctions, discriminatory price auctions, demand reduction.


11.) Combinatorial Auction: Auctions to award property rights for radio spectrum, the design of the FCC auctions for Radio Spectrum, evidence from the US and Europe, the Advanced Wireless Service auction. Encouraging truthful bidding by revealed preference theory.

- GH: Chapter 6.
  [The design of the British 3G auction.]
  [New ideas about how to design combinatorial auctions for radio spectrum and other assets.]

12.) Double Auction: real-time transactions in financial markets. Electronic markets for trading equity and other financial securities, the use of auctions for IPOs, real-time trading and market clearing, competition between exchanges.

- Securities and Exchange Commission, Concept Release on Market Structure, 2010  
  [Google: SEC concept release market structure. Interesting paper on how the introduction of electronic platforms has changed financial markets.]


- NPR Planet Monry, Episode 665: The Free Food Market
8. Miscellaneous

**Accommodations based upon sexual assault:**
The University is committed to offering reasonable academic accommodations to students who are victims of sexual assault. Students are eligible for accommodation regardless of whether they seek criminal or disciplinary action. Depending on the specific nature of the allegation, such measures may include but are not limited to implementation of a no-contact order, course/classroom assignment changes, and other academic support services and accommodations. If you need to request such accommodations, please direct your request to Kim Webb (kim_webb@wustl.edu), Director of the Relationship and Sexual Violence Prevention Center. Ms. Webb is a confidential resource; however, requests for accommodations will be shared with the appropriate University administration and faculty. The University will maintain as confidential any accommodations or protective measures provided to an individual student so long as it does not impair the ability to provide such measures.

If a student comes to me to discuss or disclose an instance of sexual assault, sex discrimination, sexual harassment, dating violence, domestic violence or stalking, or if I otherwise observe or become aware of such an allegation, I will keep the information as private as I can, but as a faculty member of Washington University, I am required to report it to my Department Chair or Dean immediately or directly to Ms. Jessica Kennedy, the University’s Title IX Director. If you would like to speak with directly Ms. Kennedy directly, she can be reached at (314) 935-3118, jwkennedy@wustl.edu, or by visiting the Title IX office in Umrah Hall. Additionally, you can report incidents or complaints to the Office of Student Conduct and Community Standards or by contacting WUPD at (314) 935-5555 or your local law enforcement agency. See: Title IX

You can also speak confidentially and learn more about available resources at the Relationship and Sexual Violence Prevention Center by calling (314) 935-8761 or visiting the 4th floor of Seigle Hall. See: RSVP Center

**Bias Reporting:**
The University has a process through which students, faculty, staff and community members who have experienced or witnessed incidents of bias, prejudice or discrimination against a student can report their experiences to the University’s Bias Report and Support System (BRSS) team. See: brss.wustl.edu

**Mental Health:**
Mental Health Services’ professional staff members work with students to resolve personal and interpersonal difficulties, many of which can affect the academic experience. These include conflicts with or worry about friends or family, concerns about eating or drinking patterns, and feelings of anxiety and depression. See: shs.wustl.edu/MentalHealth