Two-sided matching: theory and application to school choice

Introduction

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Main ingredients

- 2 populations of agents, potentially strategic (men-women, firms-workers, etc)
- Designing institutions to help policy makers:
  - student placement in schools
  - labor markets with workers and firms
  - organ donation
  - refugees and host countries
- The centralized institutions propose an allocation on the basis of the preferences (ranking, priorities) that have been declared.
- Can they perform better than decentralized institutions?
- YES, especially when there is no money involved or no wage to be negotiated, that is non transferable utility
Some historical background

The **US medical market** for residency training programs plays an important role in the development of the market design approach of matching markets.

- Size (today) around 20,000 students and 4,000 hospitals
- Starting in 1900: fully decentralized, suffered from unraveling of appointment dates.
- Contracts made two years in advance ⇒ a lot of mismatch since at that time agents don’t know their preferences!
- A centralized mechanism is designed in 1952 (NIMP, and after NRMP)
  - Students submit their rank list over hospitals
  - Hospitals submit their rank list over students
  - NIMP computes an allocation (a match): a set of pairs between students and hospitals, once and for all.
  - No unraveling, choices are almost simultaneous and the computation is immediate.
Some historical background


- They use the metaphoric illustration of a marriage problem between men and women.
- They define an algorithm, called the deferred acceptance algorithm (hereafter DA algorithm).
- The algorithm is the cornerstone of the matching theory.
- The outcome of the algorithm provides an allocation, which is stable.
- Stability is a natural property that prevents the existence of a student and a hospital not matched to each other in the allocation but who would prefer to match with each other.
Some historical background

In 1984, Alvin Roth published a pathbreaking article in Journal of Political Economy showing that NIMP is equivalent to DA.

- That’s why it works so well since its implementation
- Following, further changes have been incorporated to simplify the procedure and account for couples (want to be assigned to the same hospital).
- Beginning of the engineering of matching.
- Interesting as well from or the viewpoint of history of sciences: DA is discovered 10 years after its first practical implementation.
Some historical background


- They show that all the tools defined in the past two decades can be straightforwardly applied to deal with school choice problems.
- They define a new engineering methodology to assign students/pupils to high schools/schools.
- Huge literature since that time.
- The theory is put into practice in US: Boston and NY first, many other cities followed.
Two-sided matching
In the last 15 years, constant interplay between theory and practice:

- Applying theory to markets that were disregarded so far, and expanding theory via the details of the specific markets.
Centralized versus Decentralized

**Decentralized:**
- Agents are on their own
- Have to search themselves a partner
- Frictions:
  - Takes time
  - Costly to find someone
  - Uncertainty and trade-off between present and future opportunities.

**Centralized**
- In centralized markets, agents interact through a clearinghouse (institution)
- Agents send signals/information/request to the clearinghouse (ONCE)
- The clearinghouse computes an outcome and sends back the allocation to the agents.
Outlines

- **Chapter 1.** The marriage model and the basic core theory of one-to-one two-sided matching market
- **Chapter 2.** School choice: the interplay between practice and theory
- **Chapter 3.** Some examples of centralized procedures in education
Texts used