VIENNA UNIVERSITY OF TECHNOLOGY

105.625 PR ADVANCED ECONOMICS PROJECT

# Double Sided Matching

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# Contents

# 1 Introduction

This paper deals with the investigation of the double sided matching along with its application in economics.

Add more introduction text

## 1.1 The problem

In many daily live expierences there is an hidden double sided matching. For example But we don't have the time or energy to find the perfect or optimal solution. Whereas in some field this could be done more easily or because this is mandatory, like in the universities in germany. They have an admission restriction for the students. Only the students with the best grandes in high school can go on the best universities in germany. But these universitites can only take a limited amount of students.

Find a good example

Is this true?

Define the problem a bit better

## 1.2 The aim

The aim of the paper is to develop a prototype, which could solve the previous discussed problem and similar ones. With this software we could solve questions like: What would be an optimal solution for the german students and universities?

Add more questions

## 1.3 Structure

The seconds chapter deals with the theory overview and background of the double sided matching problem. We will take a closer look at the Gale and Shapley Algorithm and what this has to do with game theory.

The third chapter descripes our prototype, which implements the previous discussed theory into practice.

In the fourth chapter we use data from Austria with our prototype to make an statment over the college applications.

rework shortly before we are finished, because structure changes most time

add dynamic linking to chapters

Chaper five deals deals with the labor market in the european union. Our prototype will get this data and we will discuss the results of it.

In the summary we will sum up the important findings and compare the outputs of our prototype.

# 2 Theory

## 2.1 The Double Sided Matching Problem

Clemens & Flo will be here!

The double sided matching problem...

The stable matching problem refers to the problem of finding a matching between two sets of elements which may be equally sized. In [1, p. 9] this problem is firstly described based on an example of college admission: a college is considering a set of $n$ applicants of which it can admin only a quota of $q$.

The assignment of students and colleges is not allowed to be unstable, i.e. there are two applicants $\alpha$ and $\beta$ who are assigned to colleges $A$ and $B$ although $\beta$ prefers $A$ to $B$ and $A$ prefers $\alpha$ to $\beta$. If this does not occur, the assignment is called *stable*. In case there is more than one stable solution the *optimal* one is of particular interest. In the previously mentioned college example a stable assignment is called *optimal* if every applicant is at least well off as it would be under any other stable assignment [1, p. 10]. In Economics this is also known as pareto efficiency [2, p. 46].

## 2.2 Gale and Shapley Algorithm

Clemens & Flo will be here!

## 2.3 Relevance to Game Theory

...work in progress...

### 2.3.1 General

"Game theory is about what happens when people - or genes, or nations - interact". An important aspect for participating parties is to anticipate how the opposite party will react on certain actions. Mathematics shall help to analyze,

understand and estimate outcomes of such games. Depending on the information participants have, they choose how to act basing on rules contained in their strategy. Game theory is widely applied in economics. Companies use game theory to estimate e.g. reactions of competitors or behavior of employees. The major advantages of game theory are its precision and that it can be applied to analyze all kind of games. [3, p. 1ff]

In addition there are some assumptions which are made during preparation and execution by every individual who are interacting together [4]

- Well-specified choices
- Well-defined end-state
- Specified payoff
- Perfect knowledge
- Rationality

These perfect preconditions will never be met in real scenarios. But furthermore, as a consequence of these listed assumptions above, there are two different kind of games:

- Static ones and
- Dynamic ones

The two items can be combined with the following kind of knowledge

- Incomplete
- Complete

### 2.3.2 Economic Applications

### 2.3.3 Double Sided Matching Problem and Game Theory

Like described in chapter XXX, the goal of the three main problems, which will be simulated in the course of this project, is to bring two different parties together.

However, a requirement is that the matching of these parties is stable. In the original marriage problem discussed by Shapley the goal was to match men and women so the overall situation is stable. Stability in this case means that these men and women are in a better situation after the matching than they were before alone. This idea can also be expanded to other areas like the labour market or university applications. In each of these three problems the parties need to have a strategy how to react to moves of the counterparty. If, for example, a university offers a place to a student and this is not the student's favorite university, he/she has to decide whether to accept the place (to be on the safe side) or still hope to get accepted from the favorite university (and maybe accept to be on the waiting list there). Not only the student needs to have a strategy how to deal with these situations but also universities have to incorporate different reactions of students into their application process (e.g. how many students will be invited) [1].

An important aspect Roth and Sotomayor mention is, that the rules of the game/matching have to be clear. The way agents are matched to each other influences the analysis of the problem. A possible rule might be that individuals like a student and university are only brought together if both parties agree to the matching. Other rules of a game might be the way one individual proposes to another, whether there exists a moderating individual and many more [5, p. 492].

# 3 Prototype

## 3.1 Subsection

Text...

# 4 Prototype Evaluation: College Applications in Austria

## 4.1 Subsection

Text...

# 5 Prototype Evaluation: Labor Market in the European Union

## 5.1 Subsection

Text...

# 6 Summary

## 6.1 Subsection

Text...

# 7 Example

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$$\begin{aligned}(x+y)^3 &= (x+y)^2(x+y)\\ &= (x^2+2xy+y^2)(x+y)\\ &= (x^3+2x^2y+xy^2)+(x^2y+2xy^2+y^3)\\ &= x^3+3x^2y+3xy^2+y^3\end{aligned} \tag{7.1}$$

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Figure 7.1: One angry bird.

## 7.1 Heading on level 2 (subsection)

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$$A = \begin{bmatrix} A_{11} & A_{21} \\ A_{21} & A_{22} \end{bmatrix} \tag{7.2}$$

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### 7.1.1 Heading on level 3 (subsubsection)

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## 7.2 Example for list (3*itemize)

- First item in a list
  - First item in a list
    - First item in a list
    - Second item in a list
  - Second item in a list
- Second item in a list

### 7.3 Example for list (enumerate)

1. First item in a list
2. Second item in a list
3. Third item in a list

## List of Figures

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## References


[1] D. Gale and L. S. Shapley. College admissions and the stability of marriage. *The American Mathematical Monthly*, 69(1):9–15, 1962.

[2] Nicholas Barr. *Economics of the Welfare State*. Oxford University Press, 2012.

[3] Colin Camerer. *Behavioral game theory: Experiments in strategic interaction*. Princeton University Press, 2003.

[4] Robert Gibbons. An introduction to applicable game theory. *The Journal of Economic Perspectives*, 11:127–149, 1997.

[5] Alvin E Roth and Marilda A Oliveira Sotomayor. *Two-sided matching: A study in game-theoretic modeling and analysis*. Number 18. Cambridge University Press, 1992.