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Representing Roommates' Preferences with Symmetric Utilities

José Alvaro Rodrigues Neto*

Abstract

In the context of the stable roommates problem, it is shown that acyclicity of preferences is equivalent to the existence of symmetric utility functions, i.e. the utility of agent i when matched with j is the same as j's utility when matched with i.

Keywords: roommates, stable matching.

JEL Classification: C78.

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1 Introduction

In 1962 David Gale and Lloyd Shapley published the seminal article "College Admissions and the Stability of Marriage", where they defined and discussed the stable marriage, college admissions, and stable roommates problems. They showed that for all instances (i.e. for any preference profile) of the stable marriage or the college admissions problems there is at least one stable matching, but that is not the case for the roommates problem.

This paper revisits the roommates problem. There are an even number of male students to be matched. We prove that preferences are acyclic if and only if they are representable by symmetric utilities, i.e. by symmetric functions $u(\cdot,\cdot) : A \times A \to \mathbb{R}$, where $u(i, j)$ is the utility of agent $i \in A$ when he matched with $j \in A$. Symmetric utilities mean that for any i and j, agent i's utility when matched with j is the same as j's utility when matched with i.[1] One possible interpretation for symmetric utilities is that they come from the production of some concrete good (or *numeraire*). This is a reasonable way to model many situations in economics, so our symmetry condition sheds new light on this old problem. For an example where acyclicity arises naturally, consider the case when everybody agrees on the relative order of all agents, except possibly for themselves.

Why are we interested in acyclicity? Instances of the roommates problem that contain no cycle of odd size will always have at least one stable matching. Acyclic instances, with neither odd nor even size cycles, have a unique stable matching.[2]

Irving (1985) was the first to describe an algorithm that tells when a given instance of the roommates problem has a stable matching. Acyclicity is strictly stronger than Chung's (2000) "no odd rings" condition, which itself is strictly stronger than Tan's (1991) necessary and sufficient condition for the existence of

[1] The proofs here do not make use of the traditional deference-acceptance algorithm created by Gale and Shapley.

[2] Chung (2000) proved that instances with no odd cycles have at least one stable matching. On the other hand, a standard argument says that if there were two distinct stable matchings then a even cycle could be constructed. Therefore, if there are no cycles at all, we have the existence and uniqueness result. I thank a referee for pointing this out.

a stable matching.[3] Under our stronger hypothesis, one has the advantage of having uniqueness and a *simple procedure* to find the stable matching.[4] The price for this additional structure is the loss in generality; the benefit is greater intuition and a sharper prediction of the outcome.

2 The Roommates Model

Let n be a strictly positive integer. Let $A = \{1, 2, \cdots, n\}$ be the set of agents in a given population. It will be assumed that each agent $i \in A$ has his own (strict) preferences, denoted $\underset{i}{\succ}$, about his potential partners. Formally, $\underset{i}{\succ}$ is a complete, anti-symmetric and transitive relation over the set A.

A **matching** is any function $\mu : A \longrightarrow A$ such that $\forall i \in A$, $i = \mu(\mu(i))$. The interpretation is that $\mu(i)$ represents the partner (or match) of agent i, according to the matching μ. An agent i is said to be alone if and only if $i = \mu(i)$.

Agent i is said to **block** matching μ if he prefers to be alone rather than to be matched with his current partner $\mu(i)$. Formally, $i \underset{i}{\succ} \mu(i)$. A pair of distinct agents i, j, not matched with each other under the matching μ, is said to **block** μ if i prefers j to his current match $\mu(i)$, and j prefers i to his current partner $\mu(j)$, that is: $j \underset{i}{\succ} \mu(i)$ and $i \underset{j}{\succ} \mu(j)$. A matching is **stable** if it is not blocked (neither by a single agent, nor by a pair of distinct agents).[5]

An **instance** $\Im$ of the stable roommates problem is characterized by a specific preference profile: $\Im = \left(\underset{1}{\prec}, \ \underset{2}{\prec}, \ \cdots, \ \underset{n}{\prec}\right)$. The stable roommates problem (or just the roommates problem) is to find a stable matching in a given instance. A

[3] Our study is related to Chung (2000). He has a similar (but weaker) condition on preferences, named "no odd rings", that is sufficient for the existence of a stable matching. However, he does not provide a representation result. He is also not concerned about the uniqueness of stable matching assignments. On the other hand, he is able to work in a more general framework, by considering weak preferences (here all preferences are strict). Finally, Chung presents some applications to social choice that we will not cover.

[4] Under acyclic preferences there is simple algorithm to find the unique stable matching. Let $(i, j) \in \arg\max \{u(i, j) \mid (i, j) \in A \times A\}$. Match i with j and remove them from the population. Then repeat the procedure with the remaining population. Because A is finite this procedures eventually ends, and it is easy to verify that it generates the unique stable matching.

[5] The concept of stability coincides with the concept of core (by definition a matching is in the core if and only if there is no blocking coalition of any size).

particular instance $\Im$ is said to be a **stable** if the corresponding roommates problem has at least one solution, that is, if there is at least one stable matching. Otherwise $\Im$ is said to be an **unstable** instance. It is well known that there are stable and unstable instances.

The existence of cycles is a key element to the study of stability. A **cycle** of size k is an ordered subset of agents $(i(1), i(2), \cdots, i(k))$, with $k \geq 3$ and $i(j) \neq i(j+1)$, $\forall j \in \{1, \cdots, k-1\}$, such that:

$$i(1) \underset{i(2)}{\prec} i(3);\ i(2) \underset{i(3)}{\prec} i(4);\ \cdots;\ i(k-1) \underset{i(k)}{\prec} i(1);\ i(k) \underset{i(1)}{\prec} i(2)$$

A cycle is said to be even (odd) if and only if k is even (odd). An instance of the roommates problem that has no cycle is called **acyclic** (equivalently we refer to acyclic preferences).

Example 1 *Figures 1 and 2 show respectively cycles of size six and five. An arrow numbered x from box i to box j means that agent x prefers to be matched with j than with i, that is, $i \underset{x}{\prec} j$. One may observe that cycles of even size are represented by graphs with two connected components, but cycles of odd size have a representation with only one connected component.*

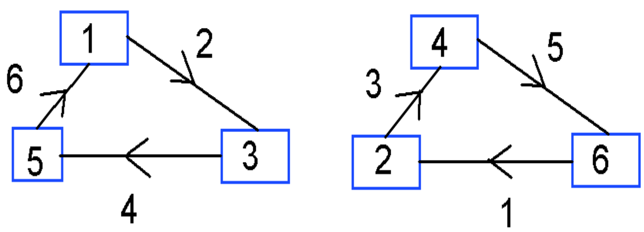

Figure 1: cycle (1, 2, 3, 4, 5, 6).

In figure 1 the left connected component (odd numbers inside the boxes) represents: $1 \underset{2}{\prec} 3$; $3 \underset{4}{\prec} 5$; $5 \underset{6}{\prec} 1$. The connected component on the right represents: $2 \underset{3}{\prec} 4$; $4 \underset{5}{\prec} 6$; $6 \underset{1}{\prec} 2$. Figure 2 represents: $5 \underset{1}{\prec} 2$; $1 \underset{2}{\prec} 3$; $2 \underset{3}{\prec} 4$; $3 \underset{4}{\prec} 5$; $4 \underset{5}{\prec} 1$.

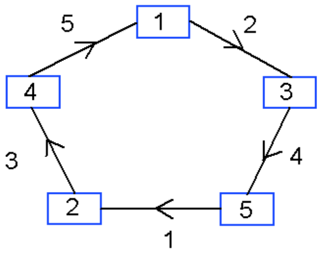

Figure 2: cycle (1, 2, 3, 4, 5).

Acyclic instances of the roommates problem will always have a unique stable matching.

3 Representation of Acyclic Preferences

Now we will study a class of utility functions that represent acyclic preferences. Let $u(\cdot,\cdot) : A^2 \to \mathbb{R}$ be a function with the interpretation that $u(i,j)$ is the utility of agent i when he is matched with agent j. This function represents agents' preferences if and only if $u(i,j) < u(i,l) \Leftrightarrow j \underset{i}{\prec} l$, $\forall i,j,l \in A$. One may always represent the preferences of the agents by some utility function because the population A is finite. Moreover, if $h : \mathbb{R} \to \mathbb{R}$ is any strictly increasing function then $h(u(\cdot,\cdot)) : A^2 \to \mathbb{R}$ also represents the same preferences.

An instance of the roommates problem is said to satisfy the **symmetric utilities hypothesis** if there exist a *symmetric* function $u(\cdot,\cdot) : A^2 \to \mathbb{R}$ representing agents' preferences, that is, $u(i,j) = u(j,i)$, $\forall\, i,j \in A$. As an example of symmetric utilities, one can image a set A of risk neutral salespersons that work in pairs or alone. The utility of vendors forming a match is the expected commission they will make (and share in equal parts) by working together. The symmetric utilities hypothesis says that vendors have the same sales expectations about working together.

The symmetric utility hypothesis restricts the feasible instances of the roommates problem. For instance, if we consider three agents, $A = \{1,2,3\}$, with preferences such that $2 \underset{1}{\prec} 3$, $3 \underset{2}{\prec} 1$, and $1 \underset{3}{\prec} 2$ then it is not possible to have *symmetric* utilities representing preferences. Suppose to the contrary they do. Then, $2 \underset{1}{\prec} 3 \Rightarrow u(1,2) < u(1,3)$; $3 \underset{2}{\prec} 1 \Rightarrow u(2,3) < u(2,1)$; and $1 \underset{3}{\prec} 2 \Rightarrow u(3,1) < u(3,2)$, but this is **not** possible under the symmetric utility hypothesis, because $u(1,2) < u(1,3) = u(3,1) < u(3,2) = u(2,3) < u(2,1) = u(1,2)$ is clearly a contradiction.

Next, we show that acyclic preferences correspond to instances that admit symmetric utilities and vice-versa.

Proposition 1 *(Representing Acyclic Preferences with Symmetric Utilities)*

(i) If an instance $\Im$ of the roommates problem has acyclic preferences then there exist symmetric utility functions $u(\cdot,\cdot) : A^2 \to \mathbb{R}$, representing the agents' preferences, i.e. $\Im$ satisfies the symmetric utility hypothesis. (ii) Conversely, if agents' preferences given by an instance $\Im$ can be represented by symmetric utility functions $u(\cdot,\cdot) : A^2 \to \mathbb{R}$, then $\Im$ is acyclic.

Proof. (i) Some additional notation is needed. Define the relation $\sim$ in A^2 by: $(i,j) \sim (k,l) \Leftrightarrow (i,j) = (k,l)$ or $(i,j) = (l,k)$. The relation $\sim$ is an equivalence[6] relation on the set A^2.

We provide a quotient structure on A^2. Let $[(i,j)] = \{(k,l) \in A^2 \mid (k,l) \sim (i,j)\}$. Let $A^2/\sim$ denote the set of equivalence classes, that is, $A^2/\sim = \{[(i,j)] \mid (i,j) \in A^2\}$. The set $A^2/\sim$ is similar to the Cartesian product A^2. The only difference is that in $A^2/\sim$ the relative order of the coordinates does not matter. A typical element of $A^2/\sim$ will be called a **point** and denoted by $[i,j]$.

A **path** connects $[i,j]$ to $[k,l]$ if for some integer $p \geq 1$ there is a finite sequence of points $[i,j] = [x_0,y_0]$, $[x_1,y_1]$, $[x_2,y_2]$, $\cdots$, $[x_p,y_p] = [k,l]$, such that $\forall s \in \{0,1,\cdots,p-1\}$ we have $\left(x_s = x_{s+1} \text{ and } y_s \underset{x_s}{\prec} y_{s+1}\right)$ or $\left(y_s = y_{s+1} \text{ and } x_s \underset{y_s}{\prec} x_{s+1}\right)$. The point $[i,j] = [x_0,y_0]$ is called the beginning of the path, and $[k,l] = [x_p,y_p]$ is called its end point. A relation (which turns out to be a partial strict order) $<$ can then be defined in $A^2/\sim$ by: $[i,j] < [k,l]$ if and only if there exists path connecting $[i,j]$ to $[k,l]$.

It should be observed that the composition of two paths is still a path whenever the end point of one coincides with the beginning of the other. This means that

[6] Reflexive, symmetric and transitive.

the relation $<$ is transitive. We show that it is a partial strict order, for which it is enough to show that $<$ is irreflexive.

A path is said to be **closed** if and only if its beginning point and its end point coincide. If $x_s = x_{s+1}$, $y_s \underset{x_s}{\prec} y_{s+1}$, $y_{s+1} = y_{s+2}$ and $x_{s+1} \underset{y_{s+1}}{\prec} x_{s+2}$ then we say that the path **changes its base point** at $[x_{s+1}, y_{s+1}]$. If there exists any closed path, then we can obtain a cycle by looking at the path points that changed their base. In other words, from any closed path we can extract a cycle. But by assumption there is no cycle. Therefore, there are no closed paths in acyclic instances. This means that the relation $<$ is irreflexive. Hence, this relation is a partial strict order in $A^2/\sim$. The weak order $\leq$ is defined as usual: $[i,j] \leq [k,l] \Leftrightarrow [i,j] < [k,l]$, or $[i,j] = [k,l]$.

Given an acyclic instance $\Im$ of the roommates problem, we consider a Hasse diagram of the associated ordered set, drawn on a cartesian plane.[7] Then, we define $\phi(i,j) = u(i,j) = u(j,i)$ to be the vertical coordinate of $[i,j]$ in the diagram. If there is a path connecting $[i,j]$ to $[k,l]$ then $[i,j] < [k,l]$ and this implies that $\phi(i,j) < \phi(k,l)$.

Now fix agents i, j and l. Then, $\phi(i,j) < \phi(i,l)$ if and only if there is a path $[i, j(1)]$, $[i, j(2)]$, $\cdots$, $[i, j(k)]$, with $k \geq 2$, such that $j = j(1)$ and $j(k) = l$. But that is the case if and only if

$$j = j(1) \underset{i}{\prec} j(2);\; j(2) \underset{i}{\prec} j(3);\; \cdots;\; j(k-1) \underset{i}{\prec} j(k) = l \tag{1}$$

which means that $j \underset{i}{\prec} l$. Conversely, if $j \underset{i}{\prec} l$, (1) holds and then $\phi(i,j) < \phi(i,l)$. So, ϕ is symmetric and represents the agents' preferences. This proves this result.

One may note that there may exist some room for arbitrariness in the assignment of the locations (values) of our $\phi(i,j)$. That is not a problem; it reflects the fact that the representation is not unique.

[7]See Davey and Priestley (2002) for details on ordered sets and Hasse diagrams. In particular, see Lemma 1.17 and Proposition 1.18. Alternatively, we could complete this proof by defining $B = A^2/\sim$, and assigning consecutive integer values for the utilities of random draws among minimal points of B. After each assignment, the corresponding point would be removed from B. This potentially creates new minimal points of the remaining partially ordered set. Because $A^2/\sim$ has finite elements, our procedure ends.

(ii) Let $\Im$ be a fixed instance of the roommates problem such that there are utility functions $u(\cdot,\cdot) : A^2 \to \mathbb{R}$, representing agents preferences in $\Im$, with $u(i,j) = u(j,i)$, $\forall i,j \in A$. Suppose that acyclicity does not hold. So, there will exist a cycle $(i(1), i(2), \cdots, i(k))$ of size k, with $3 \leq k \leq n$, that is:

$$i(k) \underset{i(1)}{\prec} i(2);\ i(1) \underset{i(2)}{\prec} i(3); \cdots;\ i(k-2) \underset{i(k-1)}{\prec} i(k);\ i(k-1) \underset{i(k)}{\prec} i(1)$$

Therefore

$$u(i(1), i(k)) < u(i(1), i(2)) = u(i(2), i(1)) < u(i(2), i(3)) = u(i(3), i(2)) < \cdots$$

$$\cdots < u(i(k-1), i(k)) = u(i(k), i(k-1)) < u(i(k), i(1)) = u(i(1), i(k))$$

The equalities hold by the assumption of symmetric utilities. But $u(i(1), i(k)) < u(i(1), i(k))$ is obviously a contradiction, proving part (ii) of this proposition. ■

References

[1] K.S. Chung, On the Existence of Stable Roommate Matchings, *Games Econ. Behav.* 33 (2000), 206-230.

[2] B.A. Davey, H.A. Priestley, Introduction to Lattices and Order, Second Edition, Cambridge University Press, 2002.

[3] D. Gale, L. Shapley, College Admissions and the Stability of Marriage, *Amer. Math. Monthly* 69 (1962), 9-15.

[4] R.W. Irving, An Efficient Algorithm for the Stable Room-mates Problem, *J. Algorithms 6* (1985), 577-595.

[5] J.J.M. Tan, A Necessary and Sufficient Condition for the Existence of a Complete Stable Matching, *J. Algorithms* 12 (1991), 154-178.

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