How (rationally) agents behave when they look for a partner: Experimental results

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Abstract

In this work, we use the experimental method to study agents decentralized decision-making in roommate markets in order to form a finite sequence of (myopic) blocking pairs to a stable matching. By using the approach by Haruvy and Ünver [6], we describe the problem as a repeated roommate market and analyze the convergence outcomes of this process under different information scenarios.

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1 Introduction

A roommate market, introduced by Gale and Shapley [5], consists of a (finite) set of agents, each of whom ranks all others in the set (including herself) according to her preferences. Each agent is allowed to form at most one partnership. Actual examples of roommate markets include roommates at university, partners in a science lab and chess players, among others. Conventionally, a solution for these markets is a stable matching, that is, a matching such that no pair of agents prefer each other to their current partner.

Several papers study the theoretical conditions under which a finite sequence of blocking pairs to a stable matching exists in roommate markets in the absence of a centralized procedure. See for instance Chung [1], Diamantoudi *et al.* [2] and Iñarra *et al.* [7]. The aim of this work is to use the experimental method to study agents' decentralized decision-making to form this blocking path.

Very few experiments on decentralized matching markets have been carried out and most of them focus on two-sided matching markets. Ünver [9] compares a decentralized two-sided market with various centralized market mechanisms in the laboratory, Haruvy and Ünver [6] report an experiment to study whether the deferred-acceptance algorithm, introduced by Gale and Shapley [5], is a good predictor for repeated matching markets under different information environments. As far as we know, the only paper analyzing decentralized roommate markets is that of Eriksson and Strimling [3], who are interested in how the size of the market and the preference structure influence the outcome of a matching process. Their purpose is therefore different from ours.

The experimental treatments we study in this work are based on those by Haruvy and Ünver [6], who consider repeated matching markets as a description of dynamic reaction by myopic agents in a decentralized environment. We define a simple proposal-acceptance mechanism to induce agents to form blocking pairs and obtain a sequence of matchings. In each period, the set of agents is split into a set of proposers and a set of responders. Each proposer can make a single offer and each responder can accept a single offer per period. These matching decisions are repeated several times, but the role of each agent may change from one period to another. The information that participants receive varies from one session to the next. First we implement a low information environment where agents only know their own preferences. Later, we implement a high information scenario where agents know the preferences of all participants. We find that in both treatments a stable matching is always reached but agents abandon it because of isolated deviations.

The rest of the paper is organized as follows. Section 2 presents the roommate problem. In Section 3 we describe the design of the experiment and the negotiation process implemented in the experimental laboratory. The main empirical findings are presented in Section 4, and Section 5 concludes with pointers for further research. The translation of the instructions used in the experiment and some tables are relegated to the Appendices.

2 Theoretical results

The *roommate problem* (Gale and Shapley, [5]) is defined by a set of agents who must be divided into pairs. Each agent is assumed to have strict preferences over the other agents in the set and the prospect of remaining single. Formally, a *roommate problem* is a pair $(N, (\succ_x)_{x \in N})$ where N is a finite set of agents and for each agent $x \in N$, $\succ_x$ is a complete, transitive and strict preference relation defined over N.

An outcome of this problem is a matching, *i.e.*, a partition of the set of agents into pairs and singletons. A matching is unstable if there is a pair of agents (not necessarily distinct) who prefer each other to their partners under the matching. This pair of agents is called a blocking pair. Formally, a *matching* μ is a one-to-one mapping from N onto itself such that for all $x, y \in N$ if $\mu(x) = y$ then $\mu(y) = x$, where $\mu(x)$ denotes the partner of agent x under the matching μ. If $\mu(x) = x$, then agent x is single under μ. A pair of agents $\{x, y\} \subseteq N$ (possibly $x = y$) is a *blocking pair* of the matching μ if

$$y \succ_x \mu(x) \text{ and } x \succ_y \mu(y). \tag{1}$$

That is, x and y prefer each other to their current partners in μ. If $x = y$, (1) means that agent x prefers being alone to being matched with $\mu(x)$.

One matching is obtained from another by satisfying a blocking pair as follows. In the new matching the agents in the blocking pair are matched to each other, their partners under the previous matching are unmatched and all other agents are matched to the same partners. Formally, let $\{x, y\}$ be a blocking pair of μ. A matching μ' is obtained from μ by *satisfying* $\{x, y\}$ if $\mu'(x) = y$ and for all $z \in N \backslash \{x, y\}$,

$$\mu'(z) = \begin{cases} z & \text{if } \mu(z) \in \{x, y\} \\ \mu(z) & \text{otherwise.} \end{cases}$$

That is, once $\{x, y\}$ is formed, their partners (if any) under μ are alone in μ', while the remaining agents are matched as in μ.

A matching is called *stable* if it is not blocked by any pair of agents. Gale and Shapley [5] show by using an example that a roommate problem can have no stable matchings. In this experiment, we consider a roommate problem which has multiple stable matchings from an empirical point of view.

In this work, we define a decentralized roommate market as a finitely repeated matching game. In order to implement this market in the lab, we define the following simple proposal-acceptance mechanism:

Let agents be matched under a matching μ,

Stage 1 The set of agents is randomly divided into proposers and responders. Let n be the number of agents. If n is even, then there will be $\frac{n}{2}$ proposers and $\frac{n}{2}$ responders. If n is odd, then there will be $\frac{n-1}{2}$ proposers and $\frac{n+1}{2}$ responders. (In the laboratory, the computer randomly assigned the role of proposer to 3 subjects in each group, in each round. The remaining 4 members of the group were responders.)

Stage 2 Each proposer decides between making an offer to at most one responder or making no offers. (In the laboratory, proposers made their decisions simultaneously.)

Stage 3 Each responder decides between accepting at most one of the offers received or rejecting all of them. (In the laboratory, responders made their decisions simultaneously.)

If this game is repeated a finite number of times, a sequence of matchings is obtained. Moreover, another feature of this repeated matching game is that agents can change their role from one period to the next. Otherwise, it would become a two-sided matching market and the set of stable matchings may change from the original one.

Given the game defined above, consider the following repeated game strategy: at the beginning of a period, if an agents is selected as proposer, he myopically makes an offer to his highest ranked responder (if this is better than his current partner) and if he is selected as responder, he myopically accepts best offer. In the market that we have implemented in the laboratory, this strategy profile will result in a stable matching.

3 Experimental design

We recruited 56 subjects at a computer lab through announcements posted across the Campus of the Universidad del País Vasco in Bilbao, Spain. They were informed that they would participate in a paid experiment on decision-making. The experiment was programmed and conducted with the software z-Tree (Fischbacher, [4]). Two sessions took place, one in April 2008 with 28 participants, and the other in June 2008 with 28 participants different from the previous session. We implemented one treatment (session 1) with a low information environment, and the other (session 2) with a high information environment. At the beginning of each session, printed instructions were given to subjects and were read aloud to the entire room. These instructions explained all the rules determining the resulting payoff for each participant. They were written in Spanish, contained a numerical example to illustrate how the program worked, and presented pictures of each screen. The English translation of the instructions, without pictures, can be found in the Appendix A.

Each session consisted of two practice periods and 25 paying rounds, which lasted around 60 minutes. At the beginning of the experiment the computer randomly assigned subjects to groups of 7. We used anonymous partner matching, *i.e.* participants were not informed about who the other members of their group were, but they did know that groups were fixed throughout the session. Subjects were not allowed to communicate with each other, the only information given to them in this respect was the size of the group. In each round, subjects were asked to make private decisions about forming couples with other members of their group.

Subjects' preferences were induced by the monetary payoff that they earned depending on who their partner was at the end of each round. These preferences were similar across subjects: every subject got 70 experimental currency units (ECU) for the top choice, 60 for the second choice, etc. The last choice of staying alone was worth 10. We implemented the same numerical example of a roommate problem with 3 stable matchings in the two sessions. The sessions differed in the information that participants had about one another's preferences. In the low information treatment preferences constituted private information, participants knew only their own payoff tables and the only information that we gave them about the others was that "they are similar".[1] In the high information treatment participants received a sheet with all others' payoff tables but they were not informed about which matchings were stable.

At the end of each session, subjects were paid individually and confidentially. In addition to the five-euro show-up fee, subjects earned an average of 7.02 Euros. The final individual payoff ranged from 7.05 to 16.76 Euros with a standard deviation of 2.03.

[1] We did not specify any probability distribution or upper and lower limits for the others' valuations in the low information treatment.

4 Experimental results

In this section we present some results about participants' behavior in the negotiation process to form the sequence of blocking pairs leading to a stable matching. To that end we analyze individual proposals and acceptance decisions considering incomplete and complete information, separately.

As we have mentioned in Section 2, under the preference profile implemented in he lab agents reach a stable matching if they behave myopically by applying the strategy of making (accepting) an offer[2] to (from) the highest ranked available agent.

Table 1: Participants' decisions.

a. Proposers

	low information	high information
highest ranked	0.586	0.473
non-highest ranked	0.368	0.271
total	0.954	0.744

b. Responders

	low information	high information
highest ranked	0.864	0.833
non-highest ranked	0.064	0.013
total	0.928	0.846

Table 1a shows proposers' decisions. In this table, the first row represents the proportion of proposers who apply the strategy of making an offer to their highest ranked available agent (if this is preferred to their current partner) and the second row represents the proportion of proposers who do not apply this strategy but they make a proposal to improve on their status quo. We observe that most proposers' behavior is consistent with this strategy, and in general, those who do not apply it make proposals with the aim of improving on their status quo, in both treatments. However, this table also shows that when agents know others' preferences, the proportion of agents who make a proposal to an agent who is less preferred than her current partner is greater than when agents do not have any information.

[2]We consider as an offer (response) the fact that a participant with the right to offer (accept a proposal) decides not to do so and stick with the status quo.

Table 1b shows that a significant proportion of responders' decisions are also consistent with the strategy of accepting the highest ranked agent who has made an offer. The first row of this table represents the proportion of responders who accept the best possible proposal received and the second row gives the proportion of agents who do not choose the best one, but who accept a proposal which allows them to improve with respect to their status quo. In the low information environment the vast majority decide to accept the best possible proposal. In the case of high information, most agents also react in this way, but the proportion is somewhat smaller than in the other case.

Therefore, we can conclude that in the laboratory most proposers and responders make decisions in order to make a bilateral agreement to form a blocking pair and both obtain improvements on their status quo, especially in the treatment with low information.

In what follows we examine what the converged outcomes are.[3] According to the fact that most proposers send offers to those agents who are more preferred than their current partners and these offers are accepted only if the responder also obtains an improvement, we would expect that once a stable matching is reached all further proposals are rejected and it is never abandoned in the proposal-acceptance mechanism.

All groups under both treatments found a stable matching through the bilateral negotiation process established by our experimental design. Tables 4 and 5 in Appendix B give a detailed overview of our results by presenting the trend over time for matchings. Starting from a situation in which everybody is alone, all groups reach a stable matching, and all of them, in both treatments, abandon that stable matching at least once.

Lastly, we look closer at those periods in which agents achieve a stable matching in order to see why they abandon it. Table 2a reports data on proposals made immediately after reaching a stable matching. We observe that agents behave as in the general case in both treatments. Therefore, stable matchings are abandoned because of a small proportion of agents (greater in the treatment with high information) who make proposals which make them get worse respect to their status quo. Table 2b shows reactions made immediately after reaching a stable matching. Since most proposers do not make offers there is only a small number of reactions, especially in

[3]Haruvy and Ünver [6] define two concepts of convergence. They define a strong convergence if at least 6 out of the last 10 periods of the profile are a particular stable matching. They define a weak convergence if at least 3 periods are a particular outcome and the majority of the remaining in the last 10 periods have at most one agent deviating from this matching.

the low information treatment. Responders' behavior is similar to proposers' behavior, although in this case there is no difference between both treatments.

Table 2: Participants' behavior immediately after reaching a stable matching.

a. Proposers

	low information	high information
full rationality	0.635	0.476
bounded rationality	0.301	0.286
total	0.936	0.762

b. Responders

	low information	high information
full rationality	0.823	0.727
bounded rationality	0.000	0.119
total	0.823	0.846

To sum up, we conclude that agents behave as theory expects by making decisions in order to find a partner who makes them improve on their status quo. However, we also observe that a small number of deviations from this behavior is enough to break stability once it has been achieved.

5 Concluding remarks and further research

As mentioned above this work seeks to test agents' behavior in decentralized matching markets. Nevertheless, this analysis and the results should be considered as preliminary. We have shown that the vast majority of agents behave as theory predicts under different levels of information, although a small proportion of agents make decisions which make them get worse respect to the current matching, especially when agents know others' preferences, which affects to stability. Moreover, we have observed that agents do not always seek to maximize their payoffs, but they try to obtain a partner to improve on their status quo who is not their best available one.

These two remarkable observations call for investigation into their causes. Regarding the greater proportion of agents who do not behave as expected in the case of high information, a potential reason for this difference may be that agents take into account how they are appreciated by other participants before making a decision to propose or accept. Regarding the existence of agents who do not maximize their payoffs, several causes may be discussed. On the one hand, agents may learn from one period to the next and they decide not to propose or accept to their most preferred choice after suffering a number of rejections or desertions. On the other hand, some agents may be considered as risk averse. In this case they may prefer to obtain a partner to assure some payoff although this is not their favorite one.

One possible course of action to study the conjectures above lies in doing some logistical regressions to determine which variables can explain the results above.

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Appendix A: Instructions

The purpose of this experiment is to study how people make decisions in a particular situation. If you have any question, you can pose it at any time by raising your hand first. From this moment until the end of the session any communication among participants is forbidden.[4]

The instructions are simple and if you follow them carefully you will receive some money in cash by the end of the experiment. The money that you earn partly depends on your decisions, but also on the decisions of the other members in your group. At the end of the session, payments will be made confidentially, so no one will receive information about the earnings of the other participants.

General instructions

This session consists of 2 practice rounds and 50 paying rounds that will determine your final payoff. At the beginning, the computer will randomly assign the participants into groups of seven. This assignment will last for the entire session, but nobody will know the identity of the other members of his/her group. Before the first round, you will be randomly assigned an identification number from 1 to 7 and a payoff table that shows your earnings in experimental currency units (ECU) at the end of each round depending on who is your partner. These two parameters will not change up to round 25, then a new identification number and a new payoff table will be assigned to every participant. These will remain until the end of the experiment. Your task in each round is to match with another member of your group. If you want you also have the option of staying alone. Let's see how you can form a couple in this experiment.

At the beginning of each round, the computer will assign randomly the role of "proposer" to three of the players and the role of "responder" to the other four. Therefore your role can change in each round. If you are a proposer, you will have to decide about offering somebody to be your partner, while if you are a responder, you will have to decide about accepting a received proposal. Each participants can have at most one partner in each round. Therefore, if you accept a proposal or your proposal is accepted, you will abandon your current partner.

In each round, first proposers will have to make their decisions privately and simultaneously. Then it will be the responders' turn who also act pri-

[4]We used these instructions in the low information treatment. In the high information treatment subjects received a sheet with the payoff tables of all participants.

vately and simultaneously. The moment you have to make a decision the following data will appear on the screen:

- On the top of the screen you find your identification number, the identification number of your current couple and the payoff that you can obtain by maintaining actual situation.
- On the left side two tables appear. One of them shows the current matching of people in your group. If a participant is matched with herself/himself it means that she/he is alone. The other table shows a brief review of the previous rounds. You can check who was your couple and what payoff you earned in each round.
- On the right of the screen, a table shows you how much you can earn at the end of the round depending on who you are matched with. These earnings are expressed in ECUs and they will only change once after period 25. The other members of your group have similar valuations, but they constitute private information.

Proposer's instructions

Proposers are the first to make a decision in each round. Each proposer will have to decide between:

- Sending a proposal to one of the participants who are choosers.
- Not sending any proposal.

See an example of the screen for a proposer on page 3.

- Your identification number, your current partner's identification number and the payoff that you would obtain if you were (again) matched with your current partner at the end of the round appear on the top of the screen.
- Two tables appear on the left-hand side. The top one shows how agents are matched in the current round. In the example, each subject is matched with herself/himself, therefore all subjects are alone. The bottom one shows a summary of the previous rounds. In this table you can see who has been your partner/s and the earnings in each round until the current one.
- Your payoff table appears on the right-hand side. The other participants in your group have similar payoffs but it is private information.

- Some red buttons labeled as **Offer** appear on the right of the payoff table. Clicking one of them you will send a proposal to the respective participants. In our example, if you clicked the top red button you would send a proposal to member number 4 of your group. Additionally, a button appears at the bottom of the screen labeled as **Don't offer**. Clicking this button you do not send any proposal.

You have 30 seconds to make your decision. If the participant who receives your proposal accepts it he/she will be your partner in the following round, and you get the corresponding payoff. Otherwise, it depends on the decisions made by other participants whether you continue with the same partner as in the previous round or you are left alone, getting the corresponding payoff.

Responder's instructions

Once a responder has observed the proposals that have been set to him/her (there can be 3,2,1 or none), he/she will have to decide between:

- Accepting one of them.
- Not accepting any.

See an example of the screen for a responder on page 4.

- Your identification number, your current partner's identification number and the payoff that you would obtain if you were (again) matched with your current partner at the end of the round appear on the top of the screen.
- Two tables appear on the left-hand side. The top one shows how agents are matched in the current round. In the example, each subject is matched with herself/himself, therefore all subjects are alone. The bottom one shows a summary of the previous rounds. In this table you can see who has been your partner/s and the earnings in each round until the current one.
- Your payoff table appears on the right-hand side. The other members of your group have similar payoffs but this is private information.
- Some red buttons labeled **Accept** can appear on the right of the payoff table. Clicking one of them you can accept one of the received proposals. In our example, subject number 6 has got two proposals: one from 1 and one from 3. Clicking the top one he/she would accept

the proposal from 1. Additionally, a button appears in the bottom of the screen labeled **Leave**. Clicking this button you leave the round without accepting any proposal.

You have 30 seconds to make your decision. If you accept one of the received proposals, that proposer will be your partner in the following round, and you get the corresponding payoff. Otherwise, it depends on the decisions made by other participants whether you continue with the same partner as in the previous round or you are left alone, getting the corresponding payoff.

Payment

After all responders have made their decision a new round starts. The computer will show the current matching within your group and determine your payment taking into account who is your current partner. The earnings accumulated along the session will give you final payment. 200 ECU equals 1 Euro.

Appendix B: Tables

Table 3: Valuation matrix and stable matchings in treatments 1 and 2

	Partner						
Player	1	2	3	4	5	6	7
1	10	70	60	30	50	40	20
2	60	10	20	70	40	30	50
3	70	30	10	60	50	40	20
4	20	50	60	10	30	70	40
5	50	40	70	20	10	60	30
6	40	30	20	60	70	10	50
7	70	60	50	40	30	20	10

Stable matching 1: {{1,2},{3,4},{5,6},{7}}
Stable matching 2: {{1,2},{3,5},{4,6},{7}}
Stable matching 3: {{1,3},{2,4},{5,6},{7}}

Table 4: Evolutions of matchings per group in the low information treatment. Theoretically stable matchings in bold. Partner ID.

		Period																								
Group	Player	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	1	6	3	3	2	**2**	1	1	1	1	1	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2
1	2	4	4	4	1	**1**	4	4	4	2	4	4	2	4	4	4	4	2	2	6	2	6	6	6	1	1
1	3	5	1	1	6	**5**	5	5	5	5	5	1	1	1	1	1	1	1	1	1	1	1	1	1	3	7
1	4	2	2	2	4	**6**	2	2	2	6	2	2	6	2	2	2	2	6	6	4	4	4	4	4	4	6
1	5	3	5	7	7	**3**	3	3	3	3	3	5	7	7	7	7	7	7	7	7	6	5	5	5	7	5
1	6	1	6	6	3	**4**	6	6	6	4	6	6	4	6	6	6	6	4	4	2	5	2	2	2	6	4
1	7	7	7	5	5	**7**	7	7	7	7	7	7	5	5	5	5	5	5	5	5	7	7	7	7	5	3
2	1	7	3	3	1	3	1	6	6	6	3	3	3	3	**3**	3	3	3	3	3	3	3	3	3	3	3
2	2	2	2	5	5	7	7	4	7	4	7	7	7	7	**4**	2	7	7	7	7	7	7	7	7	7	7
2	3	4	1	1	4	1	5	5	5	5	1	1	1	1	**1**	1	1	1	1	1	1	1	1	1	1	1
2	4	3	6	6	3	5	4	2	4	2	4	4	4	4	**2**	6	6	4	4	6	6	6	6	6	6	6
2	5	5	5	2	2	4	3	3	3	3	6	6	6	6	**6**	5	5	6	6	5	5	5	5	5	5	5
2	6	6	4	4	6	6	6	1	1	1	5	5	5	5	**5**	4	4	5	5	4	4	4	4	4	4	4
2	7	1	7	7	7	2	2	7	2	7	2	2	2	2	**7**	7	2	2	2	2	2	2	2	2	2	2
3	1	5	5	1	**2**	1	1	**2**	2	1	7	**2**	2	2	2	2	2	2	2	1	7	7	7	7	7	7
3	2	4	4	2	**1**	4	2	**1**	1	4	2	**1**	1	1	1	1	1	1	1	4	4	4	2	2	2	2
3	3	3	3	4	**4**	3	4	**4**	5	5	4	**4**	3	3	3	3	3	3	5	5	5	5	5	5	5	5
3	4	2	2	3	**3**	2	3	**3**	4	2	3	**3**	7	7	7	7	7	7	7	2	2	2	6	6	6	6
3	5	1	1	6	**6**	6	6	**6**	3	3	5	**6**	6	6	6	6	6	6	3	3	3	3	3	3	3	3
3	6	6	7	5	**5**	5	5	**5**	6	6	6	**5**	5	5	5	5	5	5	6	6	6	6	4	4	4	4
3	7	7	6	7	**7**	7	7	**7**	7	7	1	**7**	4	4	4	4	4	4	4	7	1	1	1	1	1	1
4	1	5	**2**	2	2	2	2	2	1	1	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
4	2	2	**1**	1	1	1	1	1	4	2	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
4	3	4	**4**	3	3	7	7	7	7	4	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**
4	4	3	**3**	6	6	6	6	4	2	3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
4	5	1	**6**	5	5	5	5	6	6	6	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**
4	6	6	**5**	4	4	4	4	5	5	5	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**
4	7	7	**7**	7	7	3	3	3	3	7	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**

Table 5: Evolutions of matchings per group in the full information treatment. Theoretically stable matchings in bold. Partner ID.

		Period																								
Group	Player	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	1	7	1	3	5	1	1	1	5	3	3	2	**2**	2	2	1	1	2	2	1	5	**2**	5	2	**2**	5
1	2	6	7	7	7	7	5	5	2	7	7	1	**1**	1	1	4	2	1	1	4	2	**1**	2	1	**1**	2
1	3	5	4	1	3	3	3	4	3	1	1	3	**4**	4	3	3	5	3	3	5	4	**4**	4	4	**4**	4
1	4	4	3	6	6	4	6	3	6	6	6	6	**3**	3	6	2	7	7	7	2	3	**3**	3	3	**3**	3
1	5	3	6	5	1	6	2	2	1	5	5	5	**6**	7	7	6	3	6	6	3	1	**6**	1	5	**6**	1
1	6	2	5	4	4	5	4	7	4	4	4	4	**5**	6	4	5	6	5	5	6	7	**5**	6	6	**5**	6
1	7	1	2	2	2	2	7	6	7	2	2	7	**7**	5	5	7	4	4	4	7	6	**7**	7	7	**7**	7
2	1	6	2	3	5	5	**2**	2	3	1	1	2	1	1	2	3	1	2	1	3	1	2	3	1	**2**	1
2	2	2	1	2	7	7	**1**	1	4	7	7	1	7	7	1	7	4	1	7	7	7	1	2	2	**1**	7
2	3	4	4	1	3	4	**5**	4	1	5	4	4	4	3	4	1	5	4	3	1	4	3	1	4	**5**	4
2	4	3	3	4	6	3	**6**	3	2	6	3	3	3	6	3	6	2	3	6	4	3	6	6	3	**6**	3
2	5	5	5	6	1	1	**3**	5	5	3	5	5	6	5	5	5	3	5	5	6	6	5	7	7	**3**	5
2	6	1	6	5	4	6	**4**	6	7	4	6	6	5	4	6	4	6	7	4	5	5	4	4	6	**4**	6
2	7	7	7	7	2	2	**7**	7	6	2	2	7	2	2	7	2	7	6	2	2	2	7	5	5	**7**	2
3	1	7	3	2	**3**	**3**	1	5	2	1	2	3	3	3	2	1	3	2	**2**	1	7	7	2	5	**2**	3
3	2	4	2	1	**4**	**4**	2	4	1	4	1	2	2	2	1	7	7	1	**1**	4	2	2	1	2	**1**	2
3	3	5	1	5	**1**	**1**	4	3	3	5	3	1	1	1	3	3	1	3	**4**	3	4	4	5	4	**5**	1
3	4	2	7	7	**2**	**2**	3	2	4	2	4	6	4	6	4	4	4	4	**3**	2	3	3	4	3	**6**	6
3	5	3	6	3	**6**	**6**	6	1	6	3	6	5	6	5	6	6	6	6	**6**	6	6	6	3	1	**3**	5
3	6	6	5	6	**5**	**5**	5	6	5	6	5	4	5	4	5	5	5	5	**5**	5	5	5	6	7	**4**	4
3	7	1	4	4	**7**	**7**	7	7	7	7	7	7	7	7	7	2	2	7	**7**	7	1	1	7	6	**7**	7
4	1	5	2	**2**	**3**	3	**3**	2	1	2	3	3	3	**3**	**3**	**3**	2	**2**	**2**	**2**	**2**	**2**	1	**2**	1	**2**
4	2	2	1	**1**	**4**	7	**4**	1	4	1	2	7	7	**4**	**4**	**4**	1	**1**	**1**	**1**	**1**	**1**	7	**1**	7	**1**
4	3	4	3	**4**	**1**	1	**1**	3	3	3	1	1	1	**1**	**1**	**1**	3	**4**	**4**	**4**	**4**	**4**	4	**4**	4	**4**
4	4	3	6	**3**	**2**	4	**2**	4	2	7	7	4	4	**2**	**2**	**2**	4	**3**	**3**	**3**	**3**	**3**	3	**3**	3	**3**
4	5	1	5	**6**	**6**	6	**6**	6	6	6	6	6	6	**6**	**6**	**6**	6	**6**	**6**	**6**	**6**	**6**	6	**6**	6	**6**
4	6	6	4	**5**	**5**	5	**5**	5	5	5	5	5	5	**5**	**5**	**5**	5	**5**	**5**	**5**	**5**	**5**	5	**5**	5	**5**
4	7	7	7	**7**	**7**	2	**7**	7	7	4	4	2	2	**7**	**7**	**7**	7	**7**	**7**	**7**	**7**	**7**	2	**7**	2	**7**