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Troomate - Finding a Perfect Roommate

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TROOMATE - FINDING A PERFECT ROOMMATE
A LITERATURE SURVEY

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ABSTRACT

When someone arrives at a new place, the first thing that they do is look for a place to dwell, and when the company they are with is not appropriate, it leads to disputes and sometimes shifting to a new place which can be very tedious. Finding the right roommate is very important as it affects the physical and mental health of a being. The present solutions in the market for this problem include websites like roomster.com, olx.in, indianroommates.in, etc., and applications like FlatMatch, Roomster, etc. A detailed analysis of potential competition was done in order to figure out our standing amongst them. The paper analyzes them on the basis of their features, ratings from users, etc. Roommate-finding platforms exist, but they just display a list of users without considering their preferences. This is where Troomate has an advantage. A detailed literature survey was done about how the pairing of people could be done based on their idea of the perfect roommate. This paper includes various algorithms like Gale-Shapley, Elo rating score, and techniques like clustering in order to effectively match on the basis of powerful filters like social traits, diet habits, sleeping schedules, etc. With an interactive, well-designed UI, dependable backend, and reliable algorithms, Troomate aims at solving the problem effectively.

KEYWORDS: Roommate Finder, Recommendation System, Algorithm, Match Finder, Pairing Algorithm

INTRODUCTION

Due to increasing urbanization many people shift to urban cities in search of employment, to get a better education and livelihood opportunities. As soon as they visit a new place they normally don't have a place to live. Usually, people rent out someplace and live there. Most economical thing is to share a place with some other person. It is very important to get the right person to live with. [1]

The survey conducted for the paper that asked people questions like, whether they got their roommate by choice, the various problems they faced with them, how these problems affected the person's life, what actions they took to resolve these issues, and how happy they were with their current roommate, their description of an ideal roommate, and finally, the age group they prefer being roommates with. The survey stated that a maximum of people did not

find a roommate of their choice. Moreover, common problems included bathroom-sharing and space-sharing issues, noisy/messy people, and mismatched sleeping schedules. This caused people to be late for work/college, forced to clean up the other person's mess, and created issues in studying and sleeping. In trying to verbally resolve these issues with their roommate, many people found that things worsened: they didn't change, the person had to leave, or heated arguments took place.

The traditional way to find a roommate is to book a room, and the next person that books the same room is assigned as a roommate. Or if there's no empty room available, people have to choose one of the already occupied rooms, without even knowing the person who they are sharing it with. Briefly, they get paired off with a stranger.

If people with opposite habits or interests get paired as roommates whenever they decide to move into a new place it is going to cause disputes. It might affect the mental, physical and emotional well-being of a person. For instance, if a person who always likes to keep things tidy gets a messy person as a roommate it's going to be a headache for both of them. Everyone has different lifestyles and habits. Sometimes it is easier to adjust but at times it becomes very difficult to cope with a person of the opposite nature. And if a person is not getting along with their roommate then eventually they have to look for a better place to live in. The vicious circle of shifting continues if they don't find the right roommate the second time too.

When the user registers on Troomate, the user would be asked a few simple questions about their preferences, like location, gender, hobbies, food habits, etc. Based on this user input, a list of potential roommates would be generated who have similar preferences as the user. This list would be then shown to the user in the best match first pattern.

The user would also be able to contact their matches and even set up a meeting with them before moving in. Along with this, all the users of Troomate would be verified and also reviewed to maintain the integrity of the community.

Every decision in life is taken so carefully that a person should also be able to find a roommate of their choice. By using this platform one can choose a roommate based on filters and preferences.

LITERATURE SURVEY

[6] "An exploratory investigation of the relationship between roommates' first impressions and subsequent communication patterns."

This paper focuses on some roommate relationships that last longer while others don't. It shows us that more positive initial interaction with roommates is the key to long-lasting relationships and will continue to live together in the upcoming time as well. Also, the roommates having more positive initial interactions use efficient conflict management strategies and avoid asocial or non-productive strategies. POV (Predicted Outcome Value) theory is on the impact of initial interaction on people which can help to determine the effects of future outcomes based on interpersonal relationships.

This paper supports hypothesis:

"H1. Roommates who are (a) still living together or (b) would live together in the future will report more positive initial impressions

H2. There will be a significant positive relationship between roommates' initial impressions and satisfaction with subsequent conversations.

H3 a: Roommates who report more positive initial impressions will also report using more productive conflict management strategies with their roommates.
H3 b: Roommates who report more positive initial impressions will be less likely to use unproductive conflict management strategies"

From this paper, the conclusion is that for a better roommate relationship, initial interaction has to be positive. Therefore, in Troomate, a meeting feature is included which will cover the initial interaction among the people which will play an important part in ensuring the positive or negative future outcome of the roommate relationship.

[11] "College Admissions and the Stability of Marriage."

The paper starts out by pointing out issues in college admissions for both parties: students and colleges. It discusses various uncertainties in the whole process, such as not knowing whether an applicant has applied elsewhere, what the ranking of the universities he has applied to is, and which of these other colleges will offer him admission. On the other hand, an applicant faces the risk of not getting his desired university by accepting another college's offer and not waiting for the offer of his desired university. All these lead to a situation where it becomes difficult to get the desired quota of students of desired quality for colleges. The authors suggest a procedure for assigning applicants to colleges in such a way that is satisfactory to both parties: first, all applicants apply to the college of their first choice, this college then sends offers to the top candidates (within its quota) and rejects the rest, after which these rejected candidates apply to the college of their second choice, and so on.

The paper goes on to extend the problem to another case: marrying off all people of a community in a satisfactory manner. However, the difference in this situation is that the number of women and men are equal, unlike the initial example where applicants would outnumber colleges. The authors proved that if there were two groups with an equal number of elements, stable pairs for all can always be generated. The idea is that while someone from group X is unpaired, they go to the person who they have ranked highest from the other group Y. If this person is unpaired too, then these two people are paired, i.e. married. However, if the person from Y is already married, but prefers the new person from X, they will leave their current partner. Otherwise, if that is not the case, then this person from X will move on to the next person from Y in their rank list.

The overall problem thus refers to situations where the solution to our problem is finding the most "stable" pairs possible. A pair (A, B) is said to be stable when A does not have a better choice available than B, and vice versa. A student choosing a university, men, and women looking to pair up (such as in the case of Tinder), are some practical examples of where we require to find stable pairs.

In conclusion, the solution proposed by Gale and Shapley may be of use in matching problems and can be the basis for solving many real-life issues that involve finding stable pairs.

[7] "House Allocation With Existing Tenants: An Equivalence"

"In this paper they showed that there is an important relationship between two intuitive house allocation mechanisms which are designed to avoid inefficiencies in those situations where there are existing tenants and newcomers. Since the core (or equivalently the competitive mechanism) is the undisputed mechanism in the context of housing markets, it is tempting to extend this

mechanism via constructing an initial allocation by assigning existing tenants their current houses and randomly assigning vacant houses to newcomers. However, this extended mechanism grants initial property rights of vacant houses to newcomers, and therefore its equivalence: to the "newcomer favoring" top trading cycles algorithm is quite intuitive.
Their result provides additional support for the top trading cycles mechanism by showing that its main competitor is a very biased special case.

The first mechanism chooses the unique core allocation of a "sister exchange economy" which is constructed by assigning each existing tenant her current house and randomly assigning each newcomer a vacant house.

The second mechanism -the top trading cycles mechanism first chooses an ordering from a given distribution and next determines the final outcome as follows: Assign the first agent her top choice, the next agent her top choice among remaining houses, and so on, until someone demands house of an existing tenant who is still in the line. At that point modify the queue by inserting her at the top and proceed. Similarly, insert any existing tenant who is not already served at the top of the queue once her house is demanded. Whenever a loop of existing tenants forms, assign each of them the house she demands and proceed.

Their main result is that the core-based mechanism is equivalent to an extreme case of the top trading cycles mechanism which orders newcomers before the existing tenants."

[2] "Roommate Finder Application"

This paper highlights the fact that accommodation in today's world has been soaring at high rates and finding a place that fits budget, preference, and proximity can be quite a challenging task. Even more so, if the person who is making the hunt is a student, and is looking for not just a suitable shelter but also someone to share it with. As per a study conducted, students who prefer living off-campus have increased by 13%. The reason this has become an attractive option is the fact that they can find accommodation as well as a roommate as per their preferences and taste. It explores an Android application that takes advantage of a variety of features to find a potential match for the user's preference.
It discusses multiple features for the user, a summary of which is provided below:

- Type of user is determined at the time of login- a user could be searching for a roommate or an accommodation.
- User can fill out their preferences and other information, as well as view the profiles of other users.
- User can update their profiles, i.e., their preferences and information are editable.
- A user looking for a roommate can look at potential matches, the extent to which they meet the user's criteria can be displayed as percentages. The user can shortlist and then contact the potential matches too.

The app talked about in the paper is focused on the university level. The registration process has six steps: providing a purpose of registration; basic details like name, contact information, etc.; university-specific information like year of graduation, major, etc.; adding apartment preference or roommate preferences; adding interests and activities; and finally, general preferences and additional notes.

This discussed application also makes use of a search page that will allow the user to search for profiles on the basis of the university. These profiles can be added to a "shortlist" and

can also be viewed in detail by clicking on them. The potential matches can be contacted via an in-app messaging system as well.

A separate page is created for viewing potential matches along with the percentage reflecting the degree to which the profile matches. Adding to the shortlist as well as sending a message will be supported on this page as well.

In conclusion, the app conceived in this paper can be used by a wide range of people as it satisfies the needs of two types of users, along with providing different types of communication to connect to two users like app-to-app messages, text messages to other user's phone, and direct email to other users.

[8] "Roommate similarity: Are roommates who are similar in their communication traits more satisfied?"

"This study investigated whether roommates who were similar in their communication traits would express more satisfaction with an affinity for their roommates. This study looked at roommate similarity based on three communication traits: willingness to communicate, interpersonal communication competence, and verbal aggressiveness.

There were 403 participants in this study, of which, 203 were college students enrolled in introductory communication courses at a large midwestern university. Students took one questionnaire with them for completion by a roommate (N = 200). Participants were 219 females and 184 males. There were 98 female-female pairs, 20 female-male pairs, and 82 male-male pairs. Ages ranged from 15 to 57 (Mean = 20.20 , Standard Deviation = 3.75).

Participants (college students and their roommates) completed measures of their own communication traits and their feelings about their roommates. Results showed that roommates who were prosocially similar (when both roommates were high in willingness to communicate when both roommates were high in interpersonal communication competence, and when both roommates were low in verbal aggressiveness) reported the highest roommate satisfaction and liking.

Based on this research paper, the social traits filter (extrovert, introvert, ambivert) was defined. This was defined in the results of this paper that people with similar communication styles tend to match well together. Hence, an extrovert person would match well with an extrovert roommate, an introvert person would get along with an introvert roommate, and so on. Consequently, this would lead to a harmonious relationship between roommates."

[4] "The impact of study groups and roommates on academic performance"

This paper uses random assignment of students to investigate the impact of study groups and roommates on academic achievement.

One of the results of this study is that informal social interaction with roommates has a significant positive impact on academic achievement while study group peers have no observable impact. This suggests that social interaction is more effective in boosting academic outcomes than study groups that are designed for learning.

To put it simply, this study is proof that good social interaction with roommates plays an important role in academic success as well. This makes getting the right roommates even more important. Having similar interests between roommates is one of the factors that lead to a good connection between and conversation between them.

As a result, basic interests were also included in the filters that we've defined. Pairing people with similar interests would not only ensure a good relationship between roommates but would also boost their academic performance which would improve their relationship further.

EXISTING PLATFORMS

1. Olx [14]

Accepts location from users. An optional filter is provided to select a budget range i.e minimum to maximum range. After entering the location, the user is provided with a list of accommodations available with photos of the rooms/apartments/flats and their details.

2. Indianroommates [13]

After entering the required city name, users are directed to a list of rooms available in the city, where each room has information such as room type, location, gender, and furnishing type, posted by.

3. Roomster [12]

This website is quite similar to Indianroommates as well. It asks for location and gives you a listing of people who also require a roommate or room, with their details of the budget, move-in date, and listing type. It ensures that the users are genuine by verifying their email, and mobile number.

4. Flatmatch [15]

It is an app that takes user preferences, but makes it mandatory to enter property information. It is not always the case that if someone is finding a roommate who has a property or room, so the users cannot use the platform unless they have a property. After entering all the information, the user will get a list of recommendations with match percentages.

After considering all the existing platforms, there is a need to create a dedicated platform for users to find roommates based on their preferences. This will help users to establish a good roommate relationship without having as much as fewer conflicts.

COMPARATIVE ANALYSIS

Platforms	**Flatmatch**	**Roomster**	**Indianroom mates**	**Olx**
Website /App	App	Website	Website	Website
Features	Takes user preferences from the user as well as makes it mandatory to enter the room/flat	Takes input as location and displays a list of users with people who also require a roommate	Takes location and sharing type as input and	Takes location and budget (optional) as input and it gives a list of flats

	details owned by a person and displays recommendations with match percentage	or room, with their details of the budget, a move-in date, and listing type. Roommate preferences are optional	displays a list of rooms with their details.	and rooms available and their details.
Drawbacks if any	Not necessary every person searching for a roommate has a room/flat/property	Displays a list and does not provide recommendations as per user's convenience by using enhanced filters	Does not use filters to display the roommates rather it focuses on displaying details of room	Lack of precise filters and the user has to manually search

Figure 1: Comparison of existing applications

There are various existing platforms which provide the facility to find a roommate, but very few provide the feature of preferences

NEED OF FINDING ROOMMATE

Most of the people do not get a choice to choose their roommate and end up having a roommate as a complete stranger. If the roommate is not good enough, the person may feel trapped and claustrophobic, money can make a living situation very stressful, pick up bad habits, and most importantly it can affect mental health.
Common roommate problems -

- Different sleeping habits
- Borrowing(more than required)
- Living messy
- Arguments over bill splitting

are some out of many.

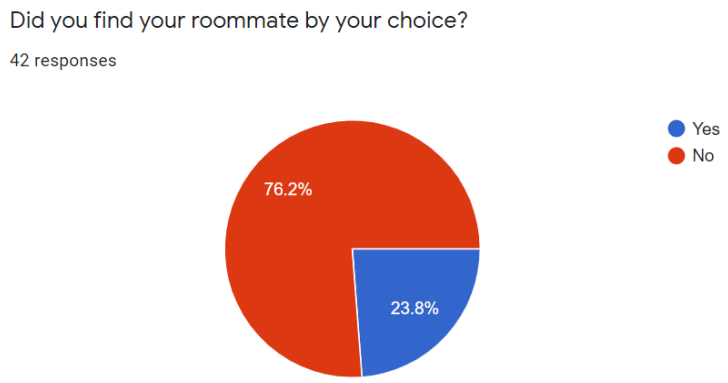

Figure 2: Response of survey form

As per the survey conducted for the paper, responses were collected from people aged 18-25, and 76% of people do not get a choice to choose their roommate.

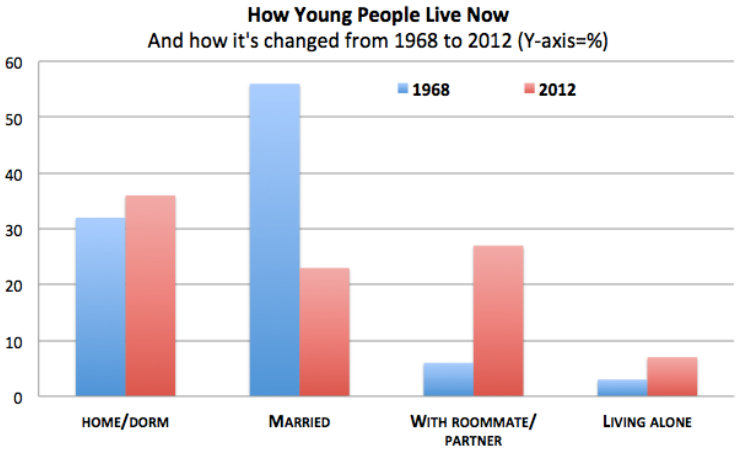

Figure 3: How young people lived in 1968 vs 2012 [5]

According to Pew Research, there is a significant increase in the number of people from America, who prefer to live with roommates from the year 1968 to 2012.

As many students are moving from rural areas to urban areas for education or jobs and by referring to the charts above, it is concluded that there is an increasing need for people to have roommates of their choice.

PROPOSED WORK

USE OF GALE-SHAPLEY ALGORITHM [11]

The problem of finding the right roommate for a person can be seen as a pairing problem. Consider that it is required to create pairs among two groups. Let each person in each of these groups rank each person in the opposite group. For simplicity, each of these groups has 4 members. Let one group be represented by capital letters (group Y) and the other by lowercase letters (group X). This gives us two matrices of 4x4:

	A	B	C	D
a	1	2	3	4
b	1	4	3	2
c	2	1	3	4
d	4	2	3	1

Figure 4: Group X ranks Group Y

This matrix represents rankings of group X. Person *a* rates people from group Y as 1-*A*, 2-*B*, 3-*C*, 4-*D*, which means, person *a* would like person *A* as roommate the most, while person *D* least. This matrix is read row-wise.

	A	B	C	D
a	3	3	2	3
b	4	1	3	2
c	2	4	4	1
d	1	2	1	4

Figure 5: Group Y ranks Group X

Similarly, this matrix represents the ranking of group Y: person *A* ranks people of group X as 1-*d*, 2-*c*, 3-*a*, 4-*b*. This matrix is read column-wise.

Suppose (*a*, *A*) are paired up initially, then it can be observed that *A* has its third choice while *a* has its first choice. If *A* can break this pair and go for someone that is higher in *A*'s list, say *c*, and if *c* can break its current pair to go for *A*, then the new pair would be (*A*,*c*) and the previous ones would break (they are "unstable").

So, the goal is to find stable pairs for everyone, such that equilibrium is achieved.

THE ELO RATING SYSTEM [10]

Developed by Arpad Elo, the Elo Rating System is used in competitive chess to rate how good a player is. Starting off with an initial rating of 1000, it goes up and down depending on wins and loses. This is used in tournaments to match players with similar abilities together. Up until 2019, it was also used by Tinder to decide matches. In Tinder, a win would mean a right swipe and a loss would mean a left swipe. A similar concept can be applied to match roommates.

Each player's ability can be shown in the form of a bell curve. Each player has the potential to play at a range of different abilities. For instance, on some days a player plays really well which means they pick high numbers. But on some days when a player is sick, they play

poorly meaning they pick low numbers. But mostly they play average, that is they pick middle numbers. So if the frequencies of the numbers is looked at, they form a bell-shaped curve.

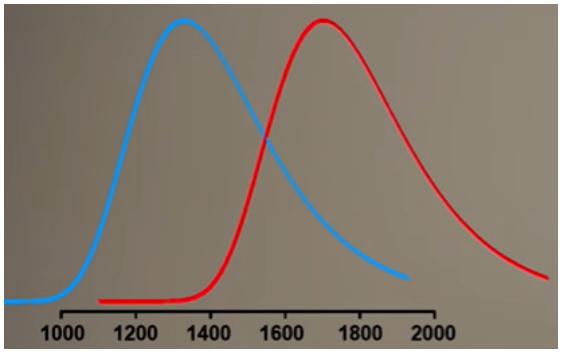

Figure 6: Playing strengths of two players [9]

The center of the curve is that player's average which is that player's rating. The Elo Rating System uses two formulae. [3]

Formula derivation:

Below is the derivation of the first formula. For this, the frequency of the differences between the two players' numbers is looked at. This is the Logistic curve. If a player has a rating that is 400 points more than another player, then they are 10 times more likely to win. So on the curve, the area to the right of zero will be 10 times the area to the left of zero.

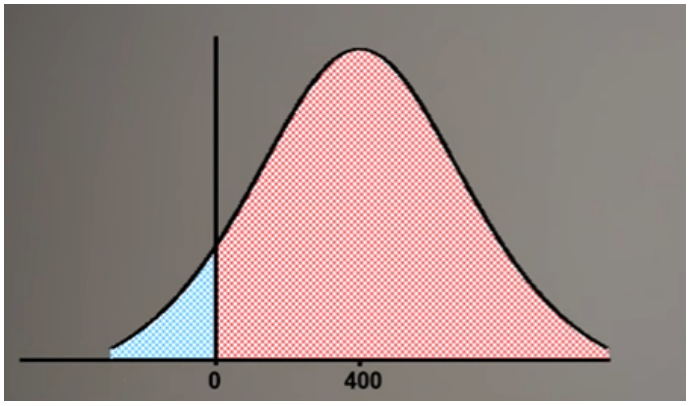

Figure 7: Difference in playing strength showing area under the curve [9]

If this statement is turned into a formula, this is the probability that Player A wins where R_A and R_B are the ratings of Player A and Player B.

$$P(A\ wins) = 10^{((R_A - R_B)/400)} * P(B\ wins)$$

$$P(A\ wins) = 10^{((R_A - R_B)/400)} * (1 - P(A\ wins))$$

$$P(A\ wins) + 10^{((R_A - R_B)/400)} * P(A\ wins) = 10^{((R_A - R_B)/400)}$$

$$P(A\ wins) = \frac{10^{((R_A - R_B)/400)}}{1 + 10^{((R_A - R_B)/400)}}$$

$$P(A\ wins) = \frac{1}{1 + 10^{((R_B - R_A)/400)}}$$

Figure 8: Simplification of formula [9]

Using this the winner of the game can be predicted. What would happen if the player performs better or worse than the predicted outcome?

- If a player performs better than expected then their rating would increase. The more surprising their win is the more points they will get up to a maximum of 32 points.
- Similarly, if a player performs worse than expected their rating would decrease up to 32 points.

Hence, after the game, the player rating is updated using the Update Formula which is based on the difference between the expected score and the actual score.

$$New\ rating = rating + 32(score - expected\ score)$$

For example: Suppose there is a player A whose rating is 1000. Assuming that A is the weaker player, A is supposed to lose the game. So the expected win is 0.35. In the turn of events, A actually wins the game and scores 1 point. So putting this in the formula, it is observed that Player A's rating has increased.

New rating of A = 1000 + 32 (1 - 0.35)
New rating of A = 1000 + 20.8
New rating of A = 1000 + 21 = 1021
This is the same amount that is decreased from the loser's rating.

OUR SOLUTION

The input will be taken from users which will be the preferences like Gender, location, social traits, and basic interests. The scores for each of the users will be calculated.The aim is to build a solution such that it will recommend us a suitable roommate by taking into consideration all the preferences.For simplicity, the easiest and shortest example with few preferences is taken as input. Let the threshold be 2.

	Weight=1	Weight=1	Weight=0.45	Weight=0.45
Person	**location**	**gender**	**food**	**var**
A	Pune	f	veg	x
B	Surat	m	non-veg	y
C	Pune	m	vegan	x
D	Pune	f	veg	z

Figure 9: Sample data of four people

Here, the weights of compulsory filters is considered as 1 and weights of additional filters(not-compulsory) as 0.45.

Weights of additional filters are taken as 0.45 because they should add up to less than the threshold.

The threshold is the summation of the compulsory filters. In this case, it is 2.

Users cannot be paired with herself/himself. So instead of evaluating the weights for herself/himself as 2.9, it is explicitly programmed as 0. So for mat[A][A] = 0

For mat[A][B] we will compare data of A with B:

A	Pune	f	veg	x
B	Surat	m	non-veg	y
score	0	0	0	0

Figure 10: Score calculation of A and B

Therefore, mat[A][B] = 0 + 0 + 0 + 0 = 0

A	Pune	f	veg	x
C	Pune	m	vegan	x
score	1	0	0	0.45

Figure 11: Score calculation of A and C

So, mat[A][C] = 1 + 0 + 0 + 0.45 =1.45

A	Pune	f	veg	x
D	Pune	f	veg	z
score	1	1	0.45	0

Figure 12: Score calculation of A and D

Hence, mat[A][D] = 1 + 1 + 0.45 + 0 = 2.45

Similarly the entire matrix is evaluated.

	A	B	C	D
A	0	0	1.45	2.45
B	0	0	1	0
C	1.45	1	0	1
D	2.45	0	1	0

Figure 13: Final Matrix with scores

The results are thus:
A [0, 0, 1.45, 2.45]
B [0, 0, 1, 0]
C [1.45, 1, 0, 1]
D [2.45, 0, 1, 0]

The data of rows is sorted like so:
For A: [2.45, 1.45, 0, 0]. Thus, ranking: D

Here preferences will be filled only if the data is more than the threshold which is 2 in this case. Similarly,
B [1, 0, 0, 0], Ranking will not be filled as data is less than the threshold.
C [1.45, 1, 1, 0], Ranking will not be filled as data is less than the threshold.
D [2.45, 1, 0, 0], Thus, ranking: A

Gale-Shapley Matrix:

A[D]	A
B	B
C	C
D[A]	D

Figure 14: Matched pair matrix

So A will be matched with D.

CONCLUSION

There are many platforms available to search for roommates but they just display a list of users searching for roommates with details of the room. They generally focus more on finding rooms than roommates. There are very few dedicated platforms to find roommates which use user preferences to recommend roommates based on their habits, cuisine, language, and much more. To ensure genuine users, OTP verification is mandatory. The details of the user are not shared with another user, thus ensuring security. After selecting the appropriate roommate, a virtual meeting will help them to finalize their decision and not just blindly trust their Troomate. Therefore, Troomate has the advantage to recommend the users, the roommates based on their preferences.

For finding roommates the swap-based model was not preferred, hence the Elo rating system was combined with the Gale-Shapley algorithm to develop an algorithm that would be suitable for the application.

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