

RECIPROCAL RECOMMENDATION IN MATCHMAKING SYSTEMS

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1. ABSTRACT - Web-based dating sites have nowadays become very popular and important platforms for people to look for partners for numerous benefits that it provides. Unlike traditional user-item recommendations where the system is tailored to the need of just one side or party for matching items (e.g., books, products, etc) with user's interests and likeness, the aim of recommendation system for online dating is to match people whose interests mutually coincide in and hence likely to communicate with each other. In this paper a detailed study has been done on this class of recommenders.

KEYWORDS- Recommendation system , Reciprocal Recommendation , Matchmaking system

2. INTRODUCTION

Ken Exploration declared its most up-to-date publication on "India Wedding Market Outlook to 2020-Focus on Online Matchmaking and Wedding Planning Segment" which gives an analysis of the Wedding Business in India. As indicated by the exploration report, the India Wedding Organizer market will develop at a significant CAGR rate hence achieving INR 1,606.9 billion by 2020, rising individual disposable income, scarcity of time, new and remarkable thoughts craved by couples to organise their weddings. The data analysis by ASSOCHAM on "Rising trends & popularity of online Jobs and Matrimonial Alliances ", uncover that jobs and matrimonial alliances looking for through online has numerous more takers now because of the numerous benefits that it provides.

Marital sites are progressively transforming into a superior alternative for the new era in their search for potential mates. The result is positively large as it gives a worldwide selection of lakhs of individuals cutting crosswise over age gatherings, professions, religions, and groups. The intelligence, openness and thus adequacy of the online medium make it a favored medium for finding a life partner.

Points of interest of Online Wedding:

- Efficient
- Economical (Easy on the pocket).
- Comfortable
- Simplicity
- Easy to use framework
- Propelled Security
- Less time for an ideal match

But in the digital age, users are presented with plethora of options to choose from. To direct a user, recommender frameworks are a way to battle this data over-burden and give user candidate suggestions customized to their preference and profile.

3. BACKGROUND

Online matrimonial is instant, convenient and anonymous. It is a powerful tool for discovering compatibility and it's fuelling an escalating number of successful marriages.

In this segment, the author gives an insight into a concise introduction to recommender systems after which the problem domain –that is online dating is being discussed.

3.1 Recommender systems

Recommender systems are assistance in the form of software, tools or algorithms that may guide a target user in making decision by proposing him recommendations based on his interests [9]. This methodology is known in the research by few other terms such as *people-to-people recommenders* [7] and in a specific domain say online-dating, *matchmaking algorithms* [19,49].

Table 1. Difference between Classical and Reciprocal recommenders.

Traditional / Classical Recommender System	Reciprocal Recommender System
Item-to-person recommendation	People-to-people recommendation
Satisfied customers will come again. So, easier to track their preferences.	Successful match and disappointed person will never come. So, Cold-start problem more significant.
Users are proactive.	Users are proactive and reactive
Popular items can be recommended to many	Limitedness
Applications :- All e-comm sites	Applications :- online dating, job recommendation, mentor-mentee, business partner etc

3.2 Reciprocity

As per [1] reciprocal means "concerning each of at least two people or things; particularly given or done in return" or a common relationship in which two individuals feel in a similar way about each other, or do or give similar things to each other.

3.3 Reciprocal Recommendation

It is a special case of recommender system where both sides we have active components, called people and mutual satisfaction is vital for a transaction to be successful. In the domain of reciprocal recommendation, the user and items have equal importance in the system, in that both have priorities and the quality of the recommendation is dependant on both parties and it should be fulfilled [18,19].

In the online dating field, the main objective is to find a partner, for which one user is being recommended to a different user having common interests and matching preferences.[16,17]. Any proposal given in an internet dating situation should consider the priorities and requirements of both the parties before being referred to each other. In web based dating, one person initiates communication based on his priorities but the success depends on the likeness of the opposite party as well.

4. Domain Overview

4.1 User Profile

A user profile where he specifies information about himself can be categorized into majorly two forms of data: constrained or attribute-valued and unconstrained or free-text. The constrained part is chosen from a given set of alternatives which contains information like qualification, income, mother tongue etc. The user can specify his preferences (like his music choice, religious inclination etc) and also express himself through free text in their own particular words. Conversely, the unconstrained attributes are comparatively harder to use to create suggestions because of the accompanying reasons. Firstly, it doesn't generally associate with the fixed attribute profile of the user, e.g. he would not say that he would like his partner to be interested in jazz music. Second, it is normally ambiguous, which can't even be handled by the complex natural language processing techniques.

4.2 Explicit Preferences

The explicit preferences of a given user X characterized by an array of attribute values as stated by X . These attributes having all their allowable values are predefined by the site. But this information may be unreliable or incomplete. Craving to have a more attractive partner and lack of self awareness influence exactness or correctness of profiles. The user can portray his/her preferences by indicating values for predefined values of those fields. Thus the rigidity and non-flexibility nature of the explicit preference model may not reflect reality, as users' activities are mostly in contrast to their expressed inclinations through fixed attributes. In this regard understanding users' implicit preferences will be more helpful in designing the model and getting more accurate information about user, who himself is not able to express himself properly. Thus the users' interaction history with a set of users will help to understand his requirements in a better way.

4.3 Implicit Preferences

The main objective of recommendation together with implicit preferences is to give personalized services through studying a person's priorities and preferences from his exploration pattern [6,19]. The activities of a user like profile exploration help in determining the implicit preferences of a user. Activities which demonstrate interest for another user are: seeing the user's profile, communicating through message, answering positively to a message or buying a token with a specific goal to send a message. To take in a user's certain inclinations, we have picked two activities: communicating something specific and answering emphatically to a message. These two activities are the most important markers to specify that a person is interested in establishing relationship with the other person. The implicit preferences gets collected with the passage of time from his message history and is quite different from the explicitly specified information. Implicit preferences provide some hint of the user's preference for certain attribute values.

In a prior review by Akehurst et al. [4], the author demonstrated that the preferences being collected implicitly is superior than the preferences which the user explicitly specifies. In this way, when sufficient message behaviour information are gathered for the target user, that information can be used gainfully. [18].

In [2], the author exploits the diversity in the priorities which have been defined previously and the similarity being mined by using similarity model which contain mixed likeness of both the sides. With the mixed resemblance, the author further created a recommendation algorithm in the pairwise preference learning framework, i.e., pairwise factored mixed similarity model (P-FMSM).

Implicit feedback, for example users' examination behaviors, is an important source to churn out effective information and has been widely used in many recommendation process. For recommendation which is based on implicit feedback, two major factors that play major role in maintaining the quality of customized services are accurate similarity calculation and appropriate preference learning.

4.3.1 Sequential Steps involved in the interaction.

A typical (successful) step by step interaction in a web-based dating site is explained below:

- The very first step involved for a user say X is to register himself on the website and provide all his information related to finding a suitable match. A sample example may be data like his age, gender, height, educational qualification, job, photo. Apart from these information (s)he is also asked to provide his preferences or the qualities he wants to have in his ideal match.
- User X goes through few profiles and if any profile appeals him he sends a message to the user say Y .
- If user Y is active, and sees the message, he goes through the details of user X 's profile and if it also appeals to him he responds with a positive message, otherwise either ignores the message or replies negatively..

- d) If the interest is reciprocal, they try to know each other better by exchanging messages iteratively.
- e) After few discussions, user X and Y may exchange contact information and meet offline, and if everything goes well they may end up setting up a relationship.

5. LITERATURE REVIEW

A considerable amount of research on web-based dating recommender is being contributed by L. Pizzato from College of Sydney. A major contribution is that they developed the techniques CCR and RECON.

RECON [9] is a reciprocal recommendation technique which is content-based which captures the user behavior from his messaging details to compute recommendations. The fundamental idea is that the information is stored about profile details (attribute values) of each user to which he sends message or positively replies to. A distribution of those attribute is calculated and thus his preference or likeness is computed. These caught preferences is used to compute reciprocal score and help the algorithm to calculate the compatibility between the users. If the score is above a threshold value, that unmet user will be recommended to him. Since it is content-based recommender, RECON utilizes the previous messaging history from his transaction-log to give efficient recommendations.

The recommendation process of RECON has three major steps to follow. 1) For a given user, construct the preference model based on his messaging behavior. 2) Calculate the compatibility score with unmet users using the preference model. 3) Lastly, provide a list of ranked recommendation to the user based on similarity score as calculated in step 2.

The major advantage of RECON is its simplicity to understand and it provides efficient and accurate recommendations which is based on the users' messaging behaviour.

Disadvantage: RECON is not so efficient in handling the cold-start problem as the information collected from the messaging history takes some amount of time. The case worsens when suggesting one new user to another new user.

A very well known hybrid approach in the literature is Content-Collaborative Reciprocal (CCR) [5] which handles the cold-start problem by aggregating the benefits of both the content-based and collaborative to provide reciprocal recommendation and can efficiently handle the cold-start problem.

The recommender is made out of three steps:

1. For a given a user, say a , the very first step is to compare the target user's fixed attributes with the unmet users and find the set of similar users S_a , or *neighbours*.
2. For every neighbour n in S_a , select the users with which he had reciprocal interest (which is the set $R+ n$, $[R+, _n]$). Thus all such unmet users constitute the candidate set C_a .
3. By comparing the communications (which may be positive or negative) with the users from set S_a , a ranked recommendation list is generated.

Another strategy called SIM-CF grew autonomously by Kim et al. [6] takes after an indistinguishable fundamental thought from CCR.

The problem becomes more challenging because a good number of users on the online dating sites are cold-start users / new-users. Collaborative filtering has been implemented with many variations to combat this challenge in the reciprocal web-based dating domain as in [16, 17]. Interestingly, they have proved that collaborative filtering is much more efficient as compared to content-based recommendations by a long shot.

Multiple compatible subgroups [7] depends on utilizing profiles' fixed attributes to divide the user base into different subgroups. Based on a selected attribute, the male and female users can be further broken down into subgroups and then reciprocity is being calculated between subgroup of one gender towards the subgroup of another gender. The technique introduced is based on the fact that two people who are similar also have similar preferences.

Thompson sampling [19] technique consolidates the best features of these two well-known algorithms: RECON's preference model, distance measure of CCR to calculate the similarity between users' based on profile attributes and also used the ranking factor and efficiency between different users' group which has been divided based on compatibility. A weighting criteria of attributes for model design may also be assumed.

Park [8] suggested a preference model for web-based dating which was similar to RECON in the sense that the weightage of the attribute features were user-defined. With the passage of time, when sufficient messaging behavior is collected, the attribute weightage was fine-tuned at each iteration towards the implicit preferences of the target user using logistic regression model. Kim et al proposed content-boosted hybrid models of recommendation system in the domain of online dating. [6] proposed content-boosted recommender for web-based dating

Their main emphasis was to handle problem of cold-start users. In [3] the author introduced a model for person-to-person recommendations using Hidden Markov Model which easily collects the temporal changes of users' actions and thus produces better customized suggestions based on the users' behaviour.

Apart of providing accurate recommendation, another desired feature which makes a recommender system more powerful is to suggest diverse recommendations which is surprising and valuable and may also be liked and accepted by the recomendee [10]. Apart from providing fixed attribute data the user is also allowed to describe himself or the features that s(he) is looking for in an ideal match in free-text format. Researchers have also demonstrated the second most dominant factor which influences the

attractiveness of a user profile in web-based dating are the free-text data. Much information about users' behavior can be extracted from this free-text and can be helpful in designing more efficient recommender.

6. REALATED WORK IN OTHER DOMAINS

Reciprocal recommendation has found applications in some other domains as well namely, mentor-mentee matching, business partner identification[9], academic social network[20] Reciprocal recommenders may likewise be utilized in suggesting friends on facebook and other social networking sites. Malinowski et al. [12] whose research in the field of Job recommendation system also emphasizes on the need of reciprocity. In this domain both parties namely the employee is looking for jobs which suits his priorities and on the other side is the recruiter who is looking for people having specialization for a particular job opening. To establish a successful relationship both the parties must fulfill mutual needs. To solve this problem they constructed two recommender frameworks. The objective of the first one was to recommend job seekers (i.e. their résumés/profiles) to job opening of a particular employer/recruiter. The second part of the framework recommended job openings to job seekers. The two recommender systems were assessed separately and demonstrated satisfactory prediction accuracy outputs.

In [5] the authors have given a reciprocal recommendation methodology for the field of recruitment and gave the calculation method of users preference and the measurement method of similarity. The proposed algorithm combines benefits of both the explicit preference and implicit preference of user and can find the users characteristic and interest much more accurately.

Based on the calculation of users comprehensive similarity, the success rate of recommendation has further improved. In [14] the author has analyzed e-recruiting process and related issues for building customized recommender systems of candidates/job matching. In [15] the author have introduced an approach for academic paper recommendation.

The author has considered the utilization of both subjective and objective features to build a customized paper recommendation model using FP growth algorithm

7. MEASURES OF SUCCESS

To evaluate the success of the reciprocal recommender various measures have been applied as described in [15, 16, 17]. Let U denote the universal set of users (participants of the test set), A be the initiatives of the test set, and M be the selected number of recommendations in the generated recommendation list.

For a specific algorithm, for every target user say $u \in U$, a recommendation list R_u with the max__size of M is generated.

i) Precision at M :

$$P_M = \frac{\sum_u |R_u \cap A_{u,*}|}{\sum_u M} = \frac{\text{\#initiatives in recommendations}}{\text{\#no. of recommendations}}$$

Provides the ratio of the recommendations that represent the number of occurred initiatives in the test set A irrespective of the type of reply. This can be considered a one-sided measure as it takes into account only the perspective of the recommendee and not of candidate.

ii) Success Rate at M

$$S_M = \frac{\sum_u |R_u \cap A_{u,+}|}{\sum_u |R_u \cap A_{u,*}|} = \frac{\text{\#positive replies in recommendations}}{\text{\#initiatives in recommendations}}$$

Reciprocated or responded initiatives are the main objectives as they result into more communications between the users and thus end up into establishing an actual relationship

iii) Failure rate at M

$$F_M = \frac{\sum_u |R_u \cap A_{u,-}|}{\sum_u |R_u \cap A_{u,*}|} = \frac{\text{\#negative replies in recommendations}}{\text{\#initiatives in recommendations}}$$

The failure rate should be as small as possible because repetitive rejections will demoralise the user and he may exit the service as he could not get satisfactory recommendations. It should be noted that this is not contrary to success rate, as it is possible that the initiatives may not receive any reply at all.

iv) Recall at M

$$R_M = \frac{\sum_u |R_u \cap A_{u,+}|}{\sum_u |A_{u,+}|} = \frac{\text{\#positive replies in recommendations}}{\text{\# positive replies}}$$

This measures computes the number of the known reciprocated initiatives in the complete test set that are also present in the recommendation lists.

8. CONCLUDING REMARKS

In reciprocal recommendation or otherwise called person-to-person recommendation, the priorities and the likes/dislikes of both the parties is considered while aiming to generate recommendations so that the probability of the pairing becomes high. In this paper, a special class of recommender systems, namely reciprocal recommenders, in the field of online dating has been presented in detail.

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