

Abstract of the Ph.D. Work

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Title : Iterative Framework for Reciprocal
Recommendations Systems.

In the big data era, users are presented with plethora of options to choose from. Searching for specific information in an ocean of information is a tough task. Recommender systems come to the rescue. Recommendation systems provide an intelligent way to navigate through an ocean of options available at users' disposal and present information that they perceive to be useful and worth trying out. Recommendation systems have found applications in almost every e-commerce website. In mid-1990s, recommender systems attracted lot of researchers since the first paper on collaborative filtering emerged (Resnick et al., 1994). Reciprocal recommendation is a special case of recommendation system where both sides we have active participants (people) and their mutual agreement is mandatory for a successful relation. As per dictionary on www.vocabulary.com *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”. Users’ interest is the pivot in any reciprocal recommendation system. The better it is captured; the better is the recommendation output.

In the research, it is known by few other terms such as *people-to-people recommenders* (Kim et. al. , 2012) and in a specific domain say online-dating, *matchmaking algorithms* (Pizzato et. al. , 2010). People on both sides of the recommendation system have equal weightage, wherein preferences of both must be satisfied. Many social websites’ core task is to recommend people to people. Various level of matching such as person to person in online dating websites, job applicants with employers and mentors with mentees are nothing but examples of such recommendations. It has been acknowledged by researchers that recommendation systems provide great opportunities and challenges for various real-world applications in the field of business, education and other domains. Some of the popular ones are as follows:

a) Job Recommendation System

An employment website using recommendation system enables users seeking a job to find opportunities that match their preferences & attributes and simultaneously allows employers to look for candidates with qualities matching their need (Hongtao et al., 2011). This domain comes under the category of *asymmetric recommendation system* since active participants on both sides of the recommender system don’t have exactly same set of attributes.

b) Online dating

In the Indian matchmaking system, the main objective is to find a life partner, for which one user is being recommended to a different user having common interests and matching

preferences. This domain comes under the category of *symmetric recommendation system* since active participants on both sides of the recommender system have exactly same set of attributes.

c) Social Network

People-to people recommendation has also found application in social networking sites like Twitter and Facebook. Few examples are suggesting friends and whom to follow on twitter.

To summarize we can say that domains in which reciprocal recommenders seem suitable exhibit the following two properties:

- i) Both sides of the recommender system must have people as active participants.
- ii) Both sides of the recommendation must share interest in each other.

Although there are many reciprocal recommenders based on different strategies which have found applications in different domains but the contribution of this thesis is multifold.

- i) A common framework has been designed for both symmetric as well as asymmetric reciprocal recommendation systems, namely Job recommendation (asymmetric) and Online Indian matrimonial system (symmetric).
- ii) Sources of explicit and implicit information about a user behaviour have been explored which was not explored yet.
- iii) Users' dynamic behaviour has been captured since it plays a significant role in generating more accurate and personalized recommendations.
- iv) In Job recommendation system, Job-seekers' personal information like his marital status, kids and current location have been utilized for suggesting recommendation. These parameters are very important from practical viewpoint of a user, how he perceives a job opening.

In order to fill in the gaps found in literature, a common framework has been designed for symmetric as well as asymmetric reciprocal recommendation systems. The proposed framework is inspired from the Iterative model of Software development. As in the iterative model of software development, initially a core-model having basic functions is built and the toy-model is given to the client to play with. Based on client's feedback, more functions and changes / corrections are embedded in the core-model and again provided to the client for his feedback. Based on his feedback, the changes are incorporated in the core model. This cycle continues until all the functionalities have been added and the client is satisfied with performance of the system. Similar approach is being used in our proposed framework for reciprocal recommendation. Initially a basic model is developed which is not very efficient but is sufficient enough to give initial recommendations to the job-seeker. The sole purpose of this base model is to handle *new-user problem or cold-start problem*(Kim et al., 2012a) which is a major drawback of any recommendation system. This base model generates recommendations totally based on users' explicit information and explicit preferences. After a threshold value (say, no. of jobs applied in Job recommendation system) is reached, the system switches to hybrid model which takes into account his feedback (implicit preferences) and fine tunes recommendations for him until we reach a specified efficiency parameter (MRR, Mean Reciprocal Rank).

The first application covered by the proposed framework is Online Indian Matchmaking System (OIMS). Web-based dating sites have nowadays become very popular and important platforms for people to look for partners for numerous benefits that it provides (Pizzato et al., 2010). 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 matchmaking system is to match people whose interests mutually coincide in and hence likely to communicate with each other. The proposed OIMS tries to fill in the gaps found in the existing system and generates better recommendations. The special contribution in this domain apart from those mentioned above is how we have extracted preferences of a registered user from the free-text part of his profile which has led to developing a weighted recommender model thus enhancing the efficiency and accuracy of the system.

The second application that is being covered by the framework is Job Recommendation System (JRS). In this digital era, most people use internet to find jobs. But due to presence of large number of jobs being posted online, it becomes a complicated task to shortlist the right ones. In recruitment 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 fulfil mutual needs. To fulfil this need, there is a need of reciprocal recommender. A JRS model has been proposed which utilizes both the explicit as well as implicit preferences of a user and captures the dynamic change in users' behaviour and generates recommendations accordingly.

To summarise, the goal of this thesis is to primarily explore the role of reciprocity in the formulation of the recommendations. An iterative framework common for both symmetric (OIMS) as well as asymmetric recommendation system (JRS) has been designed. The proposed framework has better efficiency than the existing system because useful information has been extracted from both the explicit as well as implicit sources. Practical approach has been taken like considering a job-seekers' personal details and how it can affect his choice of jobs selection while designing Job recommendation system. While designing a reciprocal recommendation system, the major objective is to generate

recommendations priority-wise and personalized. This may also be referred to as prediction accuracy, which is an important parameter to judge the relevance and effectiveness of the recommender system. Experiments have been conducted on real datasets and thus concluded that a combination of both explicit and implicit preferences must be considered for a more accurate recommendation system and proved the same in two major domains.