Recommendation, Trust and Reputation Management in a Group Online Mentorship System

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Abstract. Existing online mentorship systems typically match mentors and mentees manually. Recommender systems can be used to match mentors and mentees and trust and reputation mechanisms can be used to improve the decision process. This paper discusses the state-of-the-art in online mentorship systems, recommender systems, and trust and reputation mechanisms. It further proposes a five-stage process for automatic matching groups of mentors and mentees in online mentorship systems.

Keywords: E-learning, Online Mentorship Systems, Recommender Systems, Trust and Reputation, Social Motivation.

1   Introduction

Online mentorship systems are relatively new addition to the area of e-learning. They are different from traditional e-learning systems in the sense that they offer [15]:

i. Individualized learning opportunity: Mentees can give their preferences and goals at signup, which mentors use to set learning goals for mentees.
ii. Human-to-human interaction: At both ends of online mentorship systems, there are human beings either as mentor or mentee communicating with one another using their personal computers (PCs), or mobile phones.
iii. Possible opportunity for face-to-face meeting, if the mentorship goes on smoothly.

Examples of existing online mentorship are MentorNet, CyberMentor, the Electronic Emissary project and the Digital Clubhouse network [6, 8, 17]. A close look at these examples shows that most of the existing online mentorship systems are not just web-based, but they are supplemented with e-mail, video-conferencing and online messaging with the websites only serving as sources of the initial information for mentors and mentees. Except for MentorNet where a bidirectional matching algorithm is used for one-to-one pairing [17], existing online mentorship systems typically use manual matchmaking which can result in a high overhead in terms of time and cost s.

Recently group mentoring has been proposed as alternative to traditional one-to-one mentoring; researchers have found that group mentoring gives better opportunity for promoting positive interaction among the different parties involved [10,12]. In addition, group mentoring has been seen to work better in achieving mentees' goals, especially in cases where some mentees are too shy to initiate discussion with the

mentor, and when mentors are reluctant to check on their mentee of fear not to be intrusive. Group mentoring also saves time as mentors are able to reach out to many mentees at a time, although this has to be done with caution to devote sufficient time to each mentee [10,12]. Choosing the right combination of mentors and mentees in the group is crucial. This problem can be seen as a variant of the matchmaking problem in one-to-one mentoring, but also as a group-recommendation problem. Trust and reputation are of importance when building collaborative groups of people that need to achieve some collective goals.

This paper presents a brief overview of mentoring, recommender systems and trust and reputation systems and proposes a workflow for online group mentoring system that uses automatic group formation based on individual preferences, level of knowledge, trust and reputation.

2   Literature Review

We begin in this section by introducing the various stages in mentorship systems. Thereafter, we present a brief overview of recommender systems that can be used to pick candidates according to mentor and mentee's interests, knowledge, level, demographics, etc. Finally, we discuss trust and reputation mechanisms used in online communities that could provide group formation mechanisms to build focused groups of mentors and mentees and maintain dynamically the membership of the groups.

2.1   Stages in Mentorship Systems

According to [9], there are four generic stages in mentoring process, which can be likened to a human marital relationship.

Stage 1: *Initiation, orientation or courtship*: mentors and mentees are being introduced to one another.

Stage 2: *Getting established, nurturing or honeymoon:* This is a review stage in the relationship, when the mentee identifies areas where help is needed and the mentor creates an atmosphere for free interaction by bridging the communication gap that can ensue due to different professional status or age.

Stage 3: *Maturing, developing independence or autonomy stage*: when the actual mentoring is being done with the progress monitored by the parties involved.

Stage 4: *Ending, termination or divorce*: when one or both of the parties have achieved their aims, there is lack of bonding or the relationship is not fulfilling the intended aim, there is an abuse of the relationship by either of the parties or any other unavoidable need for either of the parties to leave [9,16].

The matchmaking process happens before Stage 1 and is done based on analysis of the features of both the mentees and the available pool of mentors. Generally, mentors are chosen among people who have achieved a status or goals that the mentee has, and is similar to the mentee with respect to education, gender, social status, personal preferences etc. This type of matchmaking is typical for content-based recommender systems, which will be discussed next.

2.2 Recommender Systems

Recommender systems aim to identify items that are of interest to users [5]. They learn from the users' history of past interactions about their preferences, interest, and use them, along with demographic information and products features in order to make personalized recommendations to users [5]. They are most commonly found in e-commerce websites (Amazon), and online movie sites (Netflix). More recently, they have been used in technology-enhanced learning (TEL) to recommend learning materials [13].There are two major technologies used for recommender systems – content-based filtering, which deploys user models (interests, preferences) in making recommendations for users [3,5]; and collaborative filtering, which makes recommendation based on the similarity of ratings between users [3,20]. To bootstrap user models, researchers have used data mining techniques to extract potential data about users on the Internet [7].

Masthoff [14], in her research on group recommendations, implemented a combination of content and collaborative approach for selecting shows to suit certain group of viewers with different preferences. Strategies suggested to make the final selection and sequencing include *average*, *average without misery*, *fairness*, *most respected person*, *most pleasure* and the *least misery* [14].

Pizzato *et al.*[18] proposed a reciprocal recommender system, which is a content-based recommender system used in making bi-directional recommendation in a situation where human beings are both subject and object of recommendation. It uses two levels of processing. The first level captures users' preferences and the second level generates recommendation by finding the compatibility scores of the users in question. Then a reciprocal score is generated for every couple of user based on their compatibility score as well as whether the simple recommender system triggers a positive response from both sides, and the users with top reciprocal scores are recommended to each other. An evaluation in the largest Australian dating network showed that the reciprocal recommender system gave more successful matching than the traditional recommender system [18].

A content-based recommender system seems a good candidate for pre-selection of suitable mentors for a given mentee. Reciprocal recommender system seems a suitable approach for matching mentors and mentees individually. Of course, modifications will be necessary in the algorithms to accommodate groups. Masthoff's average strategy for making selection for group members would be considered for resolving conflicts within the groups after some period of interaction.

2.3 Trust and Reputation Management

Trust is defined as "*a peer's belief in another peer's capabilities, honesty and reliability based on its own direct experiences*" [22]. Reputation is defined as "*a peer's belief in another peer's capabilities, honesty and reliability based on recommendations received from other peers*" [22]. Trust and reputation mechanisms have been applied in different areas including e-commerce, e-health systems, computer networks, social networks [1,4,11,21], but relatively little has been done in applying trust and reputation mechanisms in e-learning systems. Unfortunately, in e-learning sys-

tems, participants do not interact face-to-face and are likely to interact with total strangers. Hence, considering that personal data is shared between participants (especially, in online mentorship systems), trust and reputation become very essential, in order to establish trust between the parties involved as well as reveal the intention of deceitful mentors and mentees for appropriate action to be taken [2]. Trust and reputation mechanisms offer and decentralized alternative to generate recommendations and it allows naturally communities of like-minded peers to form [22]. This makes trust and reputation mechanisms a good candidate for dealing with the problem of matching groups of mentees and mentors.

3   Proposed Workflow for Online Group Mentorship Systems

In our approach to implementing an online group mentorship system matching of mentors and mentees is based on the preferences and goals of the mentees, as well as the mentors' profiles. A workflow is proposed (see Figure 1) comprising five (5) stages as an extension of current four (4) stages of mentorship system [9].

Stage 1: This *initiation stage* represents the sign up for both the mentors and mentees. The individual profiles, preferences, educational status, job status and professional abilities of mentees and mentors are stored in a centralized database. In order to motivate new users, sign up will be made very simple.

Stage 2: This *identification and grouping stage* involves retrieving the profiles of the mentees and mentors from the database, and clustering separately the mentees and the mentors into groups of different sizes, based on a measure of similarities in their features and trust values. Group profiles and group reputation values are generated for each (sub)-group of mentors and mentees.

Stage 3: This *group matching stage* involves using a reciprocal recommender [18] to match each of mentees groups with a group of mentors. All possible matches generate a large search space, as there are many possible sub-groupings and groupings involving the same people. Heuristics are used to guide the search starting from the largest possible mentee sub-groups (e.g. not larger than particular size) and if it is impossible to find a satisfactory matching mentor group (in reciprocal match of features and exceeding a give reputation value), search will expand to smaller subgroups.

Stage 4: This is the *maturing and independence stage*. Once mentors and mentees in groups have been matched together, and they start interacting, conflict may arise. Explicit conflicts can be resolved in discussion and this is normally a useful learning experience for everyone in the group. More dangerous conflicts are implicit, i.e. some participants feel that the current topic discussed by the group not of interest and may leave. Therefore, mechanisms for group recommendation [14] are used to suggest topics of discussion for a mentor-mentee group from a list of topics that may be preselected for the particular group based in its interest profile using content-based recommendation. It is very important to reinforce users' trust in the mentorship system and in each other, as well as punish defaulting mentors and mentees. A trust mechanism will be used for capturing evidence about conformity to and consistency in the required activities, mentor-mentee bonding. The evidence will be collected from written feedback and binary voting for the relevance of mentors' and mentees' activities

[20]. The results of the ratings and feedback given at this stage will be used to update the reputation values for each mentor and mentee using compositional approach proposed by [19] and this will form the bedrock of the decision to be made at stage 5. Also, some social motivating design principles will be used to encourage participation by visualizing influential mentors and mentees in their groups and will subsequently determine the weights of the trust values computed for such mentors and mentees for eventual future group matching (stages 2 and 3).

Stage 5: This is the *termination stage*, where decision is made on whether to dissolve the group or continue group interaction and mentor-mentee relationship. Relationship dissolution can arise as a result of several reasons – diminished trust/reputation of a member (mentee or mentor) due to negative feedback in Sage 4, conflicts within the individual group, conflicts between the mentors and mentees, completion of tasks or satisfaction of the goals and needs that motivated seeking mentorship. Relationship continuity arises from getting positive recommendations from both the mentors and mentees. This determines who goes into the next round of mentoring (back to stage 2) for the mentors. From here, mentors can be recommended to join another group of mentors, based on their history. Also, mentees may be required to join another group if it is discovered that their needs cannot be satisfactorily met in the group that they have been previously assigned to.

4   Conclusion

Matchmaking mentors and mentees has been a manual task in most existing online mentorship systems while the actual interactions between mentors and mentees take place via email, video and instant messaging. The introduction of recommender systems augmented by trust and reputation mechanisms can help in eliminating the manual matchmaking and allow a more flexible and dynamic approach adaptable to the users' needs. Also, the use of group communication forums decreases the need for synchronous one-to-one media and provides automatically an archive of the discussion that can be reviewed at any time. In addition, the introduction of some social motivating mechanisms can enhance users' engagement in the mentorship system.

With the proposed workflow this research proposes to apply a combination of the following techniques:

i.   the use of interest-based clustering in the initial grouping of mentors and mentees; use of content-based recommendation for discussion topics for groups;
ii. the use of reciprocal recommender system to ensure the matching suits the preferences of both groups of mentors and mentees;
iii. the use of trust and reputation mechanisms to update group membership; and
iv. social motivating principles to encourage users' participation in online mentorship systems.

In future work, the proposed workflow and techniques will be implemented in a system for online group mentoring in the area of women in science and engineering. The evaluation of the effectiveness of the techniques introduced will be done using myWISEmentor.com, a mentoring site for students and girls interested in science and engineering in Saskatchewan.

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