Social Structure and Personality Enhanced Group Recommendation

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Abstract. The social aspects of the group members are usually omitted in today's group recommenders. In this paper we propose novel approach for the inter-group processes modeling, while the friendship type, user's personality and the group context is considered in order to reflect the group member influence. Moreover, the bi-directional emotional contagion is reflected by the spreading activation over the influence graph. In this manner we are able to compute adjusted ratings for recommended items which reflect and simulates the real users' preferences.

Keywords: satisfaction modelling, group recommendation, personality.

1 Introduction and related work

Hand by hand with the social network increase we can observe the users interaction increase over the Web. The Web became the tool for the friends' activities discussion or organization. Thus the increasing trend of group recommenders' popularity can be expected in the future.

The group recommendation extends the standard single-user recommendation to the whole group by maximizing the usefulness function. The group recommendation often aggregates the single-user preferences based on various aggregation strategies [1,3], while the minimal satisfaction guarantee is the one of the important differences. The history of the group recommenders is connected to the TV domain or movies domain or the holidays and tours recommendation.

Based on the domain, various group characteristics can be observed, while the most important seems to be the group duration (stable vs. temporary), the group structure and the activeness. From the recommendation point of view the number of recommended items (one or sequence) plays important role for the recommendation method selection. Nowadays, the social aspects of individuals become more and more important. The group often includes various user's personalities and types, while not only horizontal but vertical social structure can be observed. These aspects play crucial role in the group recommendation process, as the whole group satisfaction is based on the inter-group processes and members attitudes [9]. Often the predicted individual satisfaction, based on which the group recommendations are mostly generated differs to real satisfaction

of user in the group (he/she is influenced and liable to change attitudes). The social structure (including emotional contagion) is in nowadays group recommenders considered only between two users if at all. Personal Impact Model proposed in [6] identifies user's impact on the group based on the previous activity, while the reason for the impact is hidden, thus it is unsuitable for the changing groups. Gartrell proposed a recommender based on relationship types and intensity between two users [2], while the proposed approach does not spread the impact and emotional contagion to other group members. Mashoff introduced a model for the satisfaction modeling [7]. Pro-posed satisfaction function uses the user emotions and sequence satisfaction impact. Quijano-Sanchez considers personality types and trust factors [10]. The results significantly improve the basic recommender and support the suitability of the social factors integration, while the history, the group context and the emotion influence propagation within the group should be considered when designing group recommenders.

2 Group influence

The group influence is based on the user to user individual influences. These are dependent on various personal aspects – personality, social status or relationship type. As the inter-group processes have the bi-directional character, we propose spreading activation based satisfaction function, which can be used for the rating prediction adjustment. Based on this adjusted rating we are able to choose appropriate items or sequence of items for specific group.

Similarly, the group members can be considered as the influence source. By using adjusted concept of influence modeling within the group recommendation, we are able to model real-life intergroup processes.

Group-based influence graph is an ordered pair $G = (V, E)$ where V is a set of vertices which represent group members and E set of weighted oriented edges connecting two vertexes (group members), which are associated to the influence presence between two users. The edges weights can be computed based on various social and personality based approaches (e.g. relationship type, personality).

For every group, the influence graph is constructed and each user's satisfaction (predicted rating for single-user) spread over this graph (Figure 1.). The vertexes represent group's members, while the edges refer to the emotional contagion between all pairs of users. This contagion is computed based on the social interaction type (friends, partners etc.), the single-user's personality (detected based on NEO-FFI by Costa and McCrane [8]) and the users' conflict score (obtained based on TKI by Thomas and Kilmann [11]). Moreover, the weight is adjusted with respect to the special occasions or actual context (e.g., birthdays) while these have stronger influence to the group members usually ($relationship \times personality \times context$).

Vertexes (representing group members) have assigned initial satisfaction influence values, which are derived in a standard manner (collaborative/content based recommendation prediction). The edges are present between users whose are in relationship, in other words between users with emotional contagion. Every edge has a weight, which refers to the level of emotional contagion between two users.

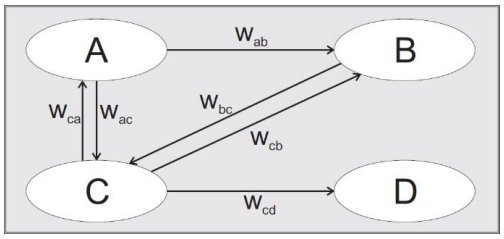

Fig. 1. Graph representation of group satisfaction modeling. Vertexes (A-D) represent users and edges the user's influence computed based on relationship, personality and actual context.

User satisfaction is the internal state of user u which describes the attitude of user to specific item i or to the all provided recommendations. This state is based on single user preferences adjusted by actual user context - emotion, mood, group members, sequence of recommended items etc.

The concept of context influence for single-user recommendations, we investigated in [5]. Based on obtained results we propose to enhance this concept to the group recommendation and introduce the group members as one of the sources for context.

In the group recommendations, often the sequence of items instead of single item is recommended. Moreover, the regularly repeated events can be considered as the sequence recommendations (time limitation required). The satisfaction does not depend only on the emotional contagion between the group members (modelled as the spreading activation through group influence graph), but on the time (emotion decrease) and previously experienced items either. Based on this assumption (previously experienced items influences user's attitudes as well) we suggest providing spreading activation several times for every item in the recommended sequence order history. The final adjusted rating is defined as follows:

$$\mathrm{r}_{\mathrm{u}\in\mathrm{Users},\mathrm{i}\in\mathrm{Items}} = \kappa\iota\left(\frac{\sum_{\mathrm{j}=1}^{|\mathrm{RI}_u|-1}\left(\left(\log_{|\mathrm{RI}_u|-1}\sqrt{\mathrm{j}+1}\right)\mathrm{sp}\left(RI_{u_j},\mathrm{u}\right)\right)}{|\mathrm{RI}_u|-1}\right) + (1-\iota)\,\mathrm{sp}(\mathrm{i},\mathrm{u}) \quad (1)$$

where i represents the item actually experienced, and u is the user, whose satisfaction is computed. The user emotional contagion is expressed as $sp(i,u)$ - the spreading activation in user's u influence graph for predicted item i. RI_u refers to the recent items - items rated by user u previously (within one recommendation sequence). By using symmetric rating scales e.g., $< 5; 5 >$ we are able to model positive and the negative emotional contagion respectively ($\kappa = 2.631$ - compensation of logarithm for the used rating scale). The previous experienced items (sequence) is combined with the ι weight. The time emotion decrease is considered from the beginning of the sequence (log). The principle of proposed approach is presented in Figure 2.

Thanks to two basic parts – modelling of influence for actual experienced item and considering the previous history, we are able to model intergroup processes and to simulate various sequences for particular group. This allows us to maximize the group satisfaction.

3 Evaluation and results

We evaluated proposed novel satisfaction modeling (based on the group members' personalities and relationships) in the controlled experiment, where we were comparing proposed approach to the standard group recommenders (considering Average or Additive aggregation strategy).

Hypothesis. Proposed approach help us to model real life inter-group processes thus we expect that - group recommendation based on the proposed novel satisfaction modeling increases precision of group recommendation generated based on standard approaches.

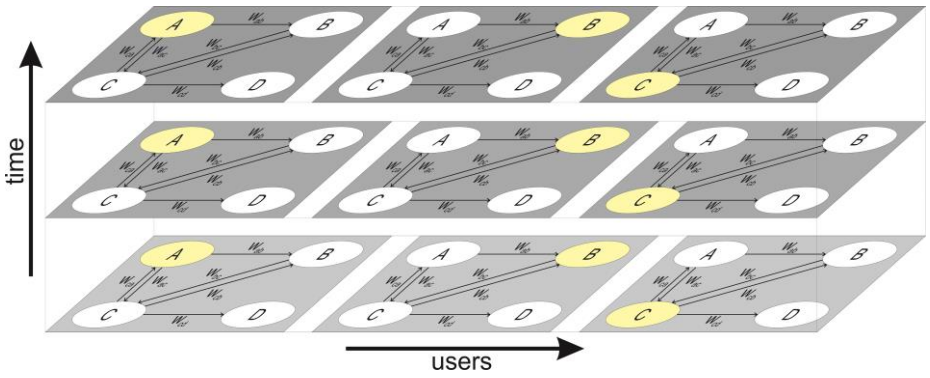

Fig. 2. Proposed satisfaction modeling for users (A,B,C,D) and several experienced items (time – each row of graphs represents one item from the recommendation history or sequence).

Participants. The total of 9 students of faculty were asked to simulate the group recommendation task in the movie domain - to choose movies which they want to watch together.

Process. Firstly, we focus on collecting personal characteristics and social structure information about participants. We asked experiment participants to complete personality based questionnaire - Neuroticism-Extroversion-Openness Five Factor Inventory (NEO-FFI), which is based on the original NEO-I measurement. Similarly, participants were asked to complete the Thomas-Killman Conflict Mode Instrument (TKI) [11] which refers to the users' competitive personality aspects. Next, each of the participants have to rate 20 movies on the rating scale 1-5 in order to model each user preferences.

In the next phase, we simulated group recommendation task. Experiment participants were spilt into groups of sizes 3 and 6 users (3 groups of size 3 and 2 groups of size 6 users) and asked to choose 3 and 5 films they want to watch together.

For each group, the influence graph was constructed, while 4 personal characteristics were considered - Competing (from TKI model) and Neuroticism, Extraversion and Cooperativeness (from NEO-FFI model). As we believe these characterises express user potential for influence other group members. For each characteristic the percentile

for the population was computed and the intensity of specific characteristic was assigned (three intensity levels - low = 0.5, average = 1.0, high = 1.5). The final weight of user to user connection was computed by multiplying of intensity levels for 4 obtained characteristics.

Results. After collecting all information about participants and simulating the group recommendation task, we generated recommendations based on proposed satisfaction modeling approach and standard group recommender. We computed Precision@3 and Precition@5 as the groups were asked to choose 3 and 5 movies to recommend. Proposed recommendation approach was implemented as the standard Top-N recommender based on the Additive and Average aggregation strategy, while ratings adjusted with proposed satisfaction modelling and raw group members' ratings were used in the comparison.

As we can see (Figure 3), proposed approach generally outperforms standard group recommendation. Our results indicate, that proposed approach scored higher when less items are recommended (Precision@3). In the group recommendation this is a desired behaviour as the group does not usually demands lot of items to experience.

Obtained results suggest, that proposed approach helps us to model real inter-group influence processes which result to the satisfaction change over group members based on the their personal characteristic. This change is important in the aggregation step, while users change their single-user preferences within the group observably.

In our experiments, the weights were computed based on the 3 basic levels of influence we expected. In the real settings, when large amount of users is available, these ratings can be learned by the machine learning techniques which should even more increase performance of our proposed method.

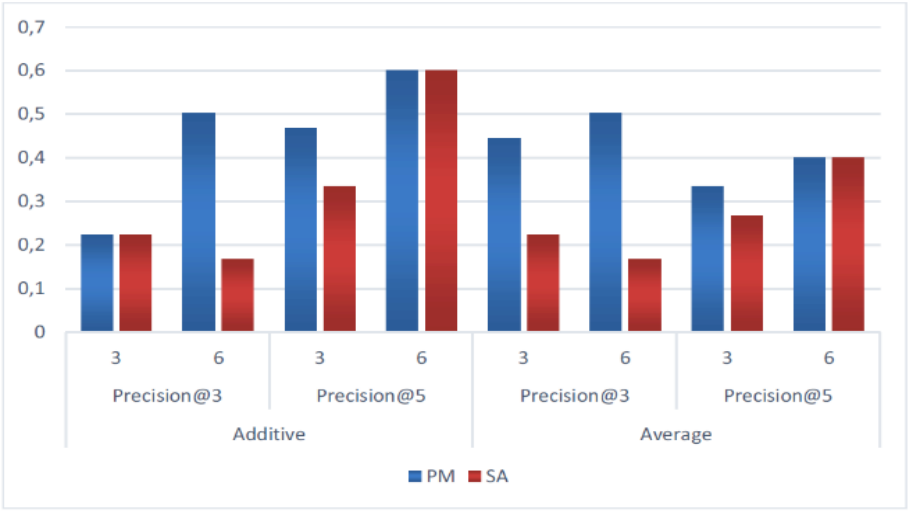

Fig. 3. Comparison of proposed influence enhanced group recommender (PM) and standard group recommender (SA). The Additive and Average aggregation strategy for group size 3 and 6 is compared.

4 Conclusions

As there are various group types, various influences can be considered in the group recommendation. When the group structure or the social characteristics are available, the consideration of such information by the influence modelling outperforms the standard group recommendation. Our proposed approach for the satisfaction modeling (adjustment of predicted ratings) models real life inter-group processes. As the emotional contagion is the bi-directional process, the spreading activation over the group influence graph allows us to reflect actual influence. Because the sequence of previously experienced items is important as well – the history of recommendation influences actual user state - proposed approach balances the present and history in order to compute adjusted rating of predicted item which in the next step is used for the recommendation. As we have shown proposed approach improves the precision of group recommender approaches and can be used for sequence optimization for group of users.

Acknowledgements. This work was partially supported by grants No. VG1/0675/11, APVV-0208-10 and by project University Science Park of STU Bratislava, ITMS 26240220084, within the Research and Development Operational Programme, co-funded by the European Regional Development Fund.

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