Recommender Systems: an Experience With GenNet Health-Care Social Network

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Abstract— **With the information overload of the Internet in the recent years, recommender systems arise as a solution to indicate content to users and to facilitate their decision processes. In the social network sites context, recommender systems have been used mainly to recommend people profiles to other users. This study analyzes GenNet social network, a collaborative virtual environment that aims health promotion to patients with physical disorders caused by genetic diseases. A recommender system that suggests people profiles to users is implemented and tested, in order to improve the level of collaboration and communication.**

Keywords-Recommender systems; friend-of-friend; social network; SNS, GenNet, healt-care

I. INTRODUCTION

In the last years, the popularity of internet has grown considerably, causing, among other things, an increase of information available on the web, and, consequently, facilitating knowledge dissemination. However, this event brought as a consequence an information overload, which hampers user navigation when they face a large amount of information.

In this context, recommender systems arise as a solution to reduce the information overload by indicating content to users and making easier the decision process. Another key-objective of this type of system in social network sites (SNS) context is recommending to the receiver items which are of its interest [1], [2].

In SNS, recommender systems have been used mainly to recommend people profiles to other users, in order to create new connections, in which the user of recommendations is interested in. Therefore, it is an incentive to make new friends, because from these relationships the virtual social network grows, enabling the knowledge exchange among network members [3].

This study analyzes the GenNet SNS, a project that involves teachers and students of a federal university in the northeast of Brazil. It is a collaborative virtual environment that aims health promotion to patients with physical disorders caused by genetic diseases. To reach this objective, this SNS develops processes that address the promotion of comprehension, adhesion and training of several actors in aspects that can promote health to these patients [4].

This paper aims to present a recommender system that suggests people profiles to users, in order to improve the level of collaboration and communication among GenNet users.

After this introduction, this paper is organized as follows: Section 2 presents some related works and GenNet SNS; Section 3 gives an overview about the methodology applied; Section 4 describes the proposed recommender systems; Section 5 briefly presents the method used to test the proposed recommender system; Section 6 contains the observed results; and finally, Section 7 draws some conclusions and points the way to further studies.

II. BACKGROUND

Pimentel and Fuks [5] define Social Network Sites as an instrument to facilitate interaction between people. Using this type of system, users can find and establish relationships, share textual and multimedia information, exchange knowledge, keep professional contacts and reduce enterprise communication costs and other activities. Thus, SNS are used to support day-to-day problems such as experience exchange between people who live similar situations; knowledge management, through a learning environment that is in constant innovation; record of events that happened in a certain period of time in an organization; reproduction and creation of new connections, even between unknown people and organizations in order to obtain collaboration.

A health social network is an online information service which facilitates information sharing between closely related

 ISBN: 978-1-61208-252-3

members of a community. Thus, a health social network provides emotional support by allowing patients to find others in similar health situations. This type of social network has shown great potential to empower patient self-care. PatientsLikeMe is an example of patient-driven health care SNS that encourages information exchange and collaboration between patients and between patients and doctors [4].

This domain-specific GenNet SNS is a collaborative social network designed to promote the health and social inclusion of people with physical disorders caused by genetic diseases. The processes performed in the social network involve several actors, such as patients, their families, healthcare professionals and organizations. Each one of those individuals has different types of profile, with some particular features in GenNet [5].

Thus, GenNet is intended to identify people with physical disorders caused by genetic diseases, to supply comprehension about these diseases and the rights ensured by legislation to the patients and their families as well as to promote engagement to treatments. It is also intended to identify associations of patients with similar diseases [5].

Beyond common features found in other social networks, such as receiving and sending messages, creation of groups of friends, among others, the following features may be highlighted in GenNet:

1. Open session for general public (virtual encyclopedia) with several information about diseases and treatments;
2. Topics for orientation about actions and activities;
3. Tools for training (those learning objects are not available yet in the current version);
4. Social profile of users on the network, in which they indicate their role: doctor, association or other kind of user (patient, family, lawyers, etc.);
5. Space for publishing ideas and experiences as a web journal (blog) which may be followed by other users.

Finally, according to Adomavicius and Tuzhilin [7], recommender systems maybe classified in three approaches. The content-based approach assumes that the user must be interested in items, in which they have shown preference in the past. The collaborative approach uses items chosen or rated by people with a profile similar to the receiver of recommendation. The hybrid approach combines the features of content-based and collaborative approaches, merging the positive points of both approaches.

III. METHODOLOGY

The action strategy used to develop the recommendation algorithm to GenNet was subdivided into four steps:

Step 1: involved a literature review to contextualize the research in question, in order to identify the features of recommendation systems as well as the approaches and algorithms used to develop this type of system.

To reach the conception of the recommender system proposed in this paper, four recommender algorithms focused on people recommendation were analyzed, based on Chen´s et al. [8] work:

Content matching: using information posted by users on the network, the algorithm tries to find users associated with similar content.

Content-plus-Link (CplusL): enhances the content matching algorithm adding social link information derived from social network structure to improve recommendations. It creates a network path to an unknown person, and the receiver of the recommendation will be more likely to accept the recommendation

Friend-of-Friend (FoF): this algorithm leverages only social network information of friendship based on the intuition that "if many of my friends consider Mary a friend, perhaps Mary could be my friend too". The algorithm operation can be seen in Fig. 1, in which each node in the graph represents a user, and each edge represents the connections between two users.

The node "Peter" represents the user of the recommendations and the node "Mary" will be recommended to "Peter" because they have four nodes in common (*x*, *y*, *k*, e *b*).

SONAR: this algorithm is based on the SONAR system, which aggregates social relationship information from different public data sources within IBM.

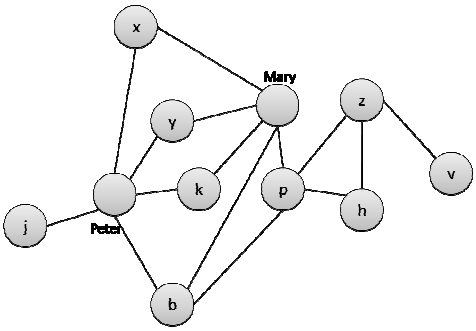

Figure 1. Example of connections among users in a social network using friend-of-friend algorithm.

Step 2: a methodological procedure was defined to build the conception of a recommender algorithm for the GenNet. Therefore, the concepts gained in the previous step were used to define which algorithm was the most appropriate to be used as a model to the algorithm to be developed in this work.

The recommender mechanism was implemented taking as base the friend-of-friend algorithm, which use the friends of friends of a user to recommend profiles, being necessary only the user information of the SNS. To implement the algorithm the following technologies were used: Windows as operational system; MySQL as database server and PHP as programming language.

These technologies were chosen to be aligned to the technologies used to implement GenNet, making the integration easier and keeping uniformity between the system modules.

 ISBN: 978-1-61208-252-3

Step 3: implementation of the algorithm on the social network, linking the developed algorithm to GenNet.

Step 4: functional tests of the algorithm (presented in detail at section V) were performed in order to validate it. Users were registered in order to observe the behavior of the algorithm. The results of recommendations by the algorithm were compared to manual results of the same test to verify the algorithm accuracy.

IV. RECOMMENDER SYSTEM PROPOSED

Content-based algorithms are more complex than those that are based on the structure of social network [8]. Additionally, the initial behavior of social network users is to find contacts already known [7]. Based on this rationale, algorithms such as friend-of-friend, which are based on social network information to perform recommendations, are indicated to recommend known people and justify the algorithm selection to the purpose of this work.

As shown in Fig. 2, after performing the login in GenNet, a user is identified as the receiver of recommendations (user A). Then, friends of this person are identified in GenNet´s database, because these profiles will be those in common between the receiver of recommendations and the recommended users (step 1).

For each friend of A (step 2), its friends are identified (step 3). The results of this search, i.e., the friends of user A friends, are the inputs to make the recommendation (step 4). Among the results may be some users already connected to user A, therefore, it is not necessary to keep these users, so they are deleted from results (step 5).

The next step is to save these data in a specific database, with recommendation data (step 6), in a table which contains the user of recommendation, its friends and the possible recommendation. It is important to highlight that duplicated lines of data are not saved in this database.

The next step is the selections on the database of users saved as possible recommendations, verifying how many times the same user appears as a possible recommendation to the user, and giving to each one a weight. With these weights a ranking is created with the most frequent users (step 7). Finally, the recommendation of 5 users is shown to user (step 8).

In the example of Table 1, user C was presented twice in the table as a recommendation to user A, while user Y just once. Consequently, user C has weight 2, and Y has 1. The user in the top of the recommendation ranking will be C, followed by Y.

If a user appears in a recommendation and he/she is added as a friend, it is necessary to remove him/her from the recommendation table. So, before the selection of A's friends (step 1) a test is performed that verifies if any of A's friends are already in the recommendation table. If so, this user is removed from this table, in order to not be recommended again.

TABLE I. EXAMPLE OF DATA STORAGE USED TO RECOMMENDATION

Receptor of recommendation	Receptor's friends	Possible recommendation
User A	User B	User C
User A	User X	User C
User A	User K	User Y

V. FUNCTIONAL TESTS

The test performed to verify the algorithm was divided in two steps: the first step was to register members on GenNet and verify the behavior of the algorithm on the SNS, observing the users recommended to each registered user. The second step was to perform the execution of the algorithm, for the same users registered calculating the ranking manually.

The results obtained after the tests were observed under the following scenarios:

- Scenario 1: user is connected to some friends, which have friends not connected to the user;
- Scenario 2: user is not connected to any user;
- Scenario 3: user is already connected to all registered contacts;
- Scenario 4: user has friends, but their friends do not have friends.

Fifteen users were registered, divided in two groups. Group 1 (related to scenarios 1 to 3) with ten members, added among themselves and with no relation with the second group. The Group 2 (related to scenario 4) with five members added among themselves and with no relation with Group 1.

Table 1 illustrates the relationship among users of Group 2, where U11 (located in the first line) is connected to U12, U13, U14 and U15 for example and represented by the number one.

TABLE II. RELATION AMONG USERS IN GROUP 2

SR	U11	U12	U13	U14	U15
U 11	0	1	1	1	1
U 12	0	0	0	0	0
U 13	0	0	0	0	0
U 14	0	0	0	0	0
U 15	0	0	0	0	0

The goal of this test was to observe the results of recommendations generated by the algorithm to each user, as well as the results calculated manually, and compare these results.

 ISBN: 978-1-61208-252-3

VI. RESULTS

The recommendations showed by the algorithm and the results obtained manually, to the same groups of friends, presented the same profiles.

Scenario 1 showed recommendations from the first to the fifth position of the ranking satisfactorily. This is the scenario with better results, because the algorithm finds inputs to create the ranking and make the recommendations. In some cases, in this scenario, four or less users were presented in the recommendation. This can be justified by the small amount of users registered in Group 1.

In Scenario 2, in which a user has no friends added, the result obtained was expected, because this scenario represents a deficiency of the friend-of-friend algorithm. The algorithm showed no recommendations because it does not find inputs (friends). The friend-of-friend algorithm is based on the friends of a certain user. So, if this user is not connected to any friend, the algorithm cannot recommend any user.

The same result was obtained in Scenario 3, where no people were recommended because the user of recommendations was already connected to all users of the group. Scenario 4 has the same result of Scenarios 2 and 3, showing no recommendations. This happened because this algorithm needs the friends of a certain user, but in this case they have no friends.

VII. CONCLUSION AND FUTURE WORK

Social network sites are very popular nowadays, and these systems allow performing several activities that provide propagation of knowledge and collaboration among its users. Thus, it is necessary to make connections increasingly effectives, in order to obtain more collaboration among users, as well as to avoid huge efforts when performing searches of people in the SNS. The recommender system is responsible to enhance this effect.

Therefore, this paper aimed to reflect over the proposal of a recommender system to recommend people in GenNet social network, which aims to warrant rights to people affected by rare diseases generated by genetic disorders.

The objective of the proposed recommender system is to improve the communication among users, increasing the medical knowledge exchange in the SNS. The higher the number of friends, the better will be the information exchange. Thus, the communication among doctors, patients and other users of GenNet in order to discuss medical information will be improved.

The algorithm developed in this work is based only on social network information. Thus, as a future work there is the intention to improve the proposed algorithm by adding content-based approach to it, making it a hybrid algorithm.

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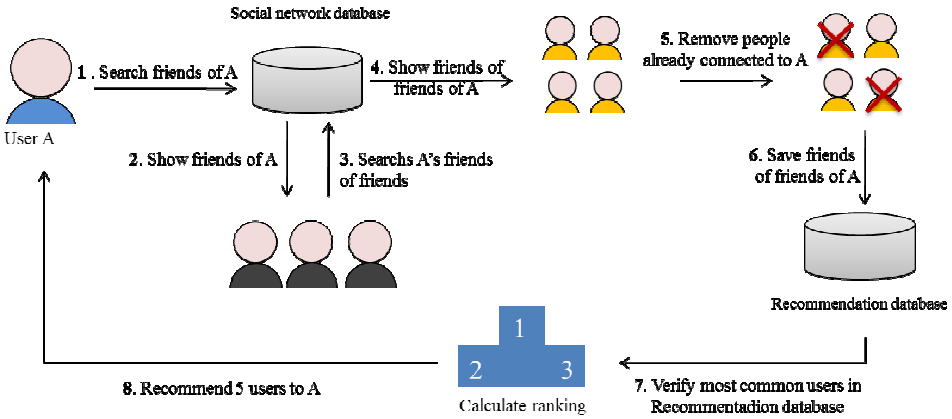

Figure 2. Functional diagram of the algorithm.