

EXPLOITING SOCIAL CONTEXTS FOR MOVIE RECOMMENDATION

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ABSTRACT

A social networking service (SNS) allows users to share information with family, friends, and communities. Since there are many kinds of information uploaded and shared through an SNS, the amount of information on such sites keeps increasing exponentially. In particular, Facebook has adopted some interesting features related to entertainment (e.g., movies, music, and TV shows). However, they do not consider contextual information of users for recommendations (e.g., time, location, and social context). Therefore, in this paper, we propose a novel approach for movie recommendations based on the integration of a variety of contextual information (i.e., when the users watched the movies, where the users watched the movies, and who watched the movie with them). Thus, we developed a Facebook application (called MyMovieHistory) for recording the movie history of users and recommending relevant movies.

Keywords: Recommendation Systems, Social Contexts, Facebook, User History, Timeline

1.0 INTRODUCTION

Social networking sites are places such as Facebook, Twitter, and Google+ where people post their thoughts and share their ideas. They are growing rapidly, becoming a part of our lives. A lot of applications have been using metadata from social networks in application development. The systems can understand and discover several important things about specific users and their friends. Information sharing among the systems is a new trend on the Internet. For example, IMDB (<http://www.imdb.com>) data has been integrated into the movies feature on social network and different movie-related systems. In addition, some authors have proposed new approaches to deal with the cold-start problem in recommendation systems by using social user profiles [1, 2].

Several applications to integrate contextual information have been used and have proved that context modeling is a potential opportunity for all types of applications [3]. Within these growing social networks, social context is a new approach to user profiling [4]. In traditional recommendation systems, we can build an individual user profile. However, in recommendation systems on social networks, not only can we build a specific user profile but we can also build group profiles [5].

Social contexts contain a set of particular situations for a user or a user group. Thus, social context extraction is an important process in understanding user activities on social networks. This not only offers user-friendly interactions to the user but it also provides useful information for social context-based applications. There are several applications that have been integrated into social networks. Facebook is a social service where users share information with family, friends, and the online community. Many kinds of data are uploaded and shared via the website, and the amount of data continues to grow incessantly.

Recommendation systems are support tools to help users choose products they may be interested in. Furthermore, the number of movie repositories on the Internet is increasing rapidly. This offers many opportunities for

everyone to watch and share movies. Thus, movie recommendation systems have been developed as an application on Facebook that bring together users who share a passion for movies.

Movie recommendation systems are personalization techniques to overcome the information overload problem by recommending movies based on a user's preferences. There is a movie section on Facebook. Using this feature, users can choose which movie they want to watch, and it shows a list of movies that the user has watched. Users can share these movie lists with friends and others. The section also suggests a list of movies of potential interest to the user.

However, Facebook has not taken into account contextual information, such as when you watched the movie, who watched with you, and where you watched the movie. Studying a user's preference in a particular situation is very important for predicting a list of movies that may be interesting to that user at any one moment. A system can be developed based on the user's current situation, emotions, and other contextual information, which may bring more satisfaction to the user. We consider the following tables:

Table 1. Context-based user model.

	i_1	i_2	i_3	i_4	i_5	i_6
u_1	r_{11}		r_{13}	r_{14}		
u_2	r_{21}	r_{22}		r_{24}		r_{26}
u_3			r_{33}	r_{34}	r_{35}	

Table 1 contains 3 users u_1, u_2, u_3 , 6 movies i_1, \dots, i_6 . The value r_{ij} expresses that u_i watched movie j . With Table 1, it is difficult to explore the relationships among the users. Assume that u_1 is the current user. This person watched the same two movies with other users. For example, how do we know if u_1 and u_2 watched movie i_1 together? Since u_1 and u_3 watched movie i_4 , how do we know if they have a relationship with each other? How do we recommend movies of potential interest to these users? It is difficult to find suitable movies. Thus, in this paper, we propose a new approach for movie recommendations based on social context information. We apply collaborative filtering by computing the similarity between two users based on social context. We also developed a new application on Facebook for our idea, called *MyMovieHistory*. In this application, we can describe a movie history as a timeline of movie watching.

The outline of this paper is organized as follows. In Section 2, we discuss social context and recommendation modeling based on social context. In Section 3, we describe the recommendation process. In Section 4, we discuss related works. Finally, in Section 5, we conclude our proposal and suggest future work.

2.0 SOCIAL CONTEXT IN MOVIE RECOMMENDATION

In this section, we discuss various contexts in social networks, and in particular, social context-based movie recommendation. We also present formal definitions for social context. Social context can provide content such as a user's location, activity, surrounding people, agenda [23, 24], and emotion [13]. Other definitions about social context refer to interactions wherein people react to events differently, depending on their immediate situation. For example, some people do not like to watch comedy movies alone, but if their friends invite them to watch this kind of movie, they might agree to join the group. Social context is contextual information describing where you are, what you are doing and who you are with. Fig. 1 shows a sample social network.

common characteristics of other people on the network in order to make friends. For example, if you like *James Cameron* movies and I do too, we can become friends on Facebook even though we did not know each other before. The following definition presents the relationship between users based on user movie history.

Definition 2 (Social relationship) $G(u)$ is a set of users who are the user's friends. $\forall u' \in G(u)$, the relationship based on watched-movie history, is denoted as $r(u)$ and is represented as follows:

$$r(u, u') = \begin{cases} w(u, u') & \text{if } I(u) \cap I(u') \neq \emptyset \\ 0 & \text{otherwise} \end{cases}$$

where, $w(u, u')$ is weight of the relationship between u and u' , $I(u)$ and $I(u')$ are watched movie sets of users u and u' , respectively.

The weight of the relationship is defined as follows:

Definition 3 (Weight of the relationship) Weight of the relationship between two users is computed as follows:

$$w(u, u') = \frac{\text{card}(I(u) \cap I(u'))}{\text{card}(I(u))} \quad (2)$$

For example, we have $I(u) = \{i_1, i_2, i_5, i_7, i_8\}$ and $I(u') = \{i_2, i_3, i_4, i_5, i_7, i_9, i_{10}\}$.

The weight of the relationship between u and u' is computed as: $w(u, u') = \frac{3}{5} = 0.6$ and $r(u, u') = 0.6$

In a social network, we usually consider two kinds of information. The first is individual user information. This information is compiled by a user. This person will be the "inviter". The second is group information. This information is accepted and shared by the user's friends. The friends will be the "invitees". Hence, there are two kinds of user profile [5].

- Individual user history profile
- Group history profile

A user movie history consists of two parts. One part contains dominant values by extracting a set of watched-item attributes and a set of attribute values. The other part contains contextual information depending on the user's situation in time intervals. A context-based user profile is considered according to two aspects:

- Time-based: We consider the time that a user accesses Facebook. This is very important in order to identify the user's situation. For example, a user who accesses in the morning is different from a user who accesses at night, and recommendation results will be different.

- Location-based: Depending on the user's current location, the system adapts different recommendations. For example, one user has taken a trip to other country; the system will recommend a list of movies that may be related. Group profile expresses the group preference. This means that it contains a list of movies that each user in the group shares with others and also a list of locations and times that they watched together.

- List of friends who shared a list of movies
- List of watched movies
- Weight of inter-relationships between friends

The main goal of context-based movie recommendation is not only to suggest movies that each user may be interested in but also that are suitable for a particular situation. In the next section, we will present our framework for recommending.

3.0 RECOMMENDATION PROCESS

3.1 Context-based Movie Recommendation Systems

Social context-based movie recommendation systems suggest a list of movies to users by using a set of user-context information. For a particular situation, the system will provide a specific recommendation. Social networks offer a lot of advantages for developing recommendation services. The services can access a user's profile, a user's interests, or the user's activities for extracting overall user preferences. Fig. 3 provides an overview of a movie recommendation process. In order to create the recommendation process, we have the following definitions.

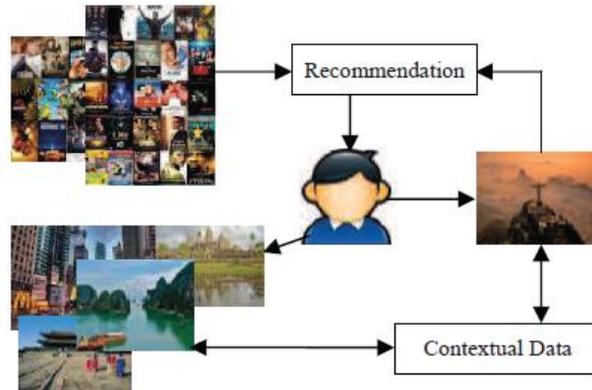


Fig. 3. Place-based recommendation process

Definition 4 (Movie history) Given social context SC , $\forall u \in U$, a movie history is defined as follows:

$$Hist(u) = \{(i, c, f) \mid \forall i \in I, c \in sc(u), f \in U\} \quad (3)$$

In this paper, we apply a collaborative filtering (CF) technique by computing the similarity between two users based on social context. Assume that we take into account two elements of social context: time and location. We have the following definition.

Definition 5 (Similarity) Let $c \in C$, given two users $u, u' \in U$. The similarity between two users based on social context is defined as follows:

$$sim(u, u') = \frac{1}{card(C)} \sum_{c \in C} (sim(u, u')_c) \quad (4)$$

where $card(C)$ is a function that returns a number of social context elements, and $\forall c \in C$.

$$sim(u, u')_c = \frac{\sum_{i=1}^n (sc_u^{hist(u)} \times sc_{u'}^{hist(u')})}{\sqrt{\sum_{i=1}^n (sc_u^{hist(u)})^2} \times \sqrt{\sum_{i=1}^n (sc_{u'}^{hist(u')})^2}} \quad (5)$$

where sc_u and $sc_{u'}$ are vectors of certain context elements of u and u' , respectively.

According to Def. 5, the similarity between users based on social context is computed by using similarities in social context elements. For example, if a set of contexts consisting of three elements *Time*, *Location*, *Friend*

is denoted t, p, f , we have:

$$sim(u, u') = \frac{1}{card(3)} (sim(u, u')_t + sim(u, u')_p + sim(u, u')_f)$$

A recommendation result is computed as follows:

$$Rec(u) = TopN(\Pi_{u' \in U} (sim(u, u'), w(u, u'))) \quad (6)$$

where, $TopN$ is a function to find out the number of potential movies that may be suitable for the user's situation. The list of movies depends on who has the highest similarity, and the Π function supports selecting the candidates. Considering the example in Fig. 1, we have a table as follows:

Table 2. Context-based user-movie model.

	<i>Wanted</i>	<i>Avatar</i>	<i>Titanic</i>	<i>Spider-man</i>	<i>Troy</i>	<i>LionKing</i>
Hau		c_2, p_2	c_3, p_3	c_4, p_4		c_6, p_6
Bao		c_2, p_2		c_4, p_4		c_6, p_6
Binh			c_3, p_3	c_4, p_4		c_6, p_6
Hieu	c_1, p_1	c_2, p_2			c_5, p_5	

In traditional CF, the relationship between two users is expressed by computing the similarity without considering the real relationship. For example, the similarity between u_1 and u_2 is the same as the similarity between u_1 and u_5 . However, on Facebook, u_1 and u_5 are close friends. Hence, if we additionally consider the social relationship, then the similarity will change. We assume that the recommendation will be better if the recommending process is based on the close relationship. It means that a recommendation from close friends will be better than others.

3.2 My Movie History as Watching Timeline

Facebook's application is a new trend to apply services to the social network. Facebook is discussed as a nation by Lee [25]. There are a lot of applications that have been developed by using the Facebook API. Facebook is the first in the list of most visited social networking sites. According to statistics at the link <http://newsroom.fb.com/Key-Facts>, in March 2013, there were 655 million daily active users, 751 million monthly active users who used Facebook mobile products, and 1.11 billion monthly active users. The total number of Facebook apps is about 10 million, and the average number of friends per Facebook user is about 142.

In this section, we introduce our recommendation system, called *MyMovieHistory*, which is a Facebook application for movie recommendations. The application provides a better recommendation process based on extracting social context. In order to use our application, users must have a Facebook account and run *MyMovieHistory* in the APPS section. Another way to use our application is to access the link <https://apps.facebook.com/mymoviehistory>. This social context-based movie recommendation system consists of components as follows:

– Creating the user history: each user talks about his/her watched movie history. Each user can add their story as a timeline. Each watched movie includes the following information:

- + Which movie they watched
- + When they watched this movie
- + Who they watched the movie with
- + Where they watched this movie



Fig. 4. My movie history function

- Extracting the user’s social context: after collecting the user’s contextual information that is related to this movie, the system will extract a set of social context. The contextual information in the application consists of three elements: time, location, and friends. If a user does not select any friend(s) who watched a movie with him (see Fig. 4), it means that she or he watched this movie alone.
- Discovering user’s relationships: the system extracts a list of user’s friends from the Facebook profile.
- Extracting the dominant attribute values: the dominant attribute values will be identified by using attributes-values pairs from the list of watched movies [26]. In this application, we focus on three movie attributes: *Genre*, *Actor*, and *Director*. The statistics are shown to the user as shown in Fig. 5.



Fig. 5. My Movie History’s main interface

- Editing movie history: the system helps users change their history. For each event, a user can share it with friends who watched this movie with them; the user can change the time that he/she watched this movie; and the user can delete the event. Each user has a list of friends. Users can share history events with their friends. When a user shares certain events with his/her friends, the system automatically identifies the inviter and the invitees. It is important to extract the relationships among users for the movie. The movie history relationship is expressed with inviter and invitee labels, as seen in Fig. 6. The *inviter* is the first user who adds a movie to the history, and the *invitee* is a friend of the user who shares this history.
- Recommendation: when users log in to our application, a list of potential movies will be recommended. If we know a user’s history, we can know what she or he may be interested in. Depending on the user context, the system can recommend different sets of movies to the user. We will recommend movies to individual users. In this process, we applied a CF method to find out the highest similarity between the current user and the others based on social context.



Fig. 6. The movie history relationship

– Notification: the system will automatically send a message to users who are on the list of friends who were watching together when a movie is added to the history, as shown in Fig. 7.



Fig. 7. Invited movies and notification in movie history

– Invited movies: the current user is shown the list of invited movies, which includes friends who watched with the user. When a certain user adds a movie to the history, if this user watched with friends, then this application will automatically send a notification to them and will also add this movie into a list of invited movies. Users can select movies that are already available in the invited movies section. Selected movies will be inserted into their history.

– Sending request application: a Facebook request will be sent to the user's friends in order to invite them to use this application if they have not used it yet. It will present an application request as shown in Fig. 8.



Fig. 8. Sent request application

– Adding new movies: users can add a new movie to our application. In order to get the right movie, the user should provide the correct movie title and provide the year of release, if there are other movies that have the same title.

– Integrated data: after adding new movies to the system, the movie information is also extracted and presented to users. This data is from IMDB. Currently, the movie database has over 3000 movies and is still being added to by participants.

Avatar (2009) with Kor Keyu [invitee], Pham Gia Bao [invitee]



Fig. 9. Movie information

– Timeline: user history will be shown as a timeline. The set of movies will be grouped according to year. Each history is marked by time and place that user watched movie.

– Movie information: this feature shows detailed movie information as shown in Fig. 9. The movie information is extracted from IMDB.

We tested our proposed approach with a small dataset described as follows:

- There are 15 user profiles.
- There are over 3000 movies in the dataset.
- The average number of movies in user histories is 10.
- The number of single-movie histories is 50.
- The number of shared movie histories is 100.

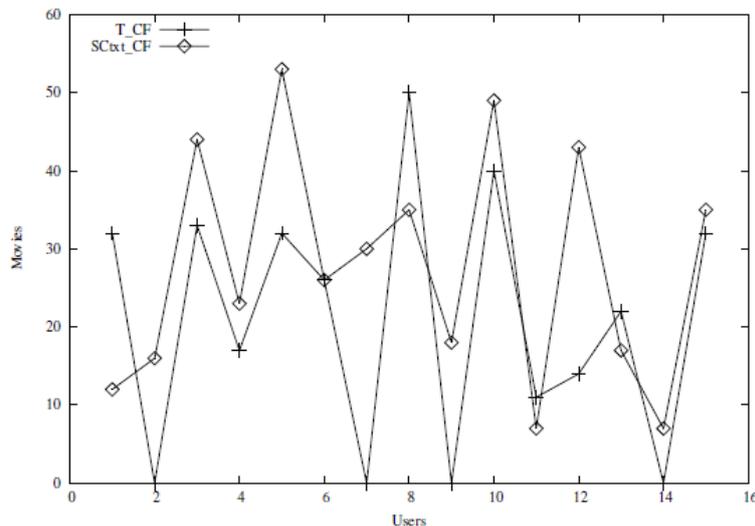


Fig. 10. Comparing recommended movies between T-CF and SCtxt-CF

In order to compare our proposed approach, we applied two kinds of collaborative filtering. One is based on watched movies, namely, traditional CF (T-CF) and the other is based on social context, namely, social context-based CF (SCtxt-CF). Fig. 10 compares the two implementations. Our approach can find recommendations for

all users, whereas TCF has some trouble; it cannot offer recommendations to four of the users. Our result also shows that the number of recommended movies in almost all cases is better.

4.0 RELATED WORK

Social context is very important in social networks. It influences user behaviour and user relationships. Mollenhorst et al. [6] examined the effect of social context on similarity in personal relationships. A particular user social context expresses a specific user situation on the system. Each user has different interactions in different situations. Doreian and Conti [7] discussed social context that influences network representation in different contexts. Ljepava et al. [8] investigated personality and social factors that can influence a user's decision to use Facebook and looked at the differences between Facebook non-users and frequent users.

Recommendation systems have been applied to social networks. However, social context-based systems for recommending have not yet been considered. Several studies looked at contextual information and applied it to recommendation systems [9, 10, 11, 12]. In addition, the investigation of context parameters in the movie domain was also mentioned. Jung et al. and Derks et al. [13, 14] focused on analyzing interactions among characters based on emotional similarity in movie stories to discover relationships. Mori et al. [15] proposed a method to extract underlying relations among entities from social networks. They found contexts in which two entities co-occur, and the given collective context was clustered based on similarity.

Quijano-Sánchez et al. [16] introduced a group recommendation system as a Facebook application. They made recommendations for user groups based on three factors: personality, social trust, and previous recommendations. However, they did not show this application on Facebook. The number of user groups on Facebook is increasing more and more. It is difficult for a user to select the right group to join. In order to solve this problem, Baatarjav et al. [17] introduced a group recommendation system using a combination of hierarchical clustering and a decision-tree technique based on users' profiles.

Movie recommendation systems have also been considered in social networks. Davidson et al. [18] presented their video recommendation system on YouTube. They proposed a recommendation framework based on a user's previous activity on the site, and a top-N algorithm is applied to find high-quality videos relevant to the user's interests. Using a network of reviewers of videos and extracting information from them to make recommendations was proposed by Qin et al. [19]. Social network profile-based systems for recommendation have been set up to deal with the cold-start problem [20, 21]. They applied existing user profiles to predict a user's interests and to make recommendations. Carrer-Neto et al. [22] proposed a social knowledge-based recommendation system. It makes use of ontology principles to build a mechanism to help users find relevant movies according to their preferences.

5.0 CONCLUDING REMARKS

Social networks have become a global phenomenon. Content and number of users in these communities grows rapidly. Users can share information and make new friends without considering location and time. Thus, developing a movie recommendation system as a Facebook application based on contextual information is a new approach, bringing a new opportunity to provide user satisfaction. Social context provides useful information for making recommendations, such as where you are, who your friends are and so on. In this paper, we propose a new framework for such an application. The recommendation process is generated by computing similarity among users based on social context and dominant attribute values. Our application is also available on Facebook, allowing users to talk about their watched movie history and to share their histories with friends. We applied the Facebook API to develop our application, called *MyMovieHistory*.

In future work, we will fully present our experimental results after collecting more data. We will consider user activities on Facebook and modify our application to make it more comfortable to use. We will also try to use the Facebook mobile API to develop a mobile application.

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