Social Context-Based Movie Recommendation: A Case Study on MyMovieHistory

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Abstract. Social networking services (in short, SNS) allow users to share their own data with family, friends, and communities. Since there are many kinds of information that has been uploaded and shared through the SNS, the amount of information on the SNS keeps increasing exponentially. Particularly, Facebook has adopted some interesting features related to entertainment (e.g., movie, music and TV show). However, they do not consider contextual information of users for recommendation (e.g., time, location, and social contexts). Therefore, in this paper, we propose a novel approach for movie recommendation based on the integration of a variety 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 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[1] 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].

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[1] http://www.imdb.com

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 brings 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 Table 1.

Table 1 contains 3 users u_1, u_2, u_3, 6 movies $i_1, .., i_6$. The pair c_{ij} expresses that u_i watched movie j within social context c.

Table 1. Context-based user model

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

Assume that u_1 is current user. This person watched the same two movies with other users. 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 recommendation 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, you can describe your movie history as a timeline of movie watching.

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

2   Related Work

Recommendation systems have been applied to social networks. However, social context-based systems for recommending have not yet been considered. In [6–9], they presented about contextual information and applied it to recommendation systems. In addition, the investigation of context parameters in the movie domain was also mentioned. In [10], author have focused on analyzing interactions among characters based on emotional similarity in movie stories to discover the relationships. In [11], they 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.

In [12], they 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. [13] 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. In [14], they 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 [15]. Social network profile-based systems for recommendations have been applying to deal with the cold-start problem [16,17].

3   Social Context in Movie Recommendation

In this section, we discuss various contexts in social network. Also, particularly, social context-based movie recommendation will be explained. We also present
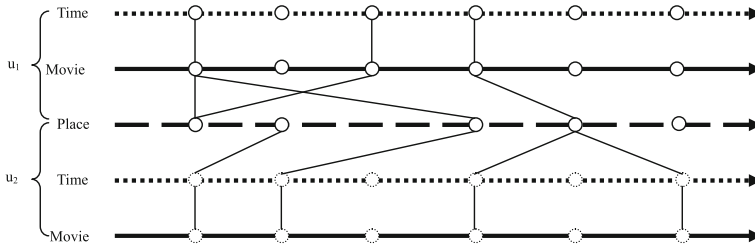
Fig. 1. Movie history as Timeline

formal definitions for social contexts. Social context can provide content such as a user's location, activity, surrounding people, agenda [18], and emotion [10]. 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 and they may be interested in this movie.. Social context is contextual information describing where you are, what you are doing and who you are with.

Contextual information is mentioned in social network sites as interaction data between user and system, or user activities. Depending on the kind of application, context is considered to have different aspects. In [3], they proposed the categories of context parameters such as User&Role, Process&Task, Location, Time and Device. In [7], they considered contextual information in music recommender systems such as environment context (e.g., location, time, weather and so on), user context (e.g., activity, demographical, emotional and so on). We assume that users with the same social context may have a sense of social consensus.

From Table 1, we can depict the movie histories of two users in the form of Timeline, as shown in Fig. 1.

The relationship between user and movie within a social context is defined formally as follows.

Definition 1 (Social context). *Given a set of users $\mathcal{U}$, a social context $\mathcal{SC}$ is represented as:*

$$\mathcal{SC} = \langle \mathcal{U}, \mathcal{I}, \mathcal{C} \rangle \tag{1}$$

where, $\mathcal{I}$ is a set of items and $\mathcal{C}$ is a set of contextual information.

For each user $u \in \mathcal{U}$, a social context for an individual user is expressed as follows: $sc(u) = \{(i, c) | i \in \mathcal{I}_u, c \in \mathcal{C}\}$.

In Fig. 1, we can see that the location for each user is the same. It means that these users watched different movies in the same location. In the social network, the relationship among users is very important. The mission of a social network is to share information and help people connect. Each user may find out about 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 movies 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:*

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

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 complied 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 profiles

A user movie history consists of two parts. One part contains a dominant values by extracting a set of watched-movies attributes and a set of attribute values. The other part contains contextual information depending on the user's situation. 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 be 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-relationship between friends

The main goal of context-based movie recommendation is not only to suggest a list of 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.

4   Recommendation Process

4.1   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. Figure 2 provides an overview of a movie recommendation process. In order to make the recommendation process, we have the following definitions.
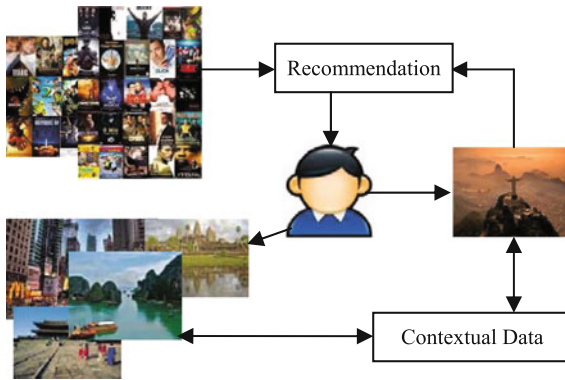

Fig. 2. Place-based recommendation process

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

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

In this paper, we apply a collaborative filtering 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 contexts is defined as follows:*

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

where $card(C)$ is a function that returns a number of social context elements and $p \in P$

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

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

According to Definition 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 $Time, Location, Friend$, 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:

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

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.

4.2   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 in [19]. 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[2], 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. Total number of Facebook apps is about 10 million, and the average number of friends per Facebook user is about 142.

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[2] http://newsroom.fb.com/Key-Facts

In this section, we introduce our recommendation system, called *MyMovieHistory*, which is a Facebook application for movie recommendation. 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 *My Movie History* in the *APPS* section. Another way to use our application is to access the link[3]. 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
– Extracting the user's social context: the system collects the user's contextual information that is related this movie. 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, it means that he/she watched this movie alone.
– Discovering user's relationship: the system extract a list of user's friends from the Facebook profile. When a certain user adds his/her friends into history, the application will send automatically the notification to them.
– Extracting the dominant attribute values: the dominant attribute values will be identified by using attributes-values pairs from the list of watched movies [20]. In this application, we focus on three movie attributes: *Genre*, *Actor* and *Director*. The statistics are shown to the user.
– 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.
– Recommendation: When users log in to our application, a list of potential movies will be recommended. If you know a user's history, you can know what he/she may be interested in. Depending on the user context, the systems can recommend different sets of movies to the user. We will recommend movies to individual users. In this process, we have applied collaborative filtering method to find out the highest similarity between current the user and the other friends.
– Integrated data: The information about movies from IMDB is also extracted and presented to users.

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[3] https://apps.facebook.com/mymoviehistory/

5   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 record 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 present our experimental results after collecting data. We will also consider user activities on Facebook and develop 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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