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Virtual friend recommendations in virtual worlds

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ABSTRACT

Virtual worlds (VWs) are becoming effective interactive platforms in the fields of education, social sciences and humanities. Computing similarity among users is a technique commonly used to make friend recommendations in social networks. However, user communities in virtual worlds tend to have fewer real world linkages and more entertainment-related goals than those in social networks. The above characteristics result in an ineffective modality with respect to applying existing friend recommendation methods in virtual worlds. This study develops a virtual friend recommendation approach based on user similarity and contact strengths in virtual worlds. In the proposed approach, users' contact activities in virtual worlds are characterized into dynamic features and contact types to derive their contact strengths in communication-based, social-based, transaction-based, quest-based and relationship-based contact types. Classification approaches were developed to predict friend relationships based on user similarity and contact strengths among users. A novel friend recommendation approach is further developed herein to recommend friends as regards certain virtual worlds based on friend-classifiers. The evaluation uses mass data collected from an online virtual world in Taiwan, and validates the effectiveness of the proposed methodology. The experiment results show that the friend classifier that takes into account user similarity and contact strengths can elicit stronger prediction performance than the friend-classifier that considers only user similarity. Moreover, the proposed friend recommendation method outperforms the traditional *friend of friend* (FOF) method of friend recommendation in virtual worlds.

1. Introduction

A *virtual world* (VW) is an electronic environment which visually mimics complex physical spaces, wherein people are represented by avatars and interact with each other via virtual objects. The growing trend of playing online games with friends has encouraged the now flourishing VW market. Ubiquitous computing has also been instrumental in the move by families away from television to participating in virtual worlds instead [3].

Increasingly more VWs have come to correlate with *social network* (SN) platforms. Successful friendship recommendation techniques may increase sales for these SN companies, a notion which has fuelled a number of studies on friend recommendations in the context of SNs. However, the concept of friend recommendation in VWs remains relatively unexplored.

Friend recommendation in VWs induces users to engage in more contact activities. Stable relationships are positively associated with social presence, and this enhances user immersion in the VW. In addition, social interactions in VWs may shape purchase behaviors. User immersion increases user intention to purchase, which increases sales from advertisements for the VW providers [2].

User contacts in VWs differ significantly from user interactions in SNs in the following ways:

(1) *Identity difference*. Players in a VW begin as strangers to other players, while users in SNs tend to associate with their real-world friends. VW players are not identified by their demographic attributes, such as their job, education or location. An avatar represents the very personality and uniqueness of each player, regardless of appearance, rather than an identity that is linked to some real-world group in an SN. Thus, virtual worlds based on models of ownership and achievements make it possible to differentiate users and build esteem [4,16].
(2) *Heterogeneous activities*. In a VW, players engage in more diverse activities, such as bidding, role-play, or joining lotteries and contests hosted by VW providers, than do those in SNs. Due to the variety of complex actions available in the VW, virtual contact activities within groups offer more interesting homophilic attributes for researchers to explore. Recommendations by friends in SNs focus on analyzing the similarity of user attributes, such as mutual interests [15], time and location [30]. Models focusing on attribute similarity may be suitable for SNs, however they are not suitable for VWs. For example, avatars can swiftly move to any location in a VW, so spatial dynamics become less important for virtual interactions than they are in the real world [2]. Motivating users and keeping them continually engaged is an important

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challenge for those who create and manage virtual world websites [31]. Therefore, an effective recommendation method that considers contact activities will enhance the success rate of recommendations and increase the degree of user flow in a VW.

(3) *Hedonic orientation*. Participants in VWs are less information- and socially-oriented than they are game- and role play-oriented [29]. Lu and Wang have shown that perceived playfulness and descriptive norms influence online game addiction [22]. As such, friendships in VWs need not be based on direct interactions. Players may complete the same quests or stay in the same community without steady communication. These kinds of contacts may deepen the impression of group players. The stability of the virtual arena increases the likelihood of regular encounters with "familiar strangers", thus establishing connections between participants and building friendships [26]. Thus, the ways that VW users make friends differ from those in SNs. In this paper we set user *contacts* rather than *interactions* in order to broaden participants' connections in VWs.

Classification and cluster methodologies have been successfully applied in merchandise recommendation, increasing related sales. Notably, there is a trend toward friend recommendation in SNs. In recent years, increasingly more research has focused on friend recommendation for weblog platforms, such as Livejournal, Amazon and Twitter. Golder et al. structurally classified friend recommendations in SNs into four categories: reciprocity, shared interests, shared audience and filtered people [11]. Kwon and Kim [20] and Hsu et al. [15] combine the idea of shared interests with social context and friends of friends, respectively. Shared interests are user attributes, and present effective results. However, little research has focused on friend recommendation in VWs. This study thus proposes a friend recommendation method for VWs. According to the special attributes of VWs, this paper has the following three contributions:

(1) This paper combines user-to-user virtual contacts with user (attribute) similarities. Most existing friend recommendation methodologies have focused on user similarities. Most studies have applied user attributes such as time, location [15], graph-based algorithm [27] or the *friends of friends* (FoF) method. This study, however, focuses on contact strengths such as quest participants and how they spend money within the context of the platforms.

(2) This study proposes a friend recommendation methodology for a complex environment in a virtual world, in which users have heterogeneous contacts with other users. Although some studies have focused on friendship recommendation in SNs, the activities are more simple, such as reading articles or replying to a message [23,15]. The proposed model decomposes the complex virtual contacts in a VW into a set of dynamic features and categories in order to derive their contact strengths in communication-based, social-based, transaction-based, quest-based and relationship-based contact types.

(3) The experiment conducted in this study collects user activity and profile data from the online Roomi (www.roomi.com.tw) database in order to build a social network in the virtual world. The data directly depicts players' lives in the VW, rather than taking information from the players' questionnaires. The proposed model performs more effectively than other recommendation models with respect to the massive amount of data and complex circumstances. This suggests that conventional SN friend recommendation models may not perform effectively in VWs. Moreover, the experiment result shows that both user similarity and contact activities affect friend-making in VWs.

The remainder of this paper is organized as follows. Section 2 reviews related works on VWs and the theory applied in this study, including the *support vector machine* (SVM), information gain and the principal of homophily. Section 3 elaborates on the proposed methodology. Section 4 demonstrates the experimental steps and results. Section 5 closes with conclusions and observations.

2. Related work and theoretic background

The essential features of social-networking web sites are such that they provide a platform in which members can easily create profiles containing information about themselves, and define their trusted circle of friends [24]. A virtual world is a three-dimensional space where everyone can play as an avatar, performing a variety of activities with each other, including games. In VWs, people can engage in social activities, as in SNs; however, the characteristics of the two platforms are very different. There are increasingly more research results regarding friend recommendations in SNs, but little research has been conducted with respect to friend recommendation in VWs.

This section first refers to existing friend recommendation methods in SNs, and then elaborates on recent research on VWs in order to demonstrate the lack of friend recommendation methodology in literature. It then introduces classification methods, SVM and KNN, and information gaining measures applied in the proposed model.

2.1. Friend recommendation in social networks

The principle of homophily is the idea that contact between similar people occurs at a higher rate than between dissimilar people. Potential new ties are heavily dependent on our existing set of ties, e.g., friends of friends, and on the organizations of which we are part, such as schools, workplaces and community groups [27]. Golder et al. [11] stated that increased internal density will help an organization build a community at the lowest expense. Three of four recommendation principals suggest friends based on common interests and tracked activities.

Some studies have utilized user interests and friends in the context of a social graph to predict friends. Kwon and Kim [20] proposed a friend recommendation method with a friendship score. The friendship score was computed using both a physical and social contexts in an SN. The physical context was represented by the similarity of user profiles, such as user location and time, and the social context was taken from the friend relation in the friendship graph. Hsu et al. analyzed the friendships in LiveJournal [15], and predicted friends by means of a decreasing count of mutual interests and graph features, such as inward/outward degree of nodes and number of mutual friends. Silva et al. [27] used the data obtained from the Oro-Aro SN in Brazil, and utilized the graph topology of the SNS (social network services) to filter second degree FoFs of a given node.

As customer behavior prediction has become extremely common in recent years, trust relationship recommendation in SNs has begun to receive a significant amount of interest. Ma et al. [23] predicted trust relationships between two users by using user interaction features in an online user-generated review application, with interaction features based on combinations of rating score and rating numbers.

Interpersonal communications constitute an important communication media, especially for social groups not easily accessible to mass media advertising [19]. Therefore, the application of social graphs, user profiles and user interests to predict friendships demonstrates a major portion of existing SN research.

2.2. Research on virtual worlds

With the increasingly ubiquitous nature of computing, VWs are rapidly growing in popularity. Kzero Worldwide stated that the total number of registered VW accounts reached 1400 million, and the reported revenue would increase from $3.9bn in 2011 to $6bn by the end of 2012 [21].