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Extraction of user profile based on workflow and information flow

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ABSTRACT

A collaborative team usually consists of team members with various domains. These members' demands for knowledge are also different from each other. For recommending potentially useful knowledge to suitable members, their user profiles should be well managed and maintained. User profile can be input by the members, but a more intelligent way should be the automatic extraction of the user profiles. Workflow and information flow are two types of collaborative processes, which exist behind every collaborative team. This paper is mainly concerned with how to extract these team members' user profile from the two types of contexts: workflow and information flow. This paper defines a model for the user profile. Then some methods are proposed for extracting the profile information on the basis of workflow and information flow. This study on the user profile extraction can pave the way for developing knowledge recommender systems, which can recommend proper knowledge to proper team members with a collaborative team.

1. Introduction

Knowledge sharing is important for collaborative teams, in which team members are usually geographically and disciplinary distributed. As the team members often belong to different domains, have different backgrounds, their requirements for knowledge are also different from each other (Zhen, Jiang, & Song, 2011). For realizing efficient knowledge sharing among a collaborative team, an important issue lies in how to accurately obtain team members' profiles, which describe their demands for knowledge. The user profiles should be extracted from context environments intelligently rather than be input by users manually (Adomavicius, Sankaranarayanan, Sen, & Tuzhilin, 2005). Workflow and information flow are two types of collaborative processes, which actually exist behind every collaborative team (Zhuge, 2002, 2002, 2006). Workflow and information flow can provide us some contextual information for obtaining the members' profiles. This paper defines a model for the user profile. Then some methods are proposed for extracting the profile information on the basis of workflow and information flow. This study on the user profile extraction can pave the way for developing knowledge recommender systems, which can recommend proper knowledge to proper team members with a collaborative team (Smirnov, Pashkin, Chilov, & Levashova, 2004).

The remainder of this paper is organized as follows. Related works are reviewed in Section 2. A model of user profile is defined in Section 3. Section 4 elaborates on the proposed approached for extracting user profile based on workflow and information flow. Section 5 illustrates the results from some numerical experiments. Closing remarks are given in the last section.

2. Related works

This paper belongs to the area of knowledge engineering, or knowledge management (KM) (Lai, 2007). KM is mainly defined as the formal management of knowledge for facilitating creation, access, and reuse of knowledge, typically by using advanced technology (Rasmus, 2000). It concerns the management aspect (e.g., the organizational learning, behavior, and culture) and technical support (Drucker, 1998). The user profile extraction is related to knowledge sharing and its technical support. The researches on knowledge sharing concern about experience reusing among teams (Petter & Vaishnavi, 2008), members' collaboration in network organizations (Santoro, Borges, & Rezende, 2006), buddy finding for knowledge exchanging and sharing (Li, Montazemi, & Yuan, 2006). Besides these technical methodologies, knowledge sharing is also implemented from the views of learning behaviors (Law & Ngai, 2008) and social cognitive theories (Chiu, Hsu, & Wang, 2006).

User profiles are an important source of metadata for recommender systems (Middleton, 2003). To improve precision and increase information access efficiency, the Web search process has to evolve further with the ability to incorporate user's search intension (Middleton, Shadbolt, & De Roure, 2004). However,

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valuable user profiles are difficult to acquire without manual intervention. Ontological user profiles can facilitate the search engines to perform more intelligent search and retrieval tasks. Recently, some ontology-based user profiles models have been developed (Li & Zhong, 2004; Trajkova & Gauch, 2004; Zhou, Li, Xu, & Lau, 2006). In these researches, user profiles focusing on various aspects have been integrated into the Web searching. For example, the profile proposed in Middleton is the reference ontology whose concepts have weights representing the perceived user interest in each of them. Li and Zhong (2006) classified Web user profiles into two diagrams: the data diagram and information diagram. Besides above ontological commitment for user profiling, Godoy and Amandi (2006) proposed a user profiling technique based on the Web Document Conceptual Clustering algorithm that lets agents acquire profiles without an a priori knowledge of user interest categories. Based on singular value decomposition along with demographic information, Vozalis and Margartis (2007) brought out a new collaborative filtering method to increase accuracy in describing and predicting users' profiles.

The target of obtaining users profile is for recommendation. The recommendation technology has become a promising and hot area in both academia and industrial, various recommendation systems have been developed (Adomavicius & Tuzhilin, 2005). Goldberg, Nichols, Oki, and Terry (1992) is one of the earliest recommendation systems. Based on this work, several automated recommendation systems have been developed. As to book recommendation, Mooney and Roy (2000) proposed a content-based recommendation system. McNee et al. (2002) proposed a recommendation system to help research paper citation. Mobasher, Cooley, and Srivastava (2000) employed web usage mining methods so as to release automatic personalized recommendations. For improving e-commerce sites sales, a taxonomy recommendation system is developed by Schafer, Konstan, and Riedl (1999). Based on analyzing customer behaviors (navigational patterns), Yong, Yum, Song, and Su (2005) proposed a CF-based recommendation system for e-commerce sites. Yeong, Yoon, and Soung (2005) proposed a new methodology in which customer purchase sequences are used to improve the quality of CF-based recommendations. Yu, Liu, and Li, 2005 proposed a hybrid collaborative filtering method for multiple interests and multiple content recommendations in e-commerce. As to the cold-starting problem in ordinary CF methods, Ahn (2008) presented a new heuristic similarity measure that focuses on improving recommendation performance when a small number of ratings are available for similarity calculation for each user. With the consideration of product profitability for sellers, Chen, Hsu, Chen, and Hsu (2008) developed a recommender system for e-commerce web sites, which could increase profit from cross-selling without losing recommendation accuracy. Zhen, Jiang, and Song (2010) proposed a recommender system for supplying proper knowledge resources for users. As to one-item recommendation scenario, Cornelis, Lu, Guo, and Zhang (2007) proposed a recommender framework by using fuzzy logic techniques, which allows to reflect uncertain information and extends collaborative filtering paradigm. Using recommendation technology into web advertising, Kazienko and Adamski (2007) designed AdROSA system for automatic web banner personalization so as to enable online and fully personalized advertising. In order to adapt to large scale P2P environment, Han, Xie, Yang, and Shen (2004) and Xie et al. (2007) suggested a distributed CF algorithm to construct a scalable distributed recommendation system.

3. User profile model

Before investigating the methods for extracting user profile, we should define user profile first, which is the basis for knowledge recommendation. The model of user profile is mainly concerned with which domains of knowledge the user is requiring. Generally, the user profile model is a static model for knowledge demands, which are input by users or some authorized users (i.e., knowledge engineer in the enterprise) at the stage of initializing the organizational workflow. Workflow consists of three key concepts: members, roles and tasks. In the environment of collaborative workflow, the user profile can be formulated from three aspects: members, roles and tasks within workflow. The user profile should contain the information for describing: a member's interests, a role's requirements for knowledge when the user is acting as the role, and a task's requirements for knowledge when the user is undertaking the task.

For how to define the above three requirements for knowledge, we can use a form of 2-tuples, $\{(c_i, w_i)|c_i \in C, w_i \in W\}$; C is a set of pre-defined knowledge categories, and W is the set of weights for rating the categories. The user profile model describes the three types of knowledge demands for each user. Based on the user profile, knowledge recommender systems can retrieve suitable knowledge from the repositories and recommend them to the suitable users.

As to the knowledge repositories, it should be mentioned that the knowledge is mainly considered in the form of documents in this research. So the knowledge representation issue is out of the scope of this study. In fact, these knowledge documents are marked with some tags which indicate their domains. The settings for these knowledge domains are related to the specific areas of the collaborative team.

As shown in Fig. 1, knowledge resources are recommended to members according the user profile, which describes their demands for knowledge, roles' demands for knowledge, and tasks' demands for knowledge. These roles and tasks are related to the user, to whom the knowledge is recommended. Here two types of mappings (i.e., mapping 2 & mapping 1) reflect the relationships between the members and roles, and roles and tasks.

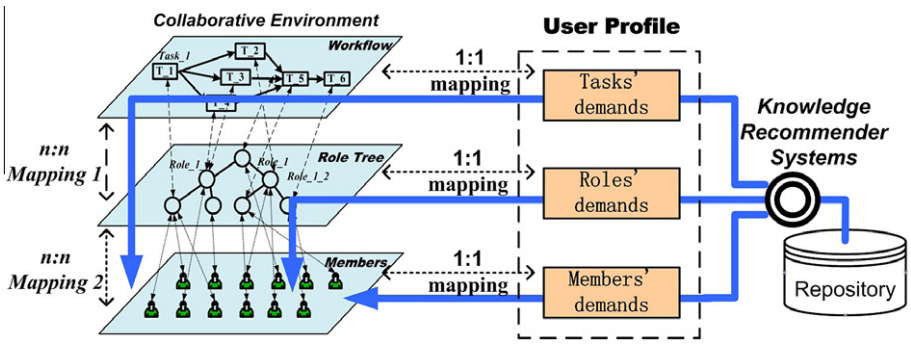

Fig. 1. User profile based knowledge recommendation process.