TOWARD AUTOMATIC USER PROFILING FOR PERSONALIZED ACCES TO INFORMATION WITHIN COLLABORATIVE LEARNING SYSTEM

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Abstract:
The use of modern educational technology methods, in order to support learning as well as collaboration, has become an important area of research. Specially with the rise of the internet and web 2.0 platforms that have transformed users' role from mere content consumers to fully content consumers-producers. Furthermore, people engaged in collaborative learning capitalize on one another's resources and skills, unlike individual learning. This paper proceeds with a categorization of the main tools and functions that characterise personalization learning aspect, in order to discuss their trade-offs with collaborative learning systems. It proposes a framework of a personalized information research (IR) within a collaborative learning system, incorporating the characterization of the research type carried by the query, as well as modeling and constructing semantic users' profiles. We use the context of the user query into a prediction mechanism of search type, based on a previous identification of users' levels and interests. The paper concludes by presenting an experiment results, revealing that the use of the subject ontology extension approach, satisfyingly contribute to an improvement in the accuracy of system's recommendations.

Keywords: information technology, collaborative learning, ontology, information research, user profile

1. INTRODUCTION

Nowadays learning is being developed and applied in new ways. The goal is transforming learning to meet learners' lifelong needs. This adequacy/personalization will accompany learners during their professional careers, then, it will promote both social and economic goals through its contribution in preventing skill mismatches, boosting productivity and also addressing social equity and social inclusion (Vuorinen, 2012). This new learning context implies a different role for learners. They need to keep up to date with new knowledge, which needs in turn to promote professional networks and learning organizations. Thus, learning becomes more collaborative and personalized at the same time. In a IT environments, there are many tools to support collaborative web which is a part of novelties brought by Web 2.0 (O'Reilly, 2005). By using these tools, the user has the opportunity to participate, share and search the content corresponding to his needs. However, the research task is the most important step regarding the support of learner during his learning process. It allows to provide him by the most adequate content, which leads in turn to the evolution of his knowledge level. In fact, the overloading data would make learners feel lost and frustrated when they search on websites relevant informations. In general, learners prefer and are more comfortable with websites that present the right content in ways that it correspond to their preference (Aragonees & Hart-Davidson, 2002, pp. 375-388). The objective of a personalized collaborative learning system is to optimize the management of knowledge exchange. Indeed, each contribution or research activity of the learner, is used in one hand to construct his own profile, on the other hand his contributions will be recommended to all other learners with similar profile. According to Tang (Tang, Yao, Zhang, Zhang, 2010) the user profiling forms the basis of the main techniques related to most recommender systems. Profiling of a Web user is the key process that allow the personalization of the information looked for by him. Considerable efforts have been made to extract the user's interests. Some applications directly involve user data through surveys, questionnaires, submitting personal information during registration, and so on. In this case, the type of content may be provided for users according to their choices and preferences (Cheng Chih, Pei-Ling, Fei-Rung, Yan-Kwang, 2009). Some other applications, building user profiles in accordance with log files, are engaged without the user direct involvement (Liu & Keselj, 2007) It's still insufficient for modeling and understanding users' behaviors. The major limitation of the classical profiling is that it is based on a general approach that consistently evaluates user requests and deliver results without considering the context of research. However, the utilization of ontologies in user profiling techniques has gained much attention since it allows inference to be employed, enabling interests to be discovered that were not directly observed in the user's behavior (Wu, Zeng, Hu, 2009). In this way, the profile of each learner is described by annotations in accordance with ontology. which allows to the system to "know" at a given time, the learner needs in order to promote the success of his learning. Furthermore, once profiles are represented using an ontology, they can communicate with other ontologies and share similar concepts, which contributes to knowledge reuse (Felden & Linden, 2007). In this paper, we propose a refined ontological profiling method based on user's information search within a collaborative learning system. According to learners profiles, the most relevant contributions of other learners will be proposed to them, which will take into account the explicit and implicit interests of the learners, and will reduce also the total reasoning time of the system by searching only in similar profiles contributions.

2. STATE OF THE ART

2.1. User profiling

Whatever the approach of personalization, we still need to collect and save data describing users in the form of profiles. These profiles are defined by contextual elements directly related to the user, such as his interests, his search preferences, etc. However, there are several methods to extract the contextual elements characterizing the user profile. In web-based social networks such as MySpace and YouTube, the user has to enter the profile by her/him-self. Unfortunately, the information obtained solely from the user entering profile is sometimes incomplete or inconsistent (Tang, Zeng, 2012). The need for a profile that supports reasoning is stressed out in (Rich, 1983). An overview of methods for building semantically a user profile are presented in (Rich, 1983) and (Cornelis, 2001). The user modeling knowledge, plans, and preferences in a domain are presented in (Kobsa, 1993). In this context a wide variety of Artificial Intelligence techniques have been used for user profiling, such as case-based reasoning, Bayesian networks, association rules, genetic algorithms, neural networks, among others (Schiaffino & Amandi, 2009, pp. 193-216). The purpose of obtaining user profiles is also different in the various areas that use them. In collaborative learning systems used in this paper, the user profile is used to provide him with the appropriate content from the contributions of other users with similar profile.

2.2. User interests and ontology

User interests are one of the most important part of the user profile in information retrieval and filtering systems, recommender systems, some interface agents, and adaptive systems that are information-driven such as encyclopedias, museum guides, and news systems (Brusilovsky & Millán, 2007, pp. 3-53). The most common representation of user interests are keyword-based models, which are extracted from his search requests or his contributions within the collaborative learning system. However, a topic ontology is used as the reference to construct a user interest profile. An ontology is used to share common understanding of the information structure among community (human or artificial agents) and To enable reuse of domain knowledge (Noy & McGuinness, 2001). It plays a principal role in the construction of learners' profiles. For this purpose, the user profile modeling in our approach is characterized by the semantic representation of the user profile based on a set of semantically-related concepts via the reference ontology used. In addition, several areas of application are using users profiles, for reasons related to personalization, with different needs. Depending on the area, personalization consists of one or more of the following tasks: filtering a flow of information, guide the search in an wide information space, recommend a set of information to the user, adjust the results of a request to the profile, adapt the interaction to the user situation (interface, interaction) (Daoud, 2009). Whatever is the area of application, the notion of user profile is defined according to dimensions related to the system purpose.

2.3. Exploitation of the user profile in the information research process

The notion of user profile is the heart of personalization in information research (IR).It is exploited in the rescheduling of the search results of queries dealing with the same information need. It is assumed that the profile has a more invariant character compared to the task context even if interests and search preferences evolve over time. Several definitions of profile have been discussed in literature of personalized IR. Can be distinguished:

- The cognitive profile exploited in several personalized systems (Lieberman, 1995, pp. 924-929; Leung, Chan, Chung, 2006, pp. 357-381; Pazzani, Muramatsu, Billsus,1996, pp. 54-61) is analog to the cognitive context of users.
- The qualitative profile in (Harrathi & Calabretto, 2006, pp. 299-304) related to the search preferences of users relatively to the quality of information returned by the system (fresh, credible sources of information, consistency, etc.).
- The multidimensional profile (Kostadinov, 2003; Tamine, Zemirli, Bahsoun, 2007) characterizing the environment and the system.

2.4. Collaborative web

Collaborative work is a work realized in common by several people leading to a common task. It assumes that people interact to accomplish a fixed goal, according to their skills and role in the group dynamics. If the goal is the acquisition of skills, we will call it a cooperative work or cooperative learning. According to (Lopriore, 1999, pp. 134-141) cooperative learning, which is a kind of collaborative learning, is a learning group activity, organized in a way that learning will be dependent on the socially structured exchange of information between the learners in the group. It is also an activity in which the learner is responsible for his own learning and motivated to participate in the learning of others. Once the internet media is used we talk about collaborative web which is one of innovations introduced by Web 2.0. This web technology allows every user to become an actor, not a spectator.

2.5. Collaborative web tools

Collaboration services are present on both the intranet and extranet. More broadly, there are many tools to support collaborative web:

- Communication tools: e-mail, forum, chat, video conferencing services, user directories, etc.
- Content sharing tools: wiki, blog, file libraries, virtual whiteboard, etc.

- Organizational tools: shared diaries, todo-list (task list), etc.

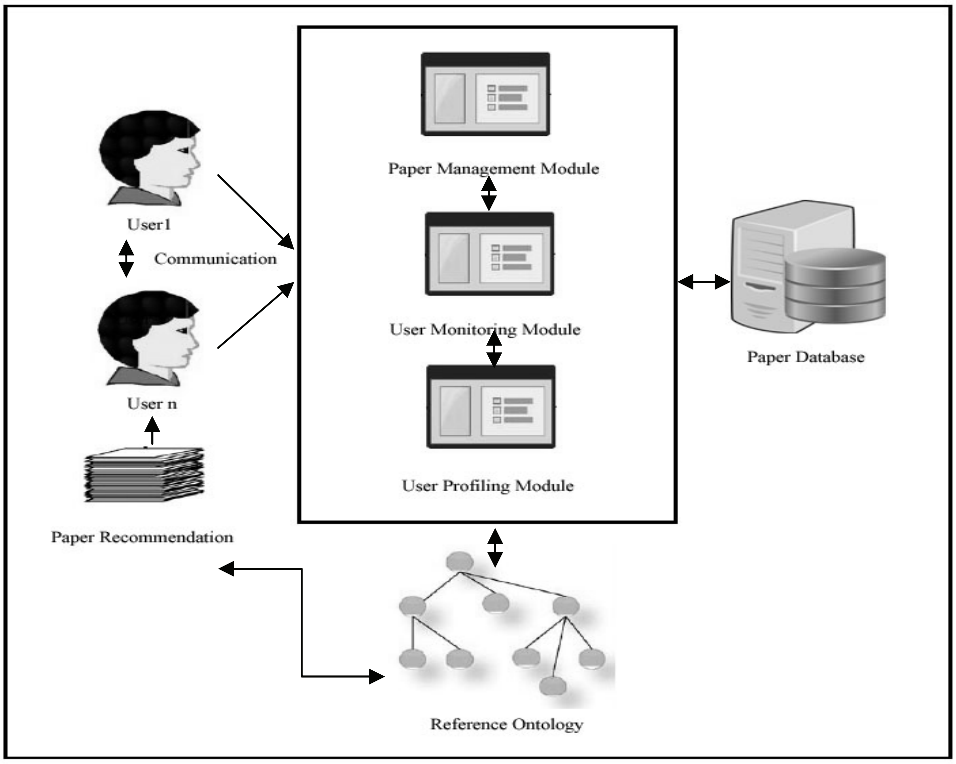
Among the software/websites the most known include: Wikipedia, Google Docs, Lotus Note, Microsoft Exchange.

There are also content management systems (CMS or CMS) to create their own tools, such as MediaWiki which is the engine used to manage Wikipedia.

3. FRAMEWORK FOR GENERATING USER'S INTEREST PROFILES

In this section, we present the framework for generating user's interest profiles within online learning systems (see Fig. 1). This framework is able to distinguish between the different contributions of the papers on the same topic to the construction of user interest profiles. Also, a part from the user profile obtained directly from the user behavior data, we apply implicit profiles to infer possible interests that users may develop in the future, in order to describe user interests more roundly and thereby improve recommendation.

Figure 1: Framework for generating user interest profiles



The main components in the framework include:

Paper management module: Users can upload, browse, download and comment on any research papers through the paper management module. All of the research papers are stored in the paper database. Each paper in the paper database is classified according to the reference ontology and can readily be viewed by users. The paper management module plays the role of fundamental component in the framework.

User monitoring module: This module is responsible for the background collection of the behavior data of each user. The user behavior data include searching keywords, browsing and commenting on papers, etc. The monitoring and collecting processes are totally implicit.

User profiling module: The user profiling module makes use of the user behavior data recorded by the user monitoring module, the paper database and the reference ontology, to create user profiles. The user profiles obtained can be used to recommend papers to them.

4. ONTOLOGY

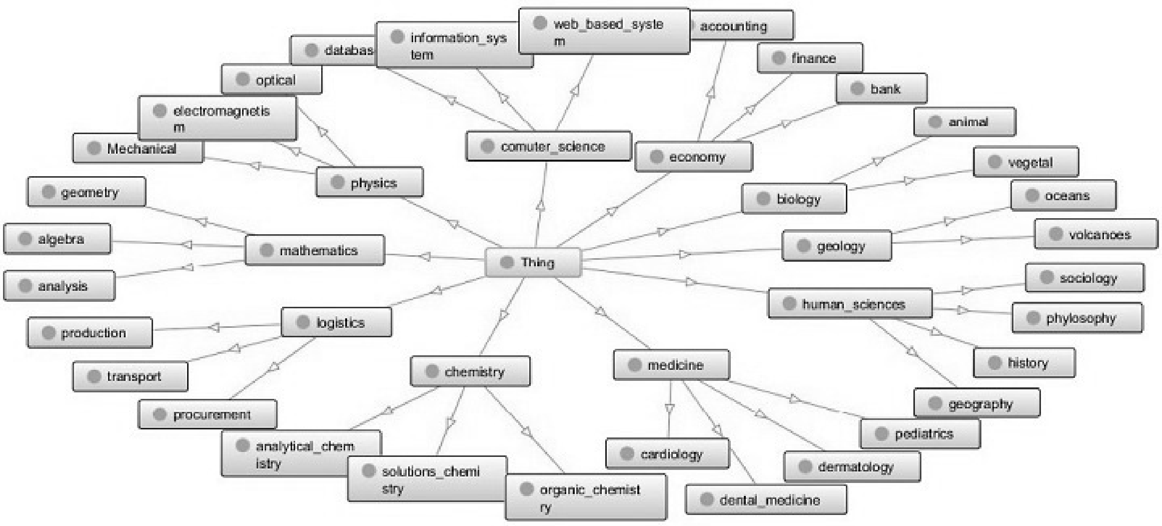
4.1. Ontology use

The term "ontology" has many different definitions, it has been widely exploited in many domains (e.g., medicine, education; and logistics) using it capacity to promote shareability of knowledge bases, knowledge organization, and interoperability between systems (Oliveira, Bacha, Mnasser, Abed, 2013, pp. 3145-3159). In educational area, ontologies and semantic web are the backbone for E-learning; they provide mechanisms for semantic annotation of learning resources, reuse and combination of course subjects and computer-assisted open question assessment (Jia, Wang, Ran, Yang, Liao, Chiu, 2011, pp. 3372-3382).

4.2. Using reference ontology to build user's profiles

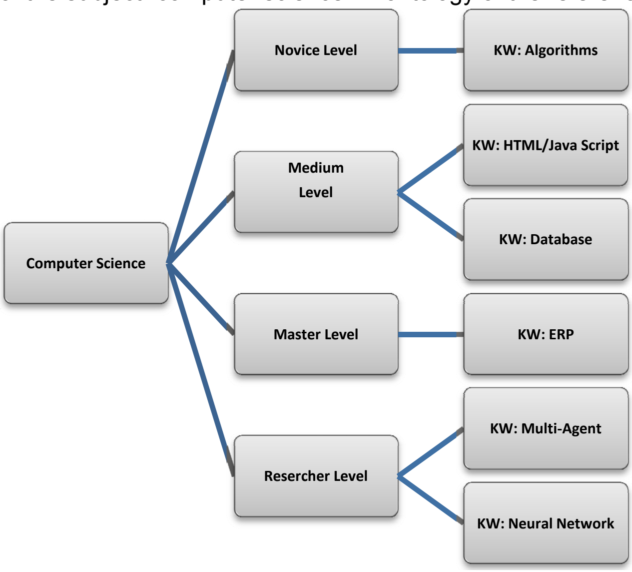
In order to solve the problems in the user profiles based on the traditional ontologies, we propose ontology for learning systems to generate the user's profiles. The simple ontology we propose consists of two levels, primary for subjects and secondary for keywords. Reference ontology presents the relationships between the subjects in different levels. Each primary subject has secondary subjects as indicated in Fig 2. This Ontology is formed of several parts among which are: Computer Science, Physics, Mathematics, Logistics, Chemistry, Medicine, Human Sciences, Geology, Biology and Economy.

Figure 2: Descriptive diagram of the reference ontology



In the paper database storing the research paper data, we associate to each paper a set of keywords. These keywords are provided by the paper's authors according to domain and level of users, and representing the keywords of each level, (i,e level = (keyword1, . . . , keywordi, . . . , keywordn) (1≤i≤n)) as shown in Fig 3.

Figure 3: The section of the subject "computer science" in ontology of the reference ontology



5. MEASURING USERS INTERESTS BASED ON KEYWORDS

This approach is based on measuring the occurrence of keywords through user's activity in learning system (browse, comment …), these measures are calculated by incrementing the counter associated to each keyword in the ontology, this can show later the level of interest of the user to a particular domain, and as well this approach can evaluate the current level for each learner. This allows later to recommend papers according to the interests centers of the user. Each keyword defined in the reference ontology belongs to a domain level, for example the keyword: 'Database', belongs to the second level (medium level) learning in the field "computer science". Generalizing this process to all subjects, the system will be able to recommend papers relating to interest centers of users.

6. EXPERIMENTS AND RESULTS

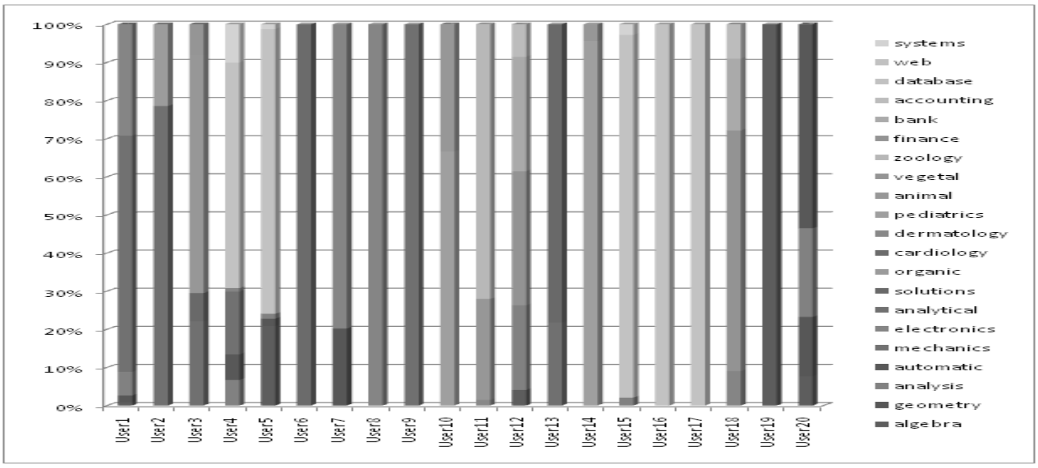
Our experiment consists in evaluating the system during 60 last days, with 20 users using academic learning system adopted in faculty of sciences in Tetuan, UAE/FS, by browsing and commenting papers, where each field number represents one topic, as shown in Table1.

Table 1: The Table of keywords' counters

User/Area	Mathematics			Physics			Chemistry			Medicine			Biology			Economy			Computers		
User/Field	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
User1	1	2	7	0	70	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
User2	0	0	0	0	0	0	44	0	12	0	0	0	0	0	0	0	0	0	0	0	0
User3	0	0	0	0	0	0	33	11	0	0	0	0	93	12	0	0	0	0	0	0	0
User4	0	0	22	22	54	3	0	0	0	0	0	0	0	0	0	0	0	0	92	102	33
User5	33	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	88	30	2
User6	0	0	0	0	0	0	0	0	0	87	0	0	0	0	0	0	0	0	0	0	0
User7	0	22	0	0	0	87	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
User8	0	0	0	0	0	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
User9	0	0	0	0	0	0	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
User10	0	0	0	0	0	0	0	0	0	0	0	12	6	0	0	0	0	0	0	0	0
User11	0	0	0	0	0	0	0	0	0	0	2	0	36	0	98	0	0	0	0	0	0
User12	12	0	65	0	0	0	0	0	0	0	0	0	0	0	0	103	88	25	0	0	0
User13	0	0	0	0	0	0	12	43	0	0	0	0	0	0	0	0	0	0	0	0	0
User14	0	0	0	0	0	0	0	0	0	0	0	66	3	0	0	0	0	0	0	0	0
User15	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	60	77	4
User16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	103	0
User17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	80	67	0
User18	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	77	23	11	0	0	0
User19	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
User20	11	22	33	76	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

The graph (see Fig 4) presents the users interests' centers by twenty users in a histogram.

Table 1: Graph representative of users interests centers



We may notice that the results (see. Fig 4) show, overall, that the model enables showing users interests of profiles: by taking user 4, has 92 keywords for ‘database subject’, 102 for ‘web subject’ and 33 for ‘system subject’. This shows that user 4 is a ‘computer science’ user, especially interested by ‘web subject’, so the learning system, will be able to first recommend papers within ‘web subject’ to user 4, secondly ‘database subject’ and finally ‘systems subject’.

7. CONCLUSTION

Recommendation service on academic publications has become a very important research topic due to the development of information personalization in learning system. In this paper, we introduced a user profiling method based on ontology. The ontology we propose is based on multiple domains, and through our framework, we propose to use ontological profiling approach to provide paper recommendations to users in learning system. This method is based on measuring the occurrence of keywords through user’s behavior in learning system. And then, recommend papers according to the interest’s centers of each user. Also our method enables identify level of all users, and then, allows recommending papers according to users’ levels. The experiment results reveal that the use of the subject ontology extension approach satisfyingly contribute to an improvement in the accuracy of papers recommendation. In the future, we may make improvements to the weighted keyword algorithm-based interest profiling approach and the subject ontology extension method. We will improve the keyword clustering algorithm through identifying synonyms among the keywords. Again, future work will develop reference ontology using a multi-agent system, and then assess the impact of agents on the recommendation system.

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