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Improving learning management through semantic web and social networks in e-learning environments

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ABSTRACT

Internet social networks have arisen in the last years as powerful tools where people exchange knowledge and multimedia content. They help to share interests between groups of people with common features. Undoubtedly, there is an inherent social network in any e-learning system, where the main *actors* are teachers, learners and learning resources. Most e-learning software are mainly focused in content dissemination and group work, but the possibilities that Internet LMSs could offer go further. Recently, there has been research work focused on Web Communities for learning and their formulation as Social Networks. Thus, social network analysis may be applied to infer group structures and to make intelligent recommendation systems and data mining.

This paper proposes a method for the formulation and interpretation of learning management platforms as social networks. In order to achieve a major generalization, we develop an ontology to integrate the information from different Learning Management Systems. After that, a personalized social network is extracted from the ontology. This change in the point of view of a LMS could be a challenge to make further studies about learners, teachers and learning resources to obtain a better understanding of their social structure, and therefore to make or improve decisions about the learning process.

1. Introduction

1.1. Aims and scope

The advances in Web 2.0 and XML-based technologies are changing our concept about WWW by mean of the inclusion of semantics in the web. Accordingly, e-learning systems are also benefit of the semantic web (Nilsson, Palmr, & Naeve, 2002). Most of efforts in this field share the use of ontologies to provide learning material with semantics (Dunkel, Bruns, & Ossowski, 2006; Dzbor, Stutt, Motta, & Collins, 2007; Yli-Luoma et al., 2006), often included within a service-oriented or multi-agent architecture (Dietze, Gugliotta, & Domingue, 2007; Dunkel et al., 2006; Henze, 2005b). The goals pursued by these proposals are wide: For example, the work Huang, Webster, Wood, and Ishaya (2006) proposes a four-stage method to improve self-learning, taking account an analysis of learner personality. In Henze (2005a, 2005b), the aim is to improve the workspace personalization using a service-oriented architecture and RDF/S. The proposal in Jovanović et al. (2007) offers a model to provide teachers with feedback information about students and learning resources interaction. In Dunkel et al. (2006), a multi-agent system is developed to provide students with intelligent recommendation for their tasks. Other proposals go further and suggest the study of semantic social interactions in e-learning (Torniai, Jovanovic, Gasevic, Bateman, & Hatala, 2008).

In this work, our approach is closed to this idea. Our aim is to provide a formulation of any learning management platform as a social network, in order to be able to do social network analysis (SNA) over teachers, learners, learning resources and their interactions. The information within these systems is usually stored in a relational database. Then, for a particular case, the problem would be to identify actors and relations in the database tables and to transform these tables into a social network. However, the main gap found in this idea is the loss of generality: database designs may differ deeply depending on the purpose and requisites of the system. Thus, in order to fulfill SNA over the information from multiple LMSs, it would be hard to match all databases with their corresponding social networks and, moreover, to integrate these networks for a general analysis. As a previous step, it should be provided a common framework where the storage design of actors and relations, and the concepts within an e-learning system, are independent. To solve this, we propose to match the relational database structure of the LMSs with an ontology.

The ontology proposed has an initial structure with classes and relations, but it could be extended by an expert to fit the database

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structure in order to enrich the knowledge extracted. Thus, the instances in the ontology could be automatically extracted from the relational model through the semantic matching. Our main interest is to give a common abstract framework to organize users and learning resources information, but the resulting ontology could provide many advantages: semantic would be added to entities and relations and therefore LMSs could share semantic information between them, therefore making it possible to extend learning capabilities between users of different LMSs. Furthermore, semantic information retrieval techniques could be used to improve the system recommendation capabilities and the learning content dissemination. But more importantly for our approach is that the common framework generated would allow us to develop a procedure to transform the information in the ontology to a social network structure. Thus, we are able to make social network analysis over teachers, learners and learning resources to obtain relevant information about the social structure inside the LMS, which teachers could use to improve their teaching methods, students groups or to provide a better personalized teaching. This change in the point of view of a LMS could be a challenge to make further studies about learners, teachers and learning resources to obtain a better understanding of their social structure, and therefore to make or improve decisions about the learning process.

1.2. Social networks

The term Network is different depending on the field to study. In social sciences, a social network comprises a set of people or groups of people (*actors*) and their interactions (*ties*) (Newman, 2003). The representation of a social network is usually given in the mathematical form of a graph $G = (V,E)$, where the set of nodes V means the set of actors and the set of edges $E \subseteq V \times V$ contains the relations between them (Hanneman, 2005). If an interaction $e \in E$ is labelled with a single value (as for example "John *knows* Peter") it is said that the social network is *simplex*. On the other hand, if e has more than one value (for example, "John *knows* and *has the same interests than* Peter") then G is a multigraph and the social network is named *multiplex* (Izquierdo & Hanneman, 2006).

Social networks have been widely studied since the 20's in disciplines like sociology (Hanneman, 1988) or economy (Mayer, 2009). In the last years, the increase in the use of Internet and user interactions in the WWW allows computer scientists to use social network analysis techniques (Ehrlich and Carboni, 2005) for data mining and knowledge discovery in large Internet social networks (Weaver & Morrison, 2008). Examples of popular social networks sites in the Internet are *Facebook*, *MySpace*, *Tuenti*, *YouTube* and *Orkut* but, in general terms, any web community and also the blogsphere could be considered social networks. Usually, these sites offer services like list of friends, people surfing, messages, events management and media uploads. The future of social networks in the Internet is promising, and it has been discussed in Breslin and Decker (2007).

Besides the current impact of social networking in user experiences, these models are also used to study people relations and profiles. Enterprises and researchers take advantage of these analyses to find new business models and to validate their assumptions over a case study population. An example is the work Ross et al. (2009) which makes a study of people's personality through Facebook use. Traditionally, SNA has been focused to obtain information from properties of the graph that represents the social network, such as centrality of nodes, walks and distance between actors, clustering detection, eccentricity, connectivity, etc. These properties have been mainly studied from the point of view of graphs theory and statistics (de Nooy, Mrvar, & Batagelj, 2004; Hanneman, 2005). The analysis may be done using specific software for SNA as described in de Nooy et al. (2004), Huisman and van Duijn (2005), although other usual mathematical environments could be used (Izquierdo & Hanneman, 2006).

Recently there have been research and projects to study social networks across the Web. A general description of some applications may be found in Staab et al. (2005). Most of these efforts combine Semantic Web and social networks in the same way: the use of ontologies to create a common framework for knowledge organization and semantic information sharing. For example, reference Zhou et al. (2008) use an ontology to integrate the information from *DBLP* and *LinkedIn* to find relations of collaborations between authors in research works. The article Jung and Euzenat (2007) describes a model to integrate three networks in a virtual community: social network, ontology network and concept network. The authors call the resulting net a Semantic Social Network, and show how to infer information in a network from data existing in the other two ones. A system for the integration of social networks using ontologies, *OpenSocial*, is described in Mitchell-Wong et al. (2007). The work in Cantador and Castells (2006) describes a method to identify semantic social networks from an ontology of user profiles. The user interests are then studied to make collaborative filtering and recommendation models. The proposal in Ganley and Lampe (2009) applies SNA over *Slashdot*, an online social network software. In this system the users are tagged with a reputation value called *Karma*. The users Karma is included in the network analysis to find brokerage, closure and other properties inside the net. Other example is the article Thushar and Thilagam (2008) which uses RDF to encode a social network and semantics between its components. This RDF model is then used to identify semantic associations inside the network. In Hamasaki et al. (2007), a tripartite model to represent ontologies is used to make an integration of social networks about authors and conferences. Recently, a model to give a representation and a query language for social networks has been presented in Martn and Gutierrez (2009) using RDF and SPARQ as the main stack for the language.

Other techniques regarding Artificial Intelligence and statistics have been also proposed to study social networks, besides Semantic Web and ontologies. In Zhdanova, Predoiu, Pellegrini, and Fensel (2007) is proposed a social network representation with hypergraphs to model a web community. It also provides mathematical tools for SNA over the hypergraph, to achieve the goal of finding closeness of community users according to the contents they upload. The social structure in the Web has also been studied by means of Internet hyperlinks exploration in Park (2003), to achieve the goal of effective link data retrieving. In Bhatia and Gaur (2008), is proposed a statistical method for community mining inside social networks. Makrehchi and Kamel (2006) describes a method to predict the topology of a large social network when only a few relations between actors are known. The problem is formulated as a text mining problem and it is solved using Support Vector Machines for classification. The same authors applies a multiple resampling method to solve this problem in Makrehchi and Kamel (2007). In Jung, Koo, and Jo (2007) the authors point out that usually there are heterogeneous relations inside social networks, and provide a Divide-and-Conquer approach to find these relations over semantic social networks. Neural networks and case-based reasoning have been applied to build resources recommendation systems for community users in Kanawati and Malek (2007), and also data mining techniques have been used to identify social networks in relational databases (Hensen & Neville, 2003).

Undoubtedly, there is an inherent social network in any collaborative e-learning Internet software. This network ties between teachers, learners and learning material are encoded inside entities and relations in the database of the system. It could be useful if a teacher could make SNA over this learning network, to find properties such as closeness between different learners according the