Towards Ontological Profiles in Communities of Practice

Alexandre M. Ribeiro¹, João L. T. Silva¹, Elisa Boff¹, Tiago Primo², Rosa M. Viccari²

¹CCTI – Universidade de Caxias do Sul (UCS)
Rua Francisco Getúlio Vargas, 1130 - CEP 95070-560 - Caxias do Sul - RS – Brazil

²Instituto de Informática – Universidade Federal do Rio Grande do Sul (UFRGS)
Caixa Postal 15.064 – 91501-970 – Porto Alegre – RS – Brazil

{aribeiro,jltsilva,eboff}@ucs.br,(ttprimo,rosa}@inf.ufrgs.br

Abstract. This work presents a reference ontology for representing user profile Communities of Practice (CoP) oriented towards learning activities. The main issue is to apply a Semantic Web approach on virtual communities in the context of collaborative learning. The concern of this work is to establish a reference ontology for the general profile that can be used as guidelines to build a computational CoP framework for the achievement of such a foundation.

1. Introduction

The use of Information and Communication Technologies (ICT) in educational contexts extends the dimensions of learning in groups [Tiffin et al. 2007, Demo 2006; Healy 2009, Carbonell 1970, Viccari 1988]. The technological support, in this point of view, expands the possibilities for educational applications, decentralizing the actors in the teaching-learning process and decoupling the content over the network. With the advent of social networking, e-learning technologies are driving each time closer to a social learning approach [Hart 2009]. The social aspect of learning is related to human interaction, i.e., collaborative learning through regular contact and associations with other individuals. Bandura (1977) defines social learning as a process of observing the behavior of other individuals and their consequences for the observer to adapt their behavior according to the group.

If on one hand the progress in network technologies and data storage has enabled the dissemination of huge amounts of content, on the other hand the notion of user profiling has been used in order to record the user context and personalize applications so as to be tailored to the user needs. Beyond this approach the user profiling can be very useful when it comes to presenting an overview of the domain related to a specific area of interest as it can be used for browsing and for query refinement. The use of information retrieval techniques profit this context and it is useful in recommendation issues and in the teaching-learning management in virtual communities.

In virtual communities we usually encounter the representation of a member's profile related to personal and professional information (like the LinkedIn¹ user Profile) as well as interests that may identify a usage and behavior profile in the context of service-oriented applications (as for example in recommendation systems). In this context, the traditional formalization of a profile is used to define not only the

¹ http://www.linkedin.com/
superficial identification and preferences of the users, but also (1) their expertise in a specific area of interest, (2) the relevance of their contributions in collaborative interactions (such as the reputation concept in StackOverflow\textsuperscript{2}) and (3) the evolution of their learning, which is promoted by interactions (as it can be observed in the user profile in Intelligent Tutoring Systems [Vicari 98]).

In the knowledge sharing between groups of people who learn collaboratively, it becomes necessary to establish a standardized and formal representation of interests along with “tacit/explicit” knowledge present in the community. To achieve this level of knowledge management, we discuss that the use of Communities of Practice (CoP) can capture such aspects of collaborative learning [Wenger 2000]. Besides a simple list or hierarchy of interests and personal information that characterize the traditional user profiling, a member of a CoP needs to register and share his knowledge and practice, and hence his intellectual evolution in the community domain along with practices. Using an ontology to model the user profile has already been proven to be a future step in this direction [Katifori et al. 2005, Trajkova et al. 2004, and Razmerita et al. 2003].

This work presents an ontology for modeling user profiles in the context of the communities of practice oriented towards learning activities. The purpose is to create a reference ontology that can become adaptable to the needs of every domain and community that represents an educational context. Our goal is to establish a standard of sufficient knowledge for modeling a CoP, but not being application-specific, neither created specifically for a particular domain.

The next section presents some related works about user profiling based on ontologies, communities of practice and the context of learning activities. Section 3 describes the general framework for communities of practice and a number of details about our proposition of a user profile based on ontology. Section 4 illustrates an example of instantiation using CoP framework and our final conclusions.

2. Related Works

Traditional user profiling is aimed at providing information regarding the user’s knowledge, goals, interests, etc. Some authors [Carreira et al. 2004, Poo 2003] claim that every expression in the user profile represents a characteristic that was obtained directly from the user and/or eventually inferred during interaction on the Web. The data is stored in a traditional database including user identification, interests and preferences, which can be maintained dynamically [Rousseau et al. 2006, Poo 2003].

An initiative towards a general ontology for user modeling is presented in [Yudelson et al. 2005]. The User Modeling Meta-Ontology (UMMO) intends to define a uniform interpretation of user models distributed in the Semantic Web environments. The UMMO approach aims to offer a central point of reference as a structural basis for capabilities of the user modeling, as well as to serve as an educational tool, helping in dealing with the problem of synonymy in the area.

Another solution to identify basic user model dimensions is the General User Model Ontology (GUMO) [Heckmann et al. 2005], with a modular approach based on user dimensions such as Emotional States, Characteristics and Personality. BasicUserDimensions, for instance, define a basic personality of a user model through a number of personal traits as professional, demographical, emotional and psychological, among others. In [Heckmann et al. 2007] the authors explore GUMO in order to

\textsuperscript{2} http://stackoverflow.com/
improve a tagging taxonomy and the generated user model. In this approach, an user tag space is automatically learned in order to map some new user's data based on a manually defining adaptation rules based on that structure.

The work from Kobsa [Kobsa 2007] also argues for a generic user modeling system in order to represent the relevant common characteristics of users pertaining to specific user subgroups (stereotypes). This approach take into account the users' behavior, particularly their past interaction with the system in order to infer a generalization of the interaction histories of many users into stereotypes through a generic ontology.

The work in [Dicheva et. al 2005] relates the ontology-based applications has to deal with two types of knowledge: subject domain and structure. They use a domain ontology to represent the basic domain concepts and a structure ontology to define the logical structure of the content. Nevertheless, the authors are concerned about content of online resources (such as papers, workshops, research groups, etc.) in a web portal without focus on the description of the portal or on the context profiling.

The work in [Isotani et al. 2009] deals with the group formation using Learner Profile (specifically knowledge about content, personality, attributes and programming styles). In this context, the authors are working on the role of an ontology for content, roles, goals and strategies for group formation on problems and tasks (goals/contents) that require certain specific related skills (roles). However, the ontology of the work covered in this profile only lists goals and roles needed for the learning activity.

In the Intelligent Tutoring Systems context there are several models of user profile [Giraffa 1999]. The Differential model, where the student performance is compared with the expert performance and the result is analyzed and classified as expected or unexpected. The student knowledge is assumed to be a subset of the expert knowledge. In the Overlay model, the knowledge about the student is assumed to be a subset of the knowledge base. In the Perturbation model, the student mistakes are supposed to be consequence of a misunderstanding or ignorance of a specific concept. The Simulation model stands that the student performance is compared with a simulation of the expert performance. This model can be used to anticipate the future behavior of the student, or the expected behavior. Finally, the Beliefs model is composed of assertions about the user knowledge concerning a specific domain (or concept). The context of Intelligent Tutoring Systems may also include affective states and interaction patterns through a model based on Bayesian networks in order to analyze students’ profiles and to organize them in workgroups [Boff 2008].

Our work also take into account two Semantic Web approaches to interoperate some common standards for communities and user representation: the SIOC (Semantically-Interlinked Online Communities) vocabulary [Bojars et al. 2010] and the FOAF (Friend of a Friend) ontology [Brickley et al. 2010]. The FOAF represents people and their social networks through their relationships and information using the Web. The SIOC project is an open format used for expressing user-generated content about virtual communities, in order to provide a Semantic Web ontology for representing data from the Social Web in RDF3.

Our approach does not intend to describe only the site or personal identification, as SIOC and FOAF applications, but also to aggregate some interaction events and user

---

3 Resource Description Framework (http://www.w3.org/TR/2004/REC-rdf-mt-20040210/).
contents in the CoP profile. These interactions, such as adding/commenting a post forum or posting blog contents, for instance, will integrate our “dynamic profile” representation.

The focus of our work is about Communities of Practice, which according to Wenger [Wenger et al. 2002], have three fundamental characteristics: Domain, Community and Practice. The Domain represents the topic or subject about which community members share knowledge. The Community is the formal relationship between a group of people who participate in discussions and group activities. The Practice is the set of shared resources and solving problem techniques used into the community. The CoP framework defined here relies on these three characteristics and also on the CoP life-cycle which defines the various stages a CoP goes through.

3. General Framework Description for Communities of Practice

This work is part of a proposal of a conceptual framework for the construction and management of Communities of Practice. The CoP Framework (CoPF) provides three layers of functionality in order to cope with the relationship among people with common interests, with technological collaboration tools and a model for community activities.

Figure 1 shows the main concept classes proposed in the CoPF: Interest Domain, Profiles, Collaboration Registers, Activity, and Web Tools. The interest domains should consider the collective construction of the fields, perhaps by a group of editors/mediators and predefined domain ontologies. Such ontologies can also be used within the portal built by the participants themselves (using mediators) and/or otherwise generated semi-automatically.

The use of FOAF [Brickley et al. 2010] and SIOC [Bojars et al. 2010] ontologies links our framework to a Semantic Web description in order to define relationships between people and communities. Each profile has a unique FOAF identifier which is used when defining these relationships. The CoPF definitions use SIOC vocabulary to identify other communities, homepages or weblogs.

Figure 1: The overall ontology for the CoP Framework.
3.1. Profile Ontology Description

For the definition of the ontology in this work we adopted a top-down approach, proposing a reference ontology by initially selecting important general concepts. Our reference ontology is based on [Brinkley et al. 2006, Burgun 2006] which represents the theory of a domain according to knowledge representation principles belonging to ontologies, and may build extensions, specializations or instantiations to another specific domain ontologies.

The focus of the ontology is the static and dynamic user profile. The static profile represents information provided by the user as personal and professional data, interests, curriculum vitae, and all information that allows entries in a “yellow pages” service base. The dynamic profile consists of information captured from its interaction with the community on all levels of knowledge, such as files and posts, practices, contributions in problem-solving activities, through the use of collaborative tools. Figure 2 illustrates the main concept classes defined as reference in the user's profile ontology.

![Figure 2: The user Profile Ontology in the CoP Framework.](image)

A Profile contains **Identity**, **Interactions**, **Interests**, **Roles** and **Skills**. In the static context, all these concepts will be informed by the user. In the dynamic context, the information can be inferred from interactions with the members of communities as well as from interactions with the tools within the community. Table 1 presents an overview of the proposed ontology of upper level classes and their descriptions.

In the definition of a CoP (Figure 2), the **CoP:Roles** are assigned to the users in order to describe a type of action/interaction in the community, but it can also carry some types of competence, expertise and skills in their field of activity/interest. In this case, the concept of role, for instance, serves as a repository of specific parameters in the instantiation of a domain ontology.

A more general domain provides the basic set of roles **Owner**, **Member** and **Moderator**. This set can derive and instantiate other behaviors like “Guest”, “Beginner”, “Regular”, “Leader” and “Senior” for example in training areas or working groups. In the domain of e-learning it will be instantiate roles such as “Teachers”, “Tutors”, “Specialists”, “Students”, “Monitors” and others.

The **CoP:Interests** class contextualizes a set of domain ontologies related to the community subject. These ontologies represent the characteristic that defines a domain
CoP [Wenger et al. 2002], i.e. the explicit knowledge that brings together community members in collaborative learning. Therefore, the set of user interests in the proposed framework can be inferred through its links with several domain ontologies (dynamic model), besides the predefined set of the user tags (static model).

Table 1: User profile ontology upper level classes.

<table>
<thead>
<tr>
<th>Class Name</th>
<th>Class Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roles</td>
<td>The function that an user plays upon an activity in the community.</td>
</tr>
<tr>
<td>Identity</td>
<td>Basic user information through single identification by using personal details as name, surname, business and residential information. Private information can also be aggregated to this class, such as date of birth, gender, marital status, and more.</td>
</tr>
<tr>
<td>Interactions</td>
<td>The relationships that may exist in intra and inter-communities that represent the type of support for multiple platforms that a user can exploit (Devices) and explicit and implicit relationships with other communities and individuals (People).</td>
</tr>
<tr>
<td>Skills</td>
<td>User skills and competencies about a knowledge domain through the user's educational and professional backgrounds provided by his/her Curriculum Vitae or community interactions.</td>
</tr>
<tr>
<td>Interests</td>
<td>User work/learning-related interests about user's knowledge domain.</td>
</tr>
</tbody>
</table>

The CoP:Skills class represents the skills and competencies that the participant has in the CoP. This work is based on Fleury's definition [Fleury et al. 2001] and it relates competence with the identity of the individual and his educational and professional backgrounds so that the framework can identify relationships in the practices used for a given field and the skills and/or knowledge that the user has mobilized for its implementation. This standardized structure can relate topics of interest (the CoP domain) with schemes to solve problems or actions carried out to respond to challenges from the community (the CoP practice). In addition, it is possible to recommend experts and to make some dynamic yellow pages available that can be updated from a topic posted by an individual in order to update the list of skills.

The CoP:Interactions class represents the relationships with intra and inter-communities that defines the type of support for multiple platforms that a user can exploit. In the CoPF approach, users who have profiles in a CoP maintain interactions (Interactions) with devices (Devices) and individuals (People) through a relationship cop:with. A number of links to people are described directly through the property foaf:knows as, for instance, to connect members from the same community or from other communities. In the social domain of the individual an owl:sameAs relationship will integrate several sites of the same user. Interactions through Devices represent the use of various devices by the same individuals who have foaf:knows or rel:acquaintanceOf relationships.

4. An example of instantiation in the CoPF

We illustrate an example of the proposed framework through a representation of a Community of Practice with a member and his profile and interactions in the community. In the context of e-learning, the tools are instantiated through the WebTools class. In this manner we may associate a CoP to a group of people related to a course context. A community (CoP) “Digital Habitats for Education” course in the domain (Interest_Domains) of “Permanent Education” keeps a group of people (Person)
interacting through a pool of collaborative tools and virtual learning environments (WebTools).

A CoP class also represents a course topic, an area of knowledge or an academic unit. The group of people (Person) does not only mean the students, teachers and tutors in the context of a class, but also external people from other areas in the context of a public CoP. In our domain they are described as ontology individuals.

The relationships are made through Object Properties and Data Properties. In the proposed example, an individual is created based on their Google openID with the data property foaf:givenName fulfilled with the value “Joao Luis” and has a relationship through the object property member-of with the individual “Digital Habitats for Education”. The value “Joao Luis” also has an object property relationship cop:hasRole with the individual Teacher and cop:holdsInterest with the individual Football (Soccer) as illustrated on Figure 3. This sort of relationship allows the reasoner to infer that an individual is member of any class that has axioms related to their object properties or data properties.

This type of CoP contains a number of practices (Activity) related to the academic activities concerning the unity of taught knowledge provided by the teacher/tutor. In addition, collaborative activities are aggregated to the community as a way of sharing knowledge and persistence. These activities are associated with the growth and sustainability of the CoP insofar as the members develop new relationships, learn and develop practical tasks and projects, thus creating new knowledge.

Figure 4 illustrates an activity representation in the CoPF. An activity example is represented by a Goal (Mastering_the_Subject) which is related to some Tasks (Tutoring, Question_and_Answers, etc.), Resources (Exercise_List & Main_Book) and Evaluation (High_grade).

The collaboration activities and interactions in the CoP are maintained as knowledge structures (Collaboration Registers) that link to events in the community domain knowledge of the CoP. In these structures, the actions of individual learning and group activities are inventoried for future evaluation and recommendation in the CoP.

---

Figure 3: A partial description of a member in the CoPF modeled in Protégé⁴.

⁴ http://protege.stanford.edu/.
4.1. User Profile Description

The importance of the profile lies in the expertise that the participant shares in the community. The static profile is related to the knowledge that the individual carries concerning the area of knowledge of the course. With the interactions in this and other communities, the dynamic profile is enriched by the interactions and associations that the framework can be inferred in order to assist the student in his learning.

![Figure 4: A partial representation of an activity model in the CoPF.](image)

Each user has his own domain of interest in the CoPF which must be aligned to the CoP interest (CoP Profile), thus it is relevant to consider personalization issues here. In the CoP:Profile class, the CoP:Interest_Domains represents an initial library of domain ontologies suitable for various user groups and domains. These ontologies are external to the CoPF and must be created beforehand after an elaborate user study. Figure 5 shows a general example illustration in which the Interest_Domain is related to a user Post in a Forum (Virtual_Communities). The Profile shows a “Teacher” Role to the Person in the community and all the interactions are registered in the Collaboration_Registers.

![Figure 5: A partial CoPF representation illustrating how the user interactions are carried out in our ontology.](image)

5. Conclusions

The main idea in the CoP Framework in this paper is to realize that a foundation for the Semantic Web is feasible to aggregate on the context of collaborative learning activities. The general idea is to establish a general profile reference ontology to
represent a learning community with its members and the learning activities related to an educational context.

This work is part of a larger proposal to build collaborative learning environments based on CoP. For this approach we advocate the need for an ontological knowledge representation for the user and the community itself so that software agents can address reasoning and recommendations for communities and individuals.

Acknowledgements

Funded by Pos-Doctoral CAPES/REUNI grant and OTICS Project ICICT/Fiocruz grant ENSP 060 LIV 09.

References


in Distance Learning Programs”. In M.D. Lytras et al. (Eds.): WSKS 2009, CCIS 49, pp. 49-56.


