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An Ontology-Based Expert Locator System in a Web 2.0-oriented Personal Learning Environment

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Abstract. Personal Learning Environments (PLE) are set up by learners using a dynamic and growing set of Web 2.0 tools which, together, foster a rich knowledge, highly personalized and collaborative environment. While there is a lot of ongoing work and successes in developing the Web 2.0 technologies, the issues of how to leverage on PLE to truly foster a co-learning environment and how to identify "experts" (or more knowledgeable people) in PLEs have not been explored so far. Invariably, as in any learning communities, different levels of expertise (and experience) exist in a community. Novice learners often lack the needed knowledge and experience in configuring their most effective PLEs. Successful and easy location of experts can not only improve learning processes and also enhance the quality of the environment for all learners. This paper presents an ontology-based expert locator framework for supporting personal learning in a Web 2.0 environment.

Keywords: Personal Learning Environment, Web 2.0, Semantic Web, Ontology, Expertise Locater System

1 Introduction

The emerging of Web 2.0 technologies has changed in the role resources, people and media play in teaching and learning [1]. As shown in Figure 1, Web 1.0 provides a one way platform, where information on web is static and restricted for reading. Meanwhile Web 2.0 can be referred as social web, as Web 2.0 is all about interaction, where it can be a good medium of knowledge sharing and exchange among learners. On the other hand, the Semantic Web (also referred as Web 3.0) is all about recommendation and personalization which can be done automatically.

Mass uptake and personalization supported by many of the Web 2.0 technologies have provided renewed opportunities for learners to create their individual personal learning environments (PLE) over the Internet. Far more than merely electronic access to content, Web 2.0 technologies have brought together learners and content artifacts in learning activities to support them in constructing and processing

knowledge. Typified by blogs, wikis, RSS, podcasts, social bookmarks, mashups and more, Web 2.0 technologies are pervasive, ubiquitous, convenient and economical/free for everyone to use. These technologies also help to harness, analyse, share, prioritise and summarize opinions and preferences from individuals participating in networked learning communities.

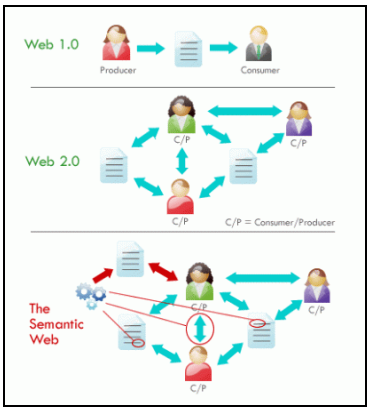


Figure 1. The view of data exchange [1]

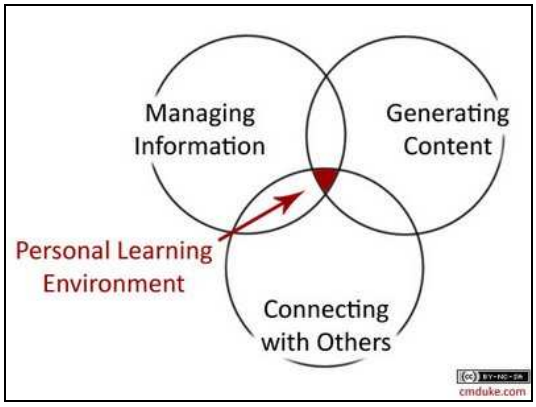


Figure 2. Personal Learning Environment [2]

Personal Learning Environments (PLE) are individual educational platforms that help learners manage and take control of their own learning [3, 4]. Such a platform provides support for learners to manage their own learning contents and processes to pursue their learning objectives [1]. A PLE platform also enables learners to communicate with other on the process of learning, for effective knowledge sharing and collaborative knowledge creation [5]. In summary, a PLE platform provides an environment for learners to managing information, generating content and connecting with others as shown in Figure 2. PLE can also engage learners in a collaborative way thereby helping to, among others, combat information overload, maintain relevance and quality of discussions, as well as foster an ongoing co-learning environment.

PLEs are commonly, though not necessarily, set up by learners using a dynamic and growing set of Web 2.0 tools which, comprised of the Web 2.0 technologies integration like social bookmarking, blogs, Wikis, Youtube, RSS feeds, Twitter, Facebook, and other social software as depicted in Figure 3. Each participant is an independent learner, has his/her own learning environment made up by various Web 2.0 components in the PLE. Together, the adopted tools, the network, and the learners (whom may also include teachers, graduates, practitioners and other guests) constitute a (knowledge) rich, personalized and collaborative environment. For example, the second author has established a PLE using Contact, GReader and Buzz in Google. This platform has been deployed to students at The Hong Kong Polytechnic University for 2 consecutive semesters with very encouraging feedback [6].

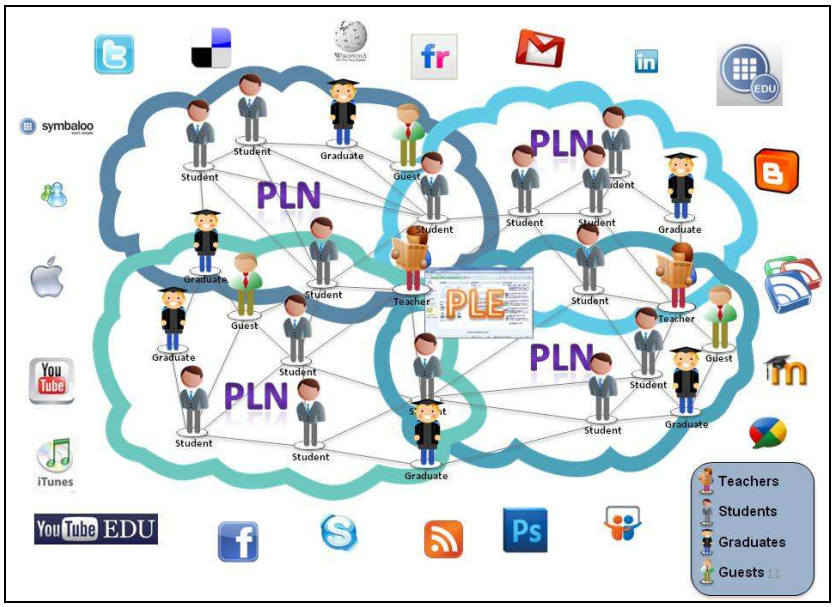


Figure 3. An Overview of Personal Learning Environment in Web 2.0 Environment [6]

While there is a lot of ongoing work and successes in developing the Web 2.0 technologies, the issues of how to leverage on PLE to truly foster a co-learning environment and how to identify "experts" (or more knowledgeable people) in PLEs have not been explored so far. Invariably, as in any learning communities, different levels of expertise (and experience) exist in a community. Novice learners often lack the needed knowledge and experience in, among other things, configuring their most effective PLEs, sourcing high quality content, determining the relevance of the content, and dealing with information overload. Successful location of expert learners can not only improve learning processes and also enhance the PLE of all learners by sharing assistance to novice learners on overcoming one or more of the above challenges. In a PLE deployed in an academic context (e.g. [6]), quality of knowledge is very much determined by the teachers, graduates and other guests (e.g. industry practitioners) who are participants in the PLE. In a commercial environment, a PLE can involve employees, subject matter experts, industry leaders, academics etc. as participants to ensure the quality of its content. This paper focuses specifically on the use of an ontology-based expert locater framework to enhance a Web 2.0 oriented personal learning environment.

2 Research Background and Problem

The emerging of Web 2.0 technologies has changed the way learners used technology to support their own learning by making it possible for knowledge workers to establish their own personalized learning environment. “Web2.0 is characterized by

being user-centered, improving user experience, achieving from collective intelligence, communicating in social network formation, and creating one's own knowledge with others" [7]. Web 2.0 technologies such as Facebook, Twitter, blogs, Wikis, social bookmarking etc. have been used by learners to design their own PLEs. Understandingly, owing to the background, age and many other factors, different learners have different preferences in adopting Web 2.0 technologies when his/her own PLE.

Needless to say, not all learners are at the same level of competency with regard to the topic of focus. Novice learners often lack prior knowledge to organize their learning resources to support their learning process; due to various reasons, they also under-leverage the use of Web 2.0 tools in establishing an effective personal learning environment. On the other hand, expert learners are generally far more resourceful and knowledgeable. As stated by the Universal Design for Learning [8], "They (Expert learners) bring considerable prior knowledge to new learning; they activate their prior knowledge to identify, organize, prioritize and assimilate new information. They recognize the tools and resources that would help them find, structure, and remember new information; and they know how to transform new information into meaningful and useable knowledge". Expert learners can be differentiated from novice learners based on their valuable skills on knowing how to learn, knowing which strategies work best and knowing what tool is more effective in the learning process. Hence, successful location and engagement with expert learners can help novice learners to improve their own learning process. According to Graham [9], "learning occurs best when an expert guides a novice from the novice's current level of knowledge to the expert's level of knowledge".

In addition, manually creating expert profiles is very tedious, time-consuming and expensive from PLE. Furthermore, there is a critical problem of maintaining up-to-date expert profile of their adopted Web 2.0 technologies, and a person's expertise changes over time and it is not feasible to rely on experts to report developments to their expertise profile.

4 A Survey of Expertise Locater System

In an expert locater system, expert finding is carried out by matching a user query with the available/extracted expert user profiles. Formulating interest profile of experts based on their personal resources (i.e. a kind of derived implicit knowledge) is an important research topic in knowledge extraction. Most of the existing and past works lead to systems that operate in a proprietary environment and very few of them operate on the Web 2.0 platform. Whereas, the traditional expert findings are derived from intranet content such as web pages [10, 11], emails [12], technical reports/publications [13, 14, 15, 16, 17] and user's desktop content [18). Looking at the resources, the system builds expert profile. Recently, Wikipedia [19] and social network [20, 21] have also been used in formulating expert profile.

Variants of expert locater systems can be found from existing works that are often designed for a specific matching task. Wu & Yang [15] developed an expert system to find the right expert (researcher) for a specific research project. A system for routing

conference papers to appropriate reviewers has been developed by Thiagarajan [17]. An ontology-based matching system for finding expert on specific academic field has been built by Liu et. al. [22]. Alpcan et. al. [23] designed a real-time search engine for an online community where users can query experts for help on various topics by processing expert documents such as resumes, webpages, blogs, etc. Chua [24] introduced a meta-search tool that searches for experts based on their blogs, bookmarks, and tags for help on specific topics.

Wu & Yang [15] use an ontology to support their expert matching. The developed system consists of four main components, which consists of ontology building, document formalization, similarity calculation and user interface. They utilize Protégé to develop the predetermined domain ontologies in which some related concepts are defined. Then, documents concerning experts and projects are formalized automatically or manually by means of concept trees with weights. Finally, a new method that integrates node-based and edge-based approach is used to match between projects and experts with the help of the domain ontologies.

Ontology has been used in the Thiagarajan [17]. research work to compute semantic similarity of user profiles using spreading activation networks to rank experts for a given requirement. They define the notion of semantic similarity between two user profiles by including additional related terms to a user profile by referring to an ontology, such as Wordnet or Wikipedia.

Liu et. al. [22] uses an expert ontology to integrate multiple expertise indications from heterogeneous data sources and domain ontology is used as foundation for building concept based-expertise profile. The expert ontology, which developed using Protégé, defines the key concepts relevant to experts within academic environment and also the relationships between these concepts. Meanwhile, the domain ontology characterizes the body of knowledge associated with the particular domain, it includes the definition of the key concepts, the attributes of the concepts (and the relations between concepts.

Alpcan et. al. [23] develop a real-time search engine for query experts by mapping user queries to an expert ontology tree where each node represents a (sub)topic. They convert each user query to a bag of words and associate each expert with its own bag, whereas the experts bag of words can be derived by processing personal documents such as resumes, webpages, blogs, etc.

Meanwhile, Chua [24] work demonstrates how to builds implicit expertise profiles from data shared through social computing services (Web 2.0) to locate experts. The meta-search tool aggregates results from blogs, social bookmarks, and people-tags using e-mail addresses as identifiers. The result of experts is presented according to recency, organizational structure, and geographic location.

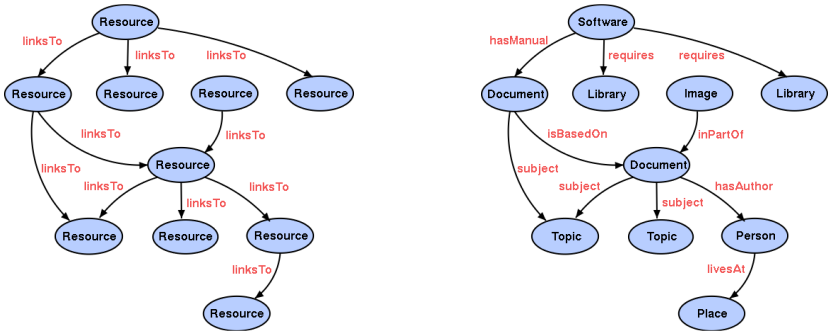
The feature comparison of the above explained existing works are presented in Table 1.

Table 1. Features comparison of existing works

	Wu & Yang [15]	Thiagarajan [17]	Liu et. al. [22]	Alpcan et. al. [23]	Chua [24]
Application	Find an expert who matches a certain project	User profile matching through ontologies	Ontology-based expertise locator for finding an academic expert	Expert peering system for information exchange	Search expertise profiles through intranet social computing services.
Methodology	An ontology is built by Protégé to fomalize the documents. Document formalization and concept extraction are performed through automatically or manually. MM Method (Maximum Matching Method) is used to segmenting Chinese documents into words. The Concept Filler is used to process the document into words by assigning their weights manually in order to improve the precision of concept extraction.	User profiles are defined as bag-of-words (BOW) representation. The process of spreading is used to include additional related terms to a user profile by referring to an ontology (Wordnet or Wikipedia). Similarity between two user profiles is computed with ontology-based Spreading Activation Networks (SAN). Multiple mechanisms for extending user profiles (set and graph based spreading) and semantic matching (set intersection and bipartite graphs) of profiles are applied.	Expert Ontology is built and map to exsiting expertise sources to semantically enriched the integrated information. Wrappers are ued to extract relevant information from different data. The extracted information is converted into XML format. Based on the integrated information, each expert's profile is modeled.	Map expert profiles and queries, which are given by arbitrary keyword lists, onto subtrees. A subsequenly described measure and mapping algorithm is used to perform similarity measure between any entity representable by a bag of words and the ontology tree.	The search tool aggregates results from internal blogs, social bookmarks, and people-tags using e-mail addresses as identifiers.
Semantic Similarity	Calculate similarities between projects and domain experts for matching.	Calculate similarity between two user profiles with ontology-based Spreading Activation Networks (SAN) by matching Bipartite Graph.	n.a	Calculate similarity measure for mapping from the dictionary space to the ontology-space	n.a

Thesauri	n.a	Wordnet or Wikipedia)	n.a	Dictionary	n.a

In contrast to the above discussed works, this research proposal aims to develop an ontology-based expert locator system to enhance the personal learning environment of a learner. New algorithm(s) will be developed for profiling expert learners from their personal learning environments by extracting implicit knowledge embedded in components and contents of the Web 2.0 technologies adopted by them. Such components and content may include, for example, discussions threads in forums, subscribed and rated content material, referral information and frequencies, social network connections, etc. Different Web 2.0 technologies, however, are using different, and mostly unstructured, knowledge representation formats to annotate their data. "An ontology is an explicit specification of a conceptualization" [25], where it provides machine-interpretable definitions of basic concepts in the domain and relations among them as depicted in Figure 4. Thus, ontology-based solution in designing expert locater system is, we believe, a promising solution to extract expert profile from heterogeneous data sources. Such an expert locater system can be applied to problem solving in e-business, consulting, marketing, recruitment and academia.



Current Web Semantic Web

Figure 4. Comparison of the Current Web and the Semantic Web [26]

5 Ontology Based Expert Locator Framework

In this section, the ontology based expert locator framework is explicated. The framework consists of three main components, they are knowledge extraction engine, ontology-based expert model and query engine as depicted in Figure 5. The framework is aimed to enhance personal learning environment of a learner by extracting expert implicit knowledge from their adopted Web 2.0 technologies in their personal learning environments.

1) *Ontology-based expert model* is formulated from expert profiling methodology. An expertise ontology will be designed and refined using an ontology builder, such as Protégé (http://protege.stanford.edu/).
2) *Knowledge extracting engine* is used to identify appropriate implicit knowledge of experts to be extracted for building the expertise profiling ontology. Extracting implicit knowledge from various Web 2.0 technologies is challenging due to different Web 2.0 technologies using different knowledge representation format to annotate their data. Hence, a dynamic knowledge extraction algorithm needs to be developed to deal with heterogeneous data format. Knowledge extraction techniques will be studied and explored at this stage. Among others, machine learning, natural language processing and ontology-based knowledge extraction techniques can be investigated for designing the knowledge extraction algorithm.
3) *Query engine* enable expert searching through ontology-based querying.

The developed prototype can be tested on a personal portal in the public domain, such as iGoogle, Netvibes, Gingervibes, MyYahoo, MyMSN etc.

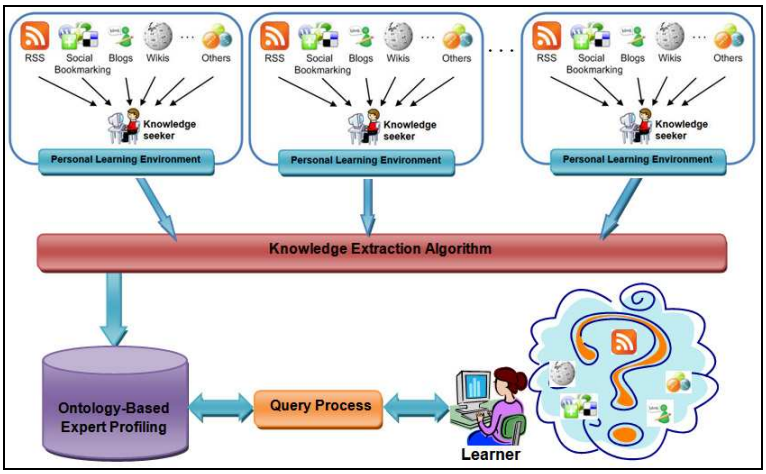


Figure 5. An ontology-based expert locater framework [31]

6 Expert Locator and Quality Knowledge

The notion of knowledge distinguishes it from information by being a process than merely an end-user product [27]. Quality knowledge can be seen from different aspects and is more subjective than information. These dimensions can be in ontology quality dimension, knowledge item quality dimension, knowledge retainer quality dimension and knowledge usage quality dimension [28]. Although all these dimensions may be defined the same for data, information and knowledge, but in terms of measurability, there significantly different [27]. Burton-Jones et. al. [29] classifies this assessment metrics into syntactic, semantic, pragmatic and social aspects for ontology quality. As the input to the ontology-based profiling in our expert

locator may come from different people within different domains, the ontology should be able to conceptualize generic to several domains (Generic Ontologies[1]) [30]. This calls for a high emphasis on the ontology quality metrics as low quality ontologies will significantly affect the usefulness in any application [29]. This takes the ontology profiling engine to use appropriate metrics to measure not only the information available to the repository, but the usefulness of acquired knowledge by the end-user within a PLE process and not as a byproduct of knowledge sharing.

7 Conclusions

In this paper, we have presented a comprehensive survey of the expert locator. We have also proposed a new framework to locate expert from the Web 2.0 environment to support learners in the learning process to pursue their objectives. We have also discussed quality knowledge for ontology-based profiling.

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[1] Generic here means independent of any application or have low value to a specific application

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