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Inference-Based user's Recommendation in E-Learning Systems

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ABSTRACT

This paper proposes a technique of user's recommendation for E-learning systems, which makes it possible to identify the best qualified profiles in a given field, the method is based on artificial intelligence in order to make connection between the knowledge expressed explicitly on a learner profile and a special need of another learner, not necessarily expressed on that profile, but which can be deduced through mechanism of inference.

Keywords—E-learning; recommendation of users; artificial intelligence; Inference ; Semantic Web.

1 Introduction

Face to face learning is often based on networks of mutual help between learners, the teacher intervenes only on specific cases, but in most cases, learners help their colleagues to understand concepts or solve problems, the identification of users whose can give support in classroom is easy, given the reduced number of learners, and the interactions which take place in classroom, with a simple reflection, one will know which learner is qualified on a given subject, and thus give support; on the other hand, in the E-learning systems, a learner does not have high visibility on his colleagues and their knowledge or skills, this is why we need to think of a mechanism, allowing to a struggling learner to identify someone that can help him.

To solve this problem, we use artificial intelligence techniques, to add a layer of intelligence similar to that of humans to E-learning systems, to do this, we need a semantic representation of learner's profiles.

This approach allows to learners to have a quick answer, instead of waiting for the intervention of their teacher, which can delay, it also allows to teachers to focus on more important tasks instead of intervening on every issue.

In Section 2, we present some related work to the recommendation systems of profiles, as well as some semantic web techniques and their uses in E-learning systems.

In Section 3 and 4, we present the general architecture and the implementation techniques of our profiles recommendation system.

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2 State of the Art

2.1 Users Recommendation

Nowadays users recommendation in E-learning systems is a necessary technique to enable learners to understand or solve problems without necessarily going through their teachers, it allows learners to have a fast response and avoid waiting a long time before getting a response from their teachers, or even worse, sometimes a learner hesitate to ask his teacher for some reason, this deadlock situation deteriorates his motivation, and so another need of monitoring of learner's motivation appears[1], on the other hand, teachers can focus on more important tasks instead of answering each learner.

Silvan ACIAR V[2] proposes a method for user's recommendation on the basis of a Text mining technique in order to extract a user knowledge from his interaction on forums.

Fabian Abel[3] shows the importance of discussion forums in E-learning and proposes a recommendation approach to facilitate the localization of the relevant information to each learner.

2.2 Semantic Web to assist E-learning users

The new generation of the web, also called semantic web provides communication between man and machine based on a semantic language, it uses several technologies that are stacked in layers and each one exploits the capabilities of those who are below such as RDF, OWL or SPARQL.

E-learning is among the areas directly affected by the innovations of the web and should fully benefit from its advantages.

In this sense, Vibhavari R. Pandit[4] presents an approach for implementing an E-learning scenario, based on semantic web technologies and focusing on benefits of ontologies using for E-learning resources description.

Ioan Szilagyise[5] presents a semantic learning system that allows filtering internal or external educational resources (i.e. Internet) to this system. This filtering is especially based on the selection of learning objects whose annotations accredit a rapprochement with the learning profile and weaknesses of the learner.

Yi Li[6] proposes a personalized semantic recommendation system for E-learning, this system allows to semantically recommend resources for learners.

Although these works are very interesting, and have an enriching contribution to traditional E-learning systems, it remains that the semantic web is not very well exploited, especially on adaptive learning and resources recommendation.

3 Objective and Implementation Techniques

The aim of our work is to realize a user's recommendation system, who can answer one or more questions on a specific area, the novelty of this system is the way of profiles filtering and selection, which is semantic and tends more towards intelligence and human reasoning.

To do this, we must first think of a semantic modeling of the learner profile, domain and application, practically speaking building a learner profile, domain and application ontology; then we define inference rules to infer implicit knowledge of learners, and finally to exploit this knowledge, we use a query language such as SPARQL or Snap-SPARQL, this process is shown in figure 1.

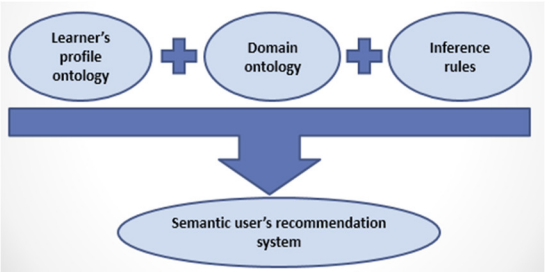

Figure 1.Semantic user's recommendation system architecture

3.1 Semantic modeling of a learner profile:

In this work, we are interested in modeling the learner's information, the purpose of the modeling is to give a complete description of all aspects relating to behavior and knowledge of the learner. At the basis of this information, we have the opportunity to do the filtering operation in order to identify the correct profile for each request, in general, learn profile modeling means collecting information about the path of this learners and his knowledge and skills. This procedure is not a goal in itself, but it is a step for performing operations such as learner's recommendation or orientation.

Adil Korchi[7] proposes a modeling approach of the learner based on an ontology. It is composed of several elements, including:

- Behavior : It is the relationship that the learner must develop with his/her environment for the success of his/her pedagogical activities. Behavior in our case concerns the motivation, autonomy, attention, responsibility, mind-opening and curiosity of the learner.
- Knowledge : This is the cognitive background of the learner. It can be general, theoretical or practical.
- Skills : Each learner admits strengths related to his/her skills. This may affect the sense of contact, creativity, speed and logic of understanding and problem solving.
- Interaction : The learner is an integral part of the interaction, otherwise he would not be a learner. It is the exchange that can have a learner with a learning environment. It may be long, medium or fast.

These are the most relevant and widely used elements in most E-learning systems, each one must play a part in our user's recommendation system, with different priorities, the first criterion that we consider, is the knowledge of a learner, being clear that the first criterion for someone to help on a given subject, is the mastery of the subject; The second criterion is skills, some issues or problems require besides knowledge, skills such as logic or sense of creativity, without taking these factors into account, and even in the presence the necessary knowledge, the resolution of these problems does not lead to satisfactory results, the behavior and interaction of a learner are low-impact elements, but they must be considered in achieving of such system, given a user who has quick interaction with the system is more likely to be present at time of request and therefore respond in a short time than a profile who has a slow interaction.

To summarize, user's recommendation is based on Knowledge, Skills, Behavior and interactions, as show in equation 1.

Users Recommendation = F (k,s,b,i) (1)

3.2 Domain ontology

The domain ontology is a crucial element for the good functioning of our recommendation system, in fact, It is based on this ontology that we can make connection between the object or concept of the request, and knowledge mastered by the recommended learner, Also this will allow us to deduce new knowledge mastered by a learner, without being already mentioned on his profile, Chaput Brigitte[8] presents an application ontology for "Applied Mathematics" module, the purpose of their modeling is to organize the notions and concepts regarding this module.

In general, the domain ontology consists of two components:

- A general ontology which consists of various general concepts in a given formation.
- A specific ontology to each course, which consists of specific notions and concepts related to this course ; in this paper, we decided to realize an ontology for Computer science course.

Computer science is a very generic and very rich area, new knowledge constantly appear, making modeling very complex task, and will always be subject to change and update according to the appearance of new concepts, However, the general organization is almost constant.

In this paper we adopt the computer science curriculum 2013 "computer science curricula 2013"[9] as the reference of our ontology, CS2013 is a report approved by the Association for Computing Machinery (ACM) and IEEE Computer Society. It is organized into a set of knowledge domains, each of which is composed of several elements and so on, there are 18 knowledge domains (Table 1), and more than 200 keywords corresponding to the thematic domains of study in Computing.

Table 1: Computer Science knowledge areas.

Knowledge Areas	Knowledge Areas
Algorithms and complexity	Networking and Communication
Architecture and Organisation	Operating Systems
Computational Science	Platform-based Development
Discrete Structures	Parallel and Distributed Computing
Graphics and visual computing	Programming language
Human-Computer Interaction	Software Development Fundamentals
Security and information assurance	Software Engineering
Information Management	Systems Fundamentals
Intelligent Systems	Social and Professional issues

We use "Protégé 5" to edit CS ontology as shown in figure 2, there are four level, and more than 250 terms, which should reflects the very fine knowledge of learners.

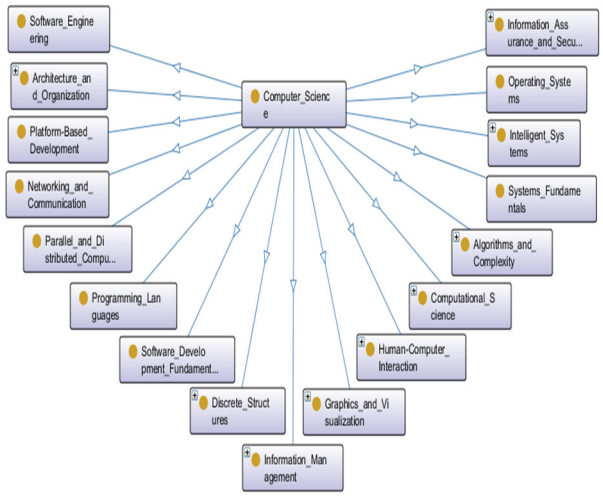

Figure 2. Computer Science ontology

3.3 Deduction of knowledge and inference engine:

Artificial intelligence allows to use a computer smartly, by facilitating communication between man and machine, and making best use of the processing power; One of the major areas of IA is the design of expert systems that are designed to meet the intelligence and performance of human experts in limited areas by exploiting a set of knowledge acquired essentially from these experts, reasoning on this knowledge requires adequate representation of such knowledge, and production rules of the form: IF condition THEN conclusion, these rules are exploited by an inference engine to produce new knowledge, this process is called inference[10].

In education field, most of notions or concepts, are composed of several concepts which are not derived from the same domain, for example we use proper mathematical concepts or sometimes physical in computer science, whence the need to design inference rules to judge some profiles able to intervene and give support about a topic, even if this particular topic is not mentioned on their profiles as a knowledge mastered, but based on the that these profiles have mastered the concepts needed to assume this concept, for example, a learner who masters the development language Java, at the same time, he has advanced concepts on network, thus our inference engine must determine that this learner is able to intervene on the subject of networks programming in Java or Socket, even in the absence of these two concepts on his profile, while a traditional user's recommendation system will not make that link.

3.4 Profiles filtering and SPARQL query:

The ontological presentation of learners profile and domain greatly facilitates filtering and localization of users mastering the desired theme, Several tools are available for this purpose, including SPARQL[11], a query language and a protocol to deal with RDF data available on a given network, it is derived from SQL, and they have many similarities, the major difference is that with SQL, we access data from a database,

whereas SPARQL gives access to all data on the web, this feature will open up the horizon to make this profile filtering technique, operating not only in a local E-learning platform, but on the global level.

4 Operating Modes

User's recommendation system operates in two modes, a simple mode, through which a query in SPARQL language browse the learners profiles and returns the users mastering the required knowledge, in the case where the system finds no Profile corresponding to the search terms, the system switches to the second mode; Intelligent mode, in which the reasoning engine is used to produce new knowledge, inference mechanism, after that a SNAP-SPARQL query is executed, this one allows to return not only the entered information but also the inferred one ; Result of the inference.

4.1 Simple query :

In the case of a simple query, the user requests assistance on a given subject, user's recommendation system sends a SPARQL query to the OMS, the result of this query is a list of users who master the subject in question, The user's recommendation system classifies returned profiles according to skills, interaction and behavior, then returns the list of sorted learners who can give support.

4.2 Intelligent query :

The simple query cannot always yield to satisfactory results, sometimes the requested theme is not written on any learner's profile, In this case the inference engine are used, and thanks to inference rules it deduces new inferred knowledge.

Unlike SPARQL, Snap-SPARQL[12] allows us to return the inferred information, which is in our case, inferred list of learners mastering the theme in question. Then the system proceeds to the classification of this list and returns it to the learner.

4.3 Multi-mode :

User's recommendation system operates in multimode, even if the two modes are asynchronous, firstly the system browse the profiles, And if this search returns no profile, inference engine are used, this transition is done by a test, which takes as argument the result of the first query.

5 Conclusion

Recommendation of learner profile who can provide assistance in case of difficulty to understand a concept or solve a problem, is one of the issues that has not been solved yet in E-learning systems, the student has no clear vision on his colleagues skills or knowledge, and even with all the information on the learners profiles, the process remains incomplete, since it often needs to add a human reasoning to find the right profile.

Our work proposes a new approach that meets this need by leveraging artificial intelligence that revolutionizes most areas, particularly E-learning.

This preliminary work has helped to design a general architecture of our profiles recommendation system, which will be completed by the conception of inference rules.

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